Estimating soil erosion rates from an intensive agricultural catchment

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Introduction

- Intensive agriculture has been frequently suggested to increase soil erosion risk due to extended periods of bare soils which can be exposed to erosive processes.
- Measurement of soil erosion is challenging as erosion events are predominantly episodic and vary in magnitude across the catchment according to soil texture, field slope, erosion mechanisms and soil drainage class.
- Field scale soil erosion assessments have been made using the radionuclide caesium-137 to calculate a medium-term ~50 year estimate of soil loss.
- This methodology was applied to an intensive arable catchment in south-east Ireland.

Fig. 1 Intensive agricultural catchment.

Fig. 2 Eroded soil (sediment) from an arable field.

Method

- Caesium-137 (Cs-137) is a radioactive tracer which was projected into the atmosphere following atomic bomb testing and the nuclear accidents around the 1960s. This was circulated around the world and deposited from the atmosphere onto the surface of soils.
- Since deposition, Cs-137 has been potentially redistributed through water– wind– and physical– redistribution (Fig. 3).
- The concentration of Cs-137 is measured using a gamma spectrometer using the half-life of radioactive decay (Fig. 4).
- Measuring the concentration of Cs-137 at multiple locations within a field can indicate soil redistribution.
- These concentrations are compared to a non-impacted location (no redistribution) to indicate total soil loss since initial deposition.

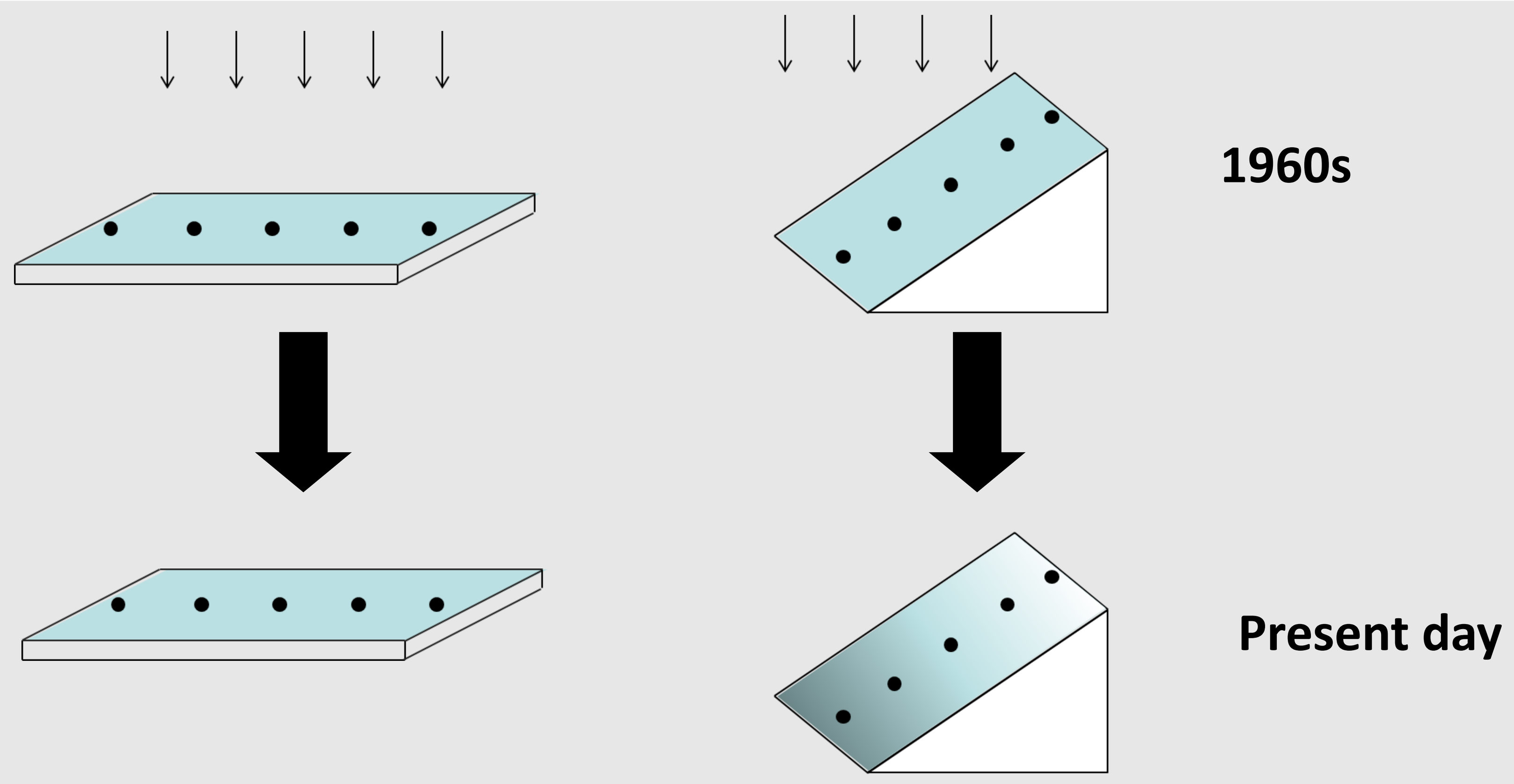

Fig. 3 Schematic use of Cs-137 for soil erosion assessment.

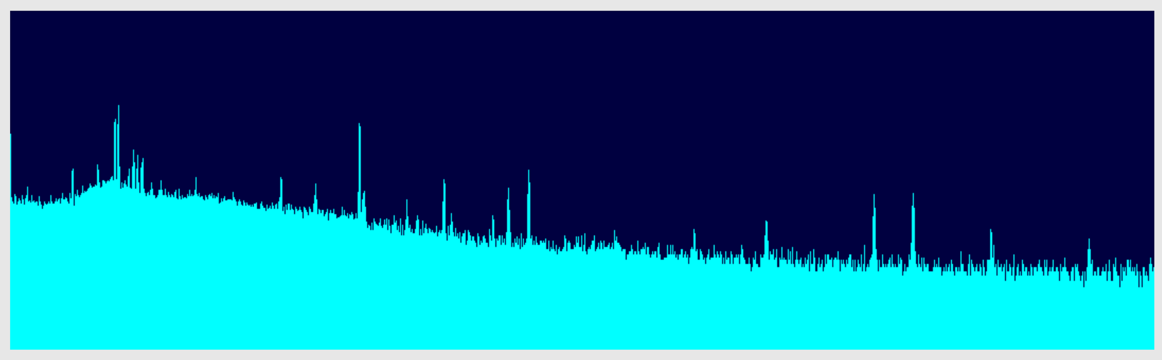

Fig. 4a (above) Output of gamma spectrometer.

Fig 4b. (right) Gamma spectrometer.

Application

- The catchment fields were categorised according to average slope as determined by 2m resolution LiDAR data (Fig. 5).
- Within each category fields were separated into grass or arable land use and five fields selected from each to be sampled for Cs-137.
- Within a field, five locations moving downslope were selected to take samples .
- At each sampling location three cores were taken to the maximum depth of the corer (~55cm) or to the maximum soil depth using a pneumatic soil auger and composited (Fig. 6). This is greater than the plough depth, therefore, captures all Cs-137 within the soil profile.
- Samples were dried and sieved to 2 mm for analysis
- Two reference sites were sampled where soil distribution was assumed negligible, here nine

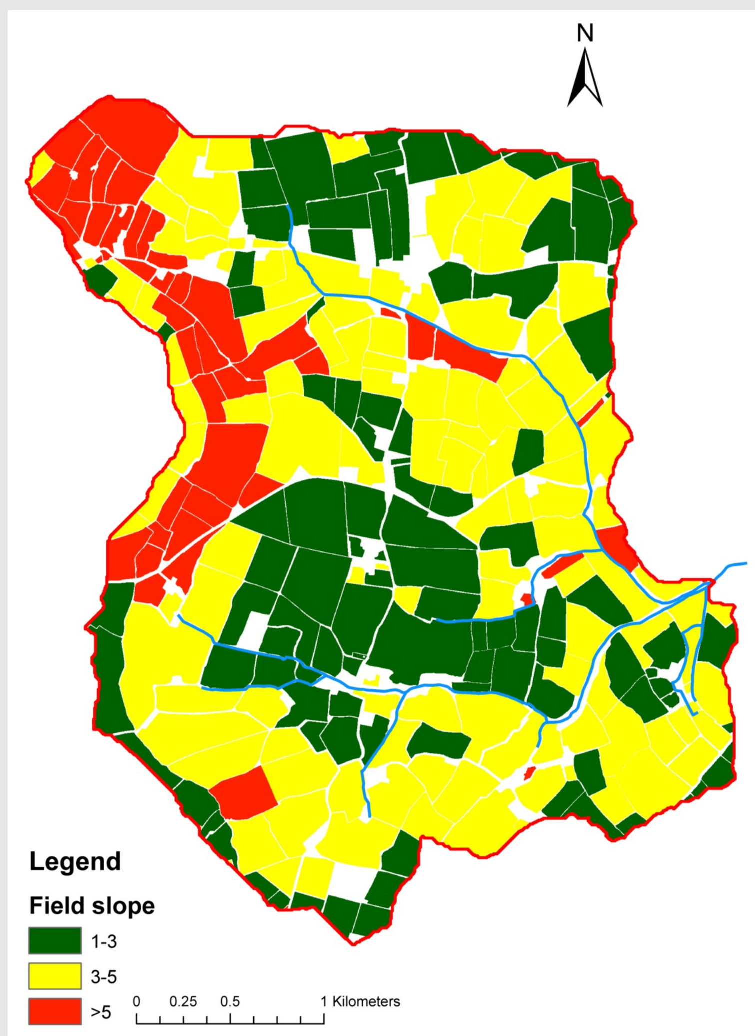

Fig. 5 (left) Division of catchment fields according to average slope.

Fig. 6 (below) Examples of collected sediment cores showing shallow soils (below left) and a full core (below right).

Discussion

- Soil loss is a key management concern and techniques such as Cs-137 offer a useful tool to assess soil loss rates.
- Measurement of fields with different slopes and land use enables a better understanding of the mechanisms underlying soil loss and the impact of these on loss rates; development of such understanding will inform cost-effective soil and sediment management.
- Average annual soil loss rates can be compared to sediment export to estimate the sediment delivery ratio of the catchment.

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