Towards climate-smart sustainable management of agricultural soils

SCALE

Managing Sediment Connectivity in Agricultural Landscapes for reducing water Erosion impacts

Deliverable WP5-D5

Report with compilation of policy documents

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1 Introduction

Soil erosion mitigation strategies include both field-scale measures to reduce on-site damages and measures targeting sediment connectivity at catchment scale to minimise off-site damages. Suitable mitigation measures should be implemented considering the available technology, local conditions (e.g. soil, climate, crops, farm type) and the location in the landscape. We investigated the selection of the optimal mitigation strategies based on a participatory evaluation method which consider both these technical aspects, and economic as well as social barriers for their implementation.

This should equip policy makers in different EU member states with better tools to implement cost-effective mitigation measures and to communicate with land managers. An increased understanding of erosion risk and the associated impacts in their specific agricultural landscape by farmers, consultants and regulatory bodies will help raise the acceptance of regulation among stakeholders and to devise targeted mitigation strategies.

This deliverable compiles the knowledge acquired within the EJP SOIL project SCALE and its work package 5 (WP5) on mitigation measures and decision support framework for stakeholders and identifies opportunities, challenges and specific technical and administrative needs. A policy brief which was produced for the EJP SOIL based on the outcomes of the SCALE project WP1, which complements some of the identified opportunities, challenges and needs found in WP5 is also included in this report as an appendix.

2 Identified opportunities

The WP5 tasks have provided substantial insights into opportunities for improved erosion mitigation and connectivity management. This work package was designed to build on the knowledge accumulated from previous work packages and offer decision support to users of soil erosion models, practitioners, and policymakers concerning the implementation of soil erosion mitigation measures at the local level. This included the description of selected agricultural catchments within project partner countries, identifying erosion problems, modelling efforts, and evaluating socio-economic barriers to implementing mitigation measures through local cost estimations and stakeholder consultations.

From the findings of WP5, several opportunities for enhanced erosion mitigation and connectivity management have emerged:

Comprehensive Catchment Cataloguing: The creation of a catalogue of 14 agricultural catchments across 8 European countries provided a representative sample of the diverse erosion issues and sediment connectivity problems in the EU. This detailed cataloguing helps in understanding the specific types of erosion (e.g., inter-rill, rill, gully erosion) prevalent in various catchments and offers a basis for tailored mitigation strategies.

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Economic Evaluation of Mitigation Measures: The report on the local costs of different mitigation measures revealed that farmers' willingness to adopt erosion control measures (ECMs) is significantly influenced by the economic viability of these measures. By using CAP subsidies as a proxy for implementation costs, the study identified variations in subsidy amounts and highlighted the need for more accurate, locally-based cost assessments to ensure effective financial support and higher adoption rates among farmers.

Stakeholder Engagement and Participatory Approaches: Focus group meetings with local stakeholders, particularly farmers, provided valuable insights into the social and economic barriers to implementing erosion control measures. These meetings underscored the importance of involving farmers in the decision-making process, as their practical knowledge and experience are crucial for identifying feasible and effective mitigation strategies. The participatory approach helps bridge the gap between scientific models and on-the-ground realities, ensuring that proposed measures are practical and well-received.

Guidelines for Localised Implementation: The development of guidelines tailored to local conditions offers a pragmatic framework for practitioners and decision-makers. These guidelines, which include a catalogue of mitigation measures and strategies for enhancing sediment connectivity management, are based on a thorough evaluation of erosion simulation models and participatory feedback. This ensures that the guidelines are both scientifically robust and locally applicable.

Integrated Modelling and Practical Insights: The integration of erosion simulation models with practical insights from farmers allows for a more comprehensive evaluation of potential mitigation measures. This combination of technical and local knowledge helps in assessing the performance, economic viability, and perceived benefits of various measures, facilitating better-informed decision-making and more effective erosion control.

3 Main challenges

Even though the issues of soil erosion and the problems it causes both on-site and off-site in agricultural landscapes are recognised, it can be challenging to select the appropriate erosion control measures in mitigation planning. In addition, some barriers to improved erosion mitigation and connectivity management are still present within the decision-making process:

Accuracy of Soil Erosion Assessments: Soil erosion models can only produce good estimations of soil erosion risk if the input data, parameterisation and modelling procedure is of high quality. In some cases, the inherent uncertainties of the modelling procedure as well as a lack of high-quality data at the specific scale needed may affect the overall accuracy of the soil erosion assessment. In addition, land managers often distrust the soil erosion assessments based on erosion models their resulting erosion risk maps. In general, farmers possess a good knowledge of the erosion problem on their farms, and the accuracy of the models and maps was often perceived as low on the individual farm. Farmers were also found to be apprehensive towards model outputs, in case inaccurate model assessments may result in excessive focus

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from authorities on their farm, in the form of regulatory restrictions or loss of subsidies. Instead, most farmers would advocate for more intensive field monitoring to obtain reliable and accurate data for specific farms.

Differing Stakeholder Perceptions: Different stakeholder groups may have varying views on the severity of soil erosion in the same area and which measures should be taken to address the issue. If all relevant stakeholders are not involved in the decision-making process for mitigation planning this could exacerbate negative attitudes towards ECMs and hinder the implementation of targeted mitigation measures. By addressing the specific concerns and preferences of different stakeholder groups, more effective and widely accepted erosion control measures can be developed and implemented.

Subsidy Schemes and Administrative Processes: The findings indicate that while subsidies are a promising tool for encouraging the adoption of erosion control measures, there is a need to improve subsidy schemes and streamline administrative processes. Land managers see the administrative process and requirements of implementing erosion control measures as well as the (in their opinion) low incentive value of subsidies as a hinderance to the uptake of soil erosion mitigation. Simplifying these processes can reduce the burden on farmers and make it easier for them to access financial support for implementing sustainable land management practices.

4 Specific technical and administrative needs

To make the implementation of ECMs more attractive and make the proposed measures more efficient some technical and administrative aspects of the decision-making process should be improved:

Acknowledge Local Landscape Differences: The variation in landscapes and erosion issues across Europe, e.g. on-site vs. off-site issues, as well as appropriate ECMs for a specific location should be considered for tailored mitigation strategies at local scale.

Improve Accuracy of Soil Erosion Assessments: To increase the trust in and the use of soil erosion risk assessments based on modelling, the accuracy of soil erosion models should be improved with high quality data, enhanced parameterisation and modelling procedure, as well as further monitoring for calibration and validation purposes.

Increase focus on connectivity within the landscape in agricultural land management and policy planning: Models with increased focus on sediment connectivity throughout the landscape will improve the prediction capability of the soil erosion assessment and ensure targeted implementation of erosion control measures, which looks beyond the single-field perspective.

Develop Accurate, Locally-Based Cost Assessment of ECM Implementation: To encourage a higher adoption of ECMs among farmers it may be worthwhile to ensure effective financial

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support based on a detailed, local and realistic cost-benefit analysis of implementation of soil erosion control measures.

Improve Uptake of Mitigation Measures by Land Managers: A greater focus on what could improve the uptake of mitigation measures by farmers – i.e. awareness raising, peer-to-peer knowledge sharing (field days, etc.), and engaging stakeholders in the design and technical specifications of ECMs, may improve the participation in mitigation measure implementation.

5 Proposed framework for decision support

We suggest here a structured framework designed to assist practitioners and decision-makers in identifying, selecting, and implementing erosion control measures tailored to local conditions. The objective is to reduce both on-site and off-site erosion impacts and sediment transport at the agricultural landscape scale.

Selecting appropriate ECMs is crucial but challenging, requiring consideration of technical, economic, and social factors. Participatory evaluation methods are essential for fostering discussions and reaching agreements among stakeholders with diverse interests. Despite this, there remains a lack of guidance for selecting the most efficient ECMs, with few practical tools available for decision-makers and land managers.

The proposed framework leverages insights from previous SCALE tasks, guiding land managers and decision-makers to:

i. Detect prevalent erosion processes and assess associated risks.
ii. Evaluate various erosion control options, emphasising those supported by the CAP's National Strategy Plans.
iii. Provide criteria and tools for assessing and selecting ECMs.
iv. Develop erosion control management scenarios for stakeholder discussions and negotiations.

We present here the **Key Components of the Integrated Decision Framework (IDF):**

1. **Establishing Context and Goals**:
    - Identifying and characterising target catchments to define spatial context and boundaries for erosion control plans.
    - Conducting a public, participatory approach to incorporate various stakeholder perspectives.
    - Using criteria such as the extent and intensity of soil erosion processes and land use distribution to select target catchments.
2. **Soil Erosion Risk Assessment**:
    - Utilising soil erosion models like RUSLE, IC, SDR, and WaTEM/SEDEM to assess soil erosion risk.
    - Presenting risk assessments as erosion risk maps to facilitate stakeholder discussions.

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3. **Identifying Mitigation Measures**:
    - Compiling a list of potential ECMs from databases and catalogues of sustainable soil management practices.
    - Assessing practices through a participatory evaluation process, considering their technical, economic, and social feasibility.
    - Focusing on practices that reduce soil erosion losses and sediment delivery by enhancing landscape connectivity.
4. **Technical and Socio-Economic Evaluation**:
    - Using soil erosion models to technically evaluate ECMs.
    - Conducting a socio-economic assessment to understand the feasibility and acceptance of ECMs among farmers and stakeholders.
    - Considering CAP subsidies and local costs in the economic evaluation.
5. **Developing Management Scenarios**:
    - Integrating selected ECMs into soil erosion model simulations to create various management scenarios.
    - Using these scenarios to compare the baseline (or "as-is") scenario with different mitigation options.
    - Following a step-wise process to deploy erosion control management scenarios, building on outcomes from previous phases.
6. **Communicating Results**:
    - Effectively communicating results to diverse stakeholders, including farmers, land managers, technicians, and policy-makers.
    - Using clear formats (tables, graphs, maps) and addressing result uncertainty to build trust and facilitate the adoption of planned measures.

In conclusion, the proposed framework provides a comprehensive approach to managing soil erosion at the catchment level. By integrating technical, economic, and social evaluations and emphasising participatory methods, the framework aims to support the development and implementation of effective erosion control plans that are context-specific and widely accepted by stakeholders.

Overall, the WP5 tasks have demonstrated that a combination of scientific research, economic evaluation, and stakeholder engagement can lead to significant opportunities for improving erosion mitigation and connectivity management. By leveraging these insights, policymakers and practitioners can develop more effective, locally adapted strategies that promote sustainable land management and soil conservation across diverse agricultural landscapes.

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Appendix

Appended is the EJP SOIL policy brief entitled *"From Risk to Resilience: Policy challenges for Soil Erosion Control"* based on the outcomes of SCALE WP1 written by Schmaltz & Johannsen (2024).

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EJP SOIL SCALE

Policy Brief

MAY, 2024

From Risk to Resilience: Policy challenges for Soil Erosion Control

Elmar M. Schmaltz, Lisbeth L. Johannsen

- Water-induced soil erosion is a growing concern in the EU, with climate change projections indicating a potential 13-23 % rise in erosion rates.
- The variability of soil erosion modelling techniques highlights the need for standardisation of data sets and harmonisation of model parameterisation to allow valid comparisons of policy measures.
- The Common Agricultural Policy (CAP) has a limited effect in decreasing erosion risk, as the voluntary measures are often not well targeted to the identified erosion-prone areas.
- Policymakers should advocate for targeted erosion mitigation measures and elaborate more appropriate assessment protocols including sediment connectivity modelling to improve accuracy in erosion risk assessments.

INTRODUCTION

Water-induced soil erosion presents a growing concern within the European Union, posing numerous challenges to soil health, agricultural sustainability, and water quality. Although typically associated with southern and central European regions, recent studies have identified unforeseen vulnerabilities in the north. Climate change projections by the European Commission's Joint Research Centre (JRC) imply an urgent need to address soil erosion, with indications showing a potential 13-23% rise in erosion rates by 2050. This policy brief is a result of the EJP SOIL SCALE project, that seeks to unravel the complexities of water erosion on farmland and its off-site impacts. Specifically examined is the effectiveness of erosion risk management measures implemented in the national CAP strategic plans (2023-27), aiming to facilitate informed policy-making for the diverse European landscapes and to address discrepancies between various methodologies for erosion risk zonation by modelling.

The challenge of soil erosion centres on connectivity and highlights the impact of landscape elements on the transport of water and sediment during hydrological events.

The regulatory framework of the CAP and Water Framework Directive (WFD) require member states to integrate measures to reduce soil erosion into their national policies. Soil erosion risk maps, acquired through a range of modelling techniques, are essential instruments for policymakers to pinpoint high-priority zones and design specific measures.

Empirical, process-based and hybrid models constitute the variety of modelling methods available. Clear comprehension of these modelling techniques is crucial in light of the varied outcomes and importance of these models. The variability in the incorporation of landscape aspects and mitigation measures in these models presents a challenge to meaningful comparisons and underscores the necessity for a comprehensive appreciation of their

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implementation throughout the European Union.

Sediment Connectivity and Mitigation Measures in National Legal Standards

Mandatory regulations that address soil erosion mitigation and sediment connectivity are rare beyond the Good Agricultural and Environmental Conditions (GAECs) standards of the CAP, such as those implementing buffer strips (GAEC 4), erosion control (GAEC 5), and minimum soil cover (GAEC 6). Although GAEC 5 presents an opportunity for land users to address erosion, the effectiveness of these efforts rests on accurately targeting erosion-prone areas. GAEC standards and voluntary measures vary significantly between countries and disparities in national regulations are reflected by the different techniques used to zonate soil erosion risk areas (e.g. modelling or expert knowledge). There is a scarcity of voluntary measures specifically designed to mitigate erosion risk, and often they lack targeting to identified erosion-prone areas. Long-term solutions, such as adapting land use, are not frequently implemented. Some measures funded under voluntary schemes, though not explicitly designed for erosion risk, may have an impact, but their effectiveness requires targeted application to identified risk areas or specific offsite problems (e.g. sediment input into water courses).

The introduction of the GAECs has had a modest impact on reducing erosion risk, with a noted 20 % reduction in overall soil loss for arable lands (JRC). The voluntary measures pose difficulties on account of their inherent non-compulsory nature. This underlines the need for policy interventions aimed at the 4 million hectares of arable land experiencing soil loss rates exceeding 5 tonnes per hectare per year, presently disregarded in the CAP policy. The new CAP period of 2023-27 builds upon greening obligations, agri-environmental and climate commitments from Pillar 2. However, its efficacy in mitigating soil erosion by water remains uncertain.

Figure 1: Example for sediment (dis-)connectivity at a parcel border. / © Elmar M. Schmaltz

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Key messages for Policy Makers

Recommendation One: Harmonisation and Standardisation

Harmonisation of datasets and parameterisation across erosion models to facilitate consistent soil erosion assessments and improve the efficiency of management requirements.

Recommendation Two: Targeted Erosion Mitigation Measures

Erosion mitigation measures ought to be applied specifically in areas exhibiting a heightened risk of erosion. It is important to enhance effectiveness by more firmly promoting voluntary measures in these risk areas, and, where needed, instituting mandatory measures in a more focused manner.

Recommendation Three: Enhanced Sediment Connectivity Modelling

Sediment connectivity ought to be a principal consideration when modelling erosion risks, particularly when utilising erosion risk maps for policy or planning purposes. It is typically recommended that validation of these maps is undertaken through the use of empirical data and threshold values from these maps should be tailored to meet regional conditions. This approach enhances the reliability and comparability of policy-relevant soil erosion risk maps.

Sediment Connectivity and Mitigation Measures in Soil Erosion Models

The Universal Soil Loss Equation (USLE) and its variations are by far the most widely used to produce policy-relevant soil erosion maps. Other models are used for planning or advising farmers, such as process-based models, expert judgement/decision tree models and qualitative models. These applications, which are geared towards different problem-solving levels and objectives, particularly in politics, research or consulting, require different levels of high-resolution initial data to calculate the erosion risk and are only applicable and effective at very different spatial scales. The ability to take mitigation methods or sediment connectivity into account also differs greatly between the models.

In order to improve the assessment of erosion risk and targeted mitigation measures, it will be necessary to continue to integrate sediment connectivity and mitigation measures particularly in large-scale modelling approaches and to develop solutions that contribute to a better understanding of the erosion and sediment transport mechanism. The SCALE project report emphasises the importance of reviewing erosion risk maps for policy using empirical data.

Hence, the use of various soil erosion models highlights the crucial necessity for harmonisation and standardisation of datasets and parameterisation approaches. By doing so, not only shall a uniform assessment of soil erosion be guaranteed, but also comparability and resolution of discrepancies arising due to disparate requirements of these risk maps.

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Improving Policy Support

To strengthen policy initiatives aimed at tackling soil erosion within the European Union, there should be a focus on harmonisation in soil erosion modelling practices, with an emphasis on consistent parameterisation and dataset utilisation to improve the comparability of model predictions across diverse landscapes within Europe.

To enhance the efficacy of policy interventions, it is necessary to implement targeted mitigation strategies specifically designed for identified erosion-prone zones. This process will optimise the efficiency of interventions and enhance the impact of policy measures. Greater focus should also be placed on modelling sediment connectivity in agricultural landscapes to improve the understanding of the effects of landscape components on connectivity, so that policies can be better tailored to reduce erosion hazards.

Ensuring empirical validation of erosion risk maps is vital for credible policy decision-making. In-field measured data must be used to verify their accuracy and reliability. Policy guidelines and thresholds must be tailored to regional circumstances to establish a reliable foundation for policy-making, taking into account the heterogeneity of European landscapes that requires adapting erosion risk management strategies to specific environmental conditions. Additionally, encouraging changes in land use practices, where feasible, can guarantee sustainable soil protection beyond immediate mitigation measures.

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