CREW CENTRE OF EXPERTISE FOR WATERS

Assessing the socio-economic impacts of soil degradation on Scotland's water environment

Policy Brief

Nikki Baggaley, Fiona Fraser, Paul Hallett, Mohamed Jabloun, Allan Lilly, Kenneth Loades, Thomas Parker, Mike Rivington, Zulin Zhang, Michaela Roberts

The James Hutton Institute
SRUC
1495 UNIVERSITY OF ABERDEEN
Scottish Government gov.scot

CREW CENTRE OF EXPERTISE FOR WATERS

Recommendations

- **Soil compaction alone already costs farmers more than £25 million per year due to yield loss and additional fuel use. The cost of worsening compaction could exceed £70 million at the farm gate, without considering more inefficient fertiliser use on compacted soils. The overall costs of soil degradation to the wider Scottish economy are far greater due to impacts from erosion, flooding, contamination, biodiversity loss and greenhouse gas production.**
- **Further work on soil monitoring is required to improve an assessment of both impacts and costs.**
- **The impacts of sealing and flooding on flood extent and intensity should be assessed in combination with the range of nature-based solutions for flood mitigation.**
- **Improved linking of biophysical, socio-economic policy and research relating to soil degradation would improve modelling of impacts and deliver stronger evidence to support adaptive and agile policy development.**
- **A framework is required that links the impacts and costs of the degradation of peat and peaty soils and soils across a wider range of land uses other than those from cultivated land.**

Background

Healthy soils underpin and cut across many policy areas including parts of the Scottish National Adaptation Plan (2024–2029) and the Scottish Biodiversity Strategy. Scotland's soils are vulnerable to degradation and, as demonstrated in a previous study on the cost of erosion in Scotland (Rickson et al., 2019), their degradation incurs large costs to the Scottish economy. Protecting and managing soils as a valuable national asset is essential for agricultural production, managing water flows and maintaining good water quality.

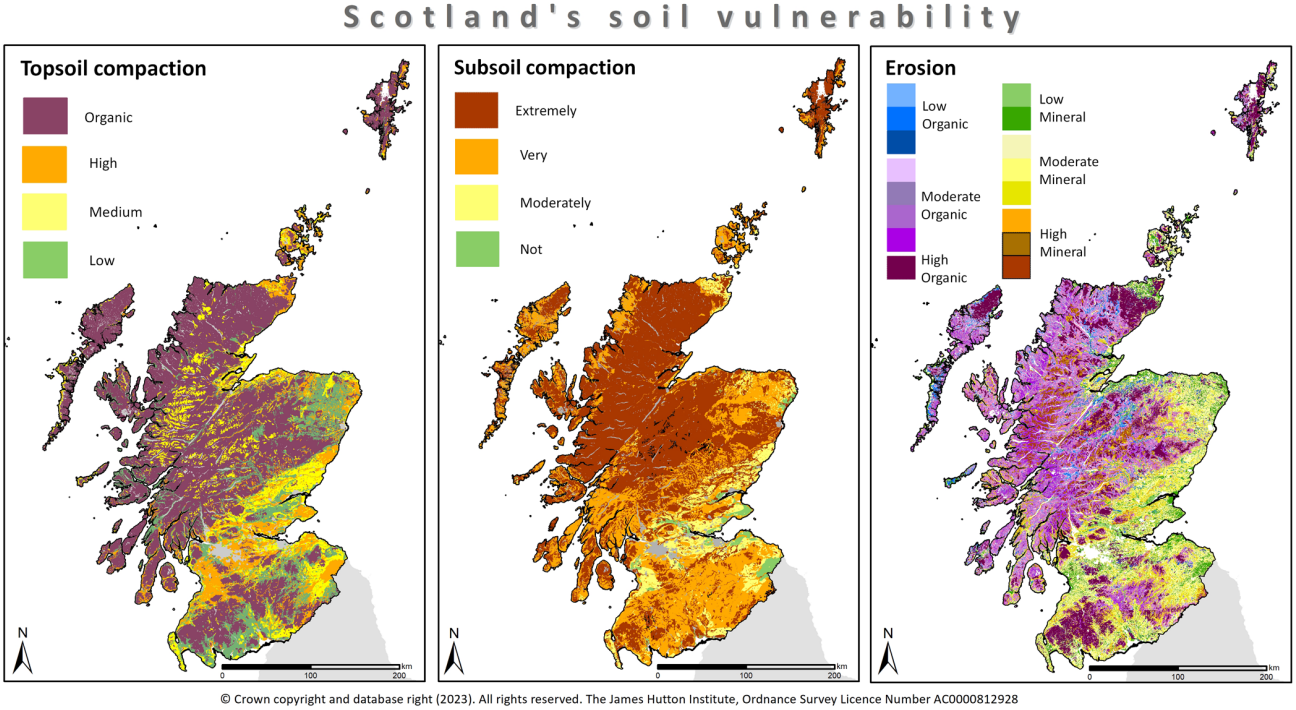

Figure 1 Topsoil (Left), Subsoil compaction (Centre), Erosion vulnerability (Right) (Baggaley et. al., 2020) from National Soil map of Scotland (Soil Survey of Scotland Staff, 1981).

Key Findings

- Building on existing data, we estimated the extent of soil compaction in Scotland which shows that 26% of cultivated topsoils are compacted.
- The compaction of soils leads to a loss of between £16 million and £49 million per year in crop yields alone. Input costs (e.g., fuel, fertilisers) are also higher for compacted soils with potential fuel use increasing between £9 million and £26 million per year without considering the impacts and costs from additional GHG emissions.
- Surface runoff increases in areas with compacted soils. The additional runoff associated with compaction in studied catchments was estimated to be between 0.2% and 7.8%.
- Minimising soil sealing (covering with an impermeable surface) for the protection of ecosystem services such as agricultural production, biodiversity, carbon storage, and flood protection are key elements of the National Planning Framework 4. In a small test catchment, we have shown that a 1% increase in sealed area over the last 15 years resulted in an increase in runoff of 1.5% (Baggaley et al., 2024).
- The combination of compaction and sealing could lead to a 1% increase in the flood area or intensity which would be a cost of £2.6 million for local authorities, and each affected home claiming an average £57,000 to £76,000 in insurance per flood event (Baggaley et al., 2024).
- Additional compaction-associated runoff is likely to increase the export of sediments and pollutants to rivers through increasing soil erosion and adding to the previous estimates of the cost of soil erosion.
- Costs of soil contamination could not be estimated due to limited data on its extent. However, contamination will impact water and food quality, as well as potentially cause damage to human health and ultimately the loss of productive land. There are likely to be yet unknown impacts from contaminants of emerging concern such as microplastics.
- All soil degradation leads to changes in soil biodiversity and the impacts of this is unknown. Changes will likely add to the impacts and costs but are inestimable due to lack of coordinated data collection and collation.

Implications for policy

- An integrated soils policy is required to protect Scotland's soils as they underpin Scotland's National Adaptation Plan, Scottish Biodiversity Strategy, River Basin Management Plan for Scotland 2021-2027, Scotland's Third Land Use Strategy 2021-2026, Scotland's National Planning Framework 4.
- Including soil measures within the agricultural reform bill should support prevention and mitigation of compaction, therefore forming a key part of flood mitigation and water quality protection.
- The impact of soil sealing on runoff should be explicitly considered as part of the National Planning Framework 4.
- The impacts and costs of degrading peatlands and peaty soils and land uses other than agriculture such as forestry should be integrated into a single framework with the combined impacts on water bodies assessed.
- Improving national scale monitoring and collation of soils data will provide additional evidence to link the impacts from soil compaction, soil biodiversity, soil contamination and soil erosion. This should also include an assessment of subsoil compaction as recommended by the draft EU Soil Monitoring and Resilience Directive.
- The impacts of soil degradation are likely to both contribute to and be exacerbated by climate change, particularly the predicted increase in spring droughts and extreme rainfall events. Both the management and monitoring of soils is becoming increasingly important and forms a key part of flood mitigation and water quality protection as well as helping agriculture to be more resilient.

Contributors

Nikki Baggaley

Nikki is a Soil Scientist researching soil health and monitoring through spatial and temporal analysis of large scale soils data sets. She leads SRP underpinning National Capacity for soils and related environmental data, which includes the translation of soils data into tools for land managers, agencies and policy.

Nikki Baggaley@hutton.ac.uk

Michaela Roberts

Michaela is an environmental economist, whose work focuses on cost-benefits analysis of environmental management and policy. Her work foscuses on building links between biophysical and socio-economic data.

Michaela.roberts@hutton.ac.uk

Allan Lilly

Allan is a soil scientist with more than 40 years experience in soil survey, soil mapping and biophysical resourse analyses.

Allan.Lilly@hutton.ac.uk

Kenneth Loades

Kenneth is a soil physicist researching soil management to improve ecosystem services and function. He is also active in the development, and validation of soil health indicators, and a knowledge broker for soils and crops within the Scottish Environment, Food and Agriculture Research Institutions (SEFARI) Gateway.

Kenneth.Loades@hutton.ac.uk

Thomas Parker

Thomas is a soil and ecosystem ecologist with primary interests in upland and peatland soil processes. Thomas links plant and soil interactions following land cover change to greenhouse gas fluxes and the wider carbon cycle.

Thomas.parker@hutton.ac.uk

Contributors

Fiona Fraser

Fiona is a soil scientist, her work focuses on soil health and nutrient cycling and how the resilience of these processes is driven by soil biology.

fiona.fraser@sruc.ac.uk

Mike Rivington

Mike's research focuses on how climate change impacts land use, Natural Capital assets and ecosystem services and how mitigation and adaptation options can be developed. He uses crop simulation models, mapping agrometeorological indicators, Land Capability for Agriculture combined with climate model projections to visualise the future.

Mike.Rivington@hutton.ac.uk

Mohamed Jabloun

Mohamed has a range of research interests and experience in crop modelling and remote sensing. He has specific research interests in spatial modelling of soil water processes, crop growth and agrometeorology in the context of climate change impacts and adaptation.

Mohamed.Jabloun@hutton.ac.uk

Zulin Zhang

Zulin is an environmental chemist. His work is mainly on the environmental monitoring, fate and transport, risk assessment and sustainable removal of micropollutants, particularly of emerging contaminants in the water and soil environment.

Zulin.Zhang@hutton.ac.uk

Prof. Paul Hallett

Professor Paul Hallett is a Soil Physicist at the University of Aberdeen. His research explores solutions to food and environmental security, focussed on the interactions between plants, microorganisms and the physical behaviour of soil. He has authored over 180 refereed papers and is President-Elect of the British Society of Soil Science.

Paul.Hallett@abdn.ac.uk

CREW CENTRE OF EXPERTISE FOR WATERS

Published by CREW – Scotland's Centre of Expertise for Waters. CREW connects research and policy, delivering objective and robust research and expert opinion to support the development and implementation of water policy in Scotland. CREW is a partnership between the James Hutton Institute and all Scottish Higher Education Institutes. The Centre is funded by the Scottish Government.

This document was produced by:
Nikki Baggaley[1], Fiona Fraser[2], Paul Hallett[3], Allan Lilly[1], Mohamed Jabloun[1], Kenneth Loades[4], Thomas Parker[1], Mike Rivington[1], Zulin Zhang[1], Michaela Roberts[1]

[1]James Hutton Institute, Aberdeen [2]Scottish Rural College (SRUC), Aberdeen
[3]University of Aberdeen, [4]James Hutton Institute, Dundee

CREW Project Manager: Maureen Whalen

Please reference this policy brief as follows:
Nikki Baggaley, Fiona Fraser, Paul Hallett, Allan Lilly, Mohamed Jabloun, Kenneth Loades, Thomas Parker, Mike Rivington, Zulin Zhang, Michaela Roberts (2024)
Assessing the socio-economic impacts of soil degradation on Scotland's water environment Policy Brief. CRW2022_04. Centre of Expertise for Waters (CREW).

Available online at: crew.ac.uk/publication/socio-economic-impacts-soil-degradation

ISBN: 978-1-911706-27-4

Dissemination status: Unrestricted

Cover photographs courtesy of: Nikki Baggaley.

CREW CENTRE OF EXPERTISE FOR WATERS

Centre of Expertise for Waters

James Hutton Institute
Craigiebuckler
Aberdeen AB15 8QH
Scotland UK

www.crew.ac.uk

CREW publications can be accessed here:
www.crew.ac.uk/publications

@crew_waters CREW-scotland

CREW is a partnership between the James Hutton Institute
and all Scottish Higher Education Institutes and Research Institutes.
The Centre is funded by the Scottish Government.

Scottish Government
Riaghaltas na h-Alba
gov.scot