



Application of the Landsoil model to simulate water and tillage erosion in an intensively farmed landscape submitted to land consolidation with contrasting soil types

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Sébastien Salvador-Blanes, E. Halais, Benjamin Gaudubert, Joël J. Daroussin, Florent Hinschberger, et al.. Application of the Landsoil model to simulate water and tillage erosion in an intensively farmed landscape submitted to land consolidation with contrasting soil types. 4. International Congress Eurosoil 2012 - Soil Science for the Benefit of Mankind and Environment, Jul 2012, Bari, Italy. 2012. hal-02809227

HAL Id: hal-02809227

<https://hal.inrae.fr/hal-02809227>

Submitted on 6 Jun 2020

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INTRODUCTION AND AIMS

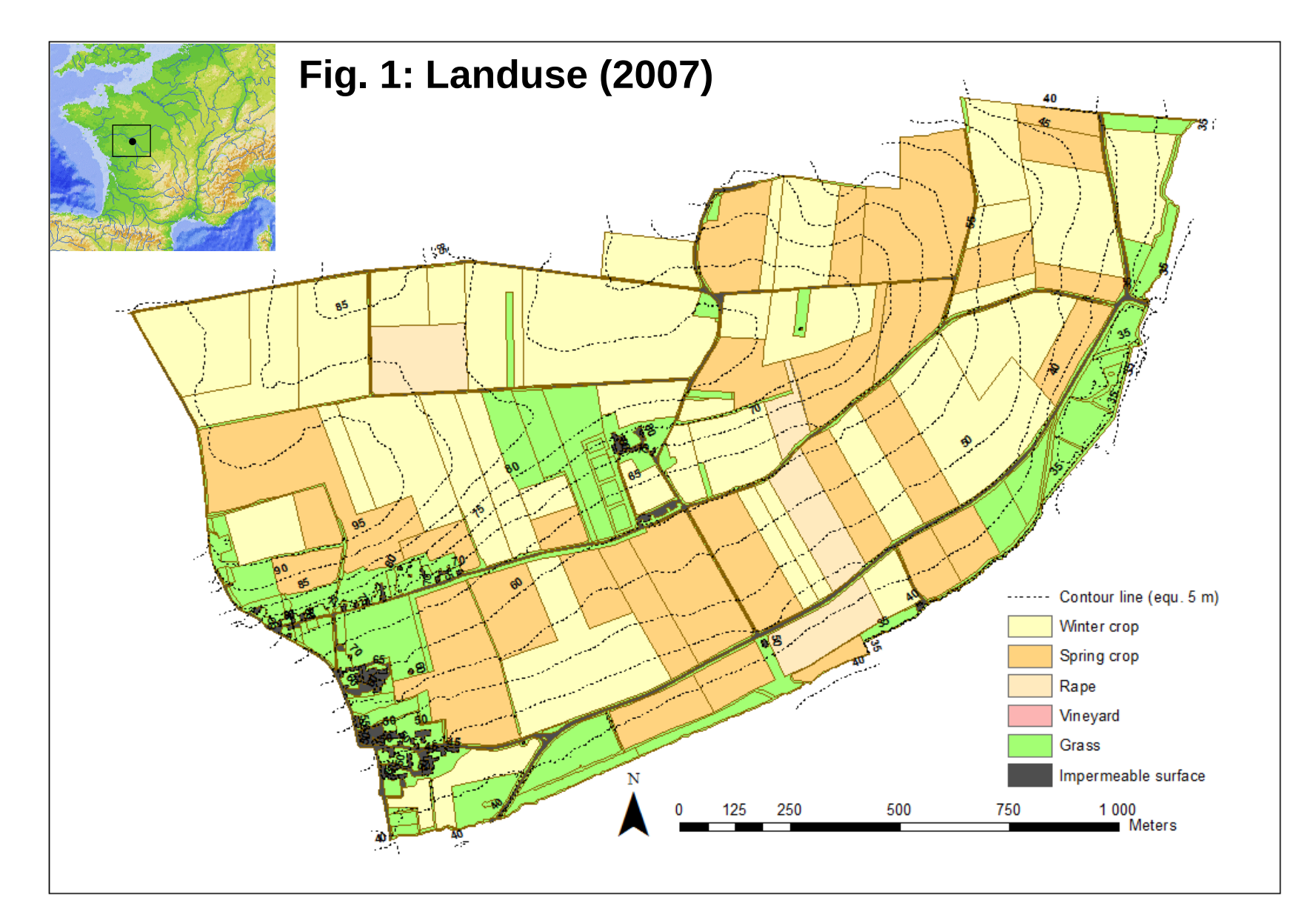
Soil erosion processes have increased through the last decades in particular through land consolidation. Water and tillage erosion processes have been extensively studied and modeled at various time and space scales. The recently developed Landsoil model (Ciampalini *et al.*, in press), partly based on the STREAM model (Cerdan *et al.*, 2002) is the first expert model to spatially simulate both water and tillage erosion at the event scale.

We apply it here for the period 2010-2100 to an intensively farmed area in temperate climate, where two contrasting soil types are observed. The aim is to quantify the effect of water and tillage erosion on morphogenesis over a century.

STUDY AREA

Seuilly (Loire valley), NW France

- 240 ha, elev. 30-100 m, SE facing slope 0-25%.
- Climate: oceanic, 615 mm rain evenly distributed throughout the year.
- Geology: quaternary loess on the plateau, cretaceous chalks on the slopes and fluvial deposits.
- Soil types: clayey Calcaric Cambisols on the slopes, loamy Cambisols on the plateau.
- Landuse (Fig. 1): winter and spring crops (85%, cereals and oilseeds). Land consolidation in 1967, 1982.



STRUCTURE OF THE MODEL

Each year between 2010-2100: water and tillage erosion processes simulated successively according to Figure 2. After each rainfall event or tillage operation, a new topography is calculated.

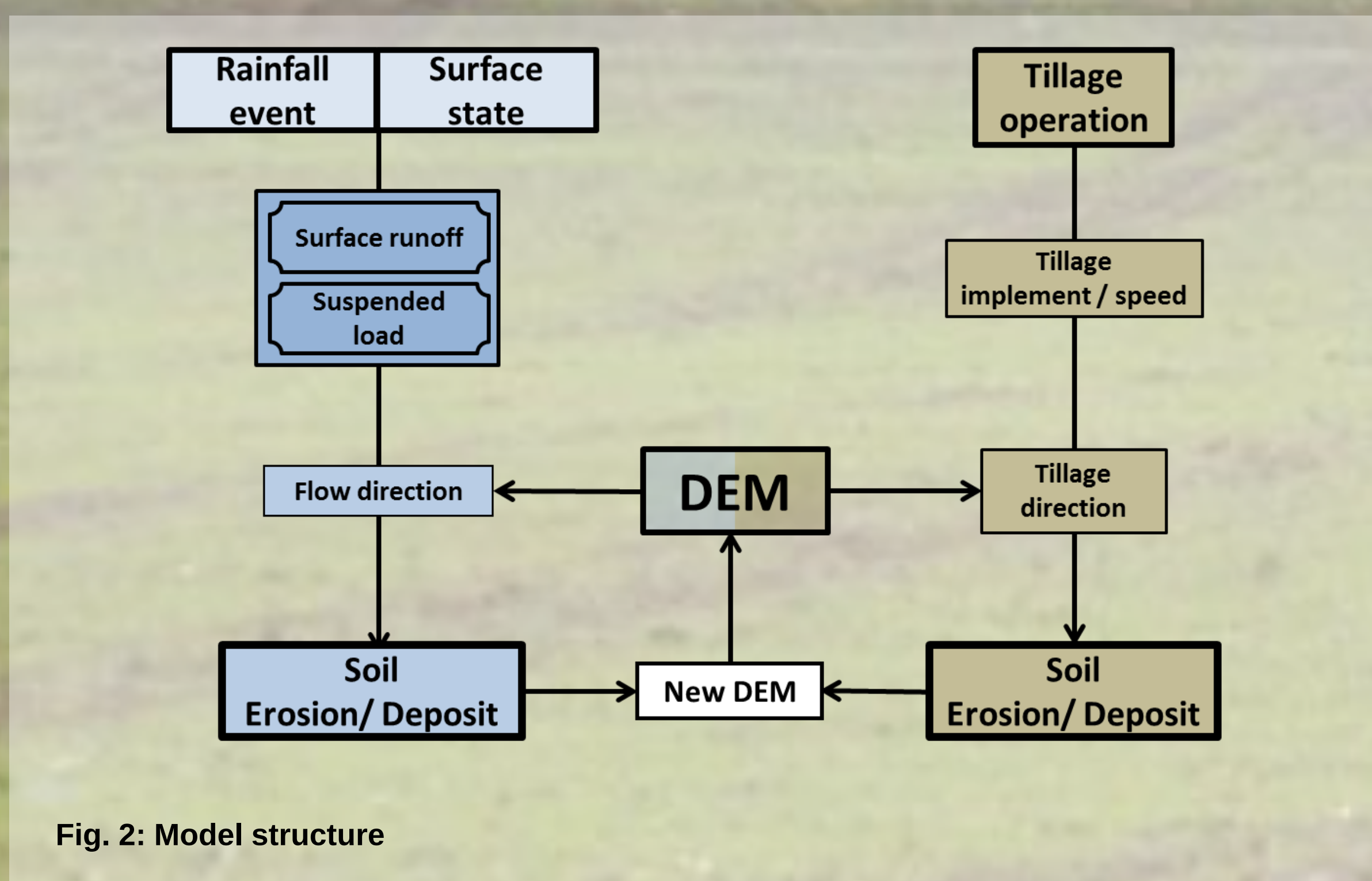


Fig. 2: Model structure

MODEL PARAMETERS

Rainfall events

Simulated till 2100 by using GIEC B1 scenario regionalised data, and implemented as 6 mn data to determine total rainfall, duration, 6mn max. intensity, 48 hrs antecedent rainfall.

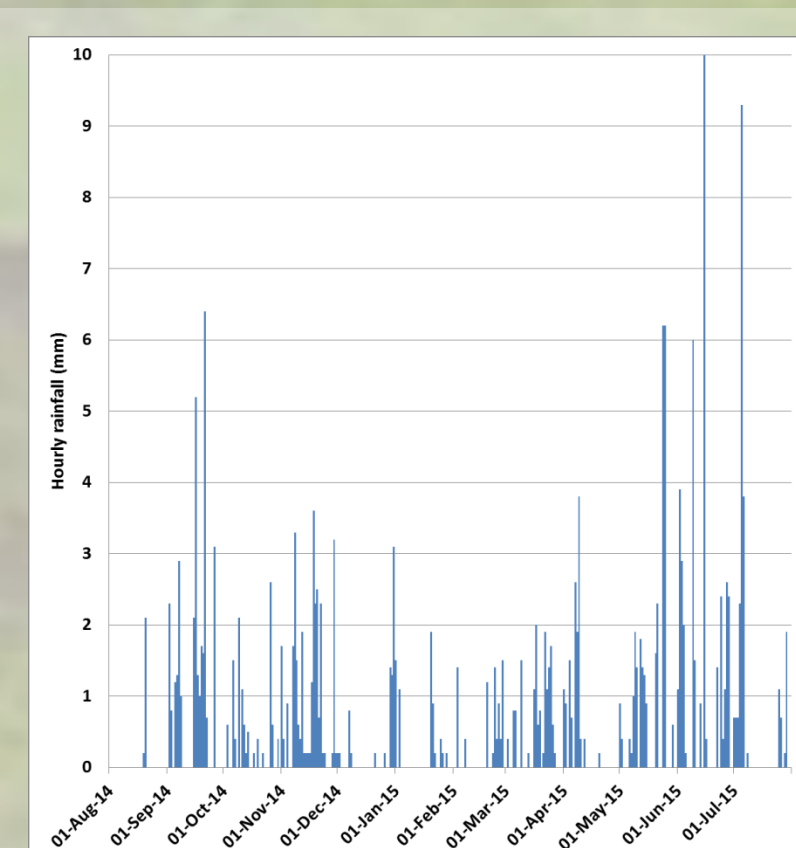


Fig. 3: Simulated rainfall data

Rules for soil susceptibility to erosion (surface runoff, suspended load): adapted to the study site according to literature data.

Flow and tillage direction:

2x2m DEM resulting from the treatment of 2009 LiDAR data (application of filters).

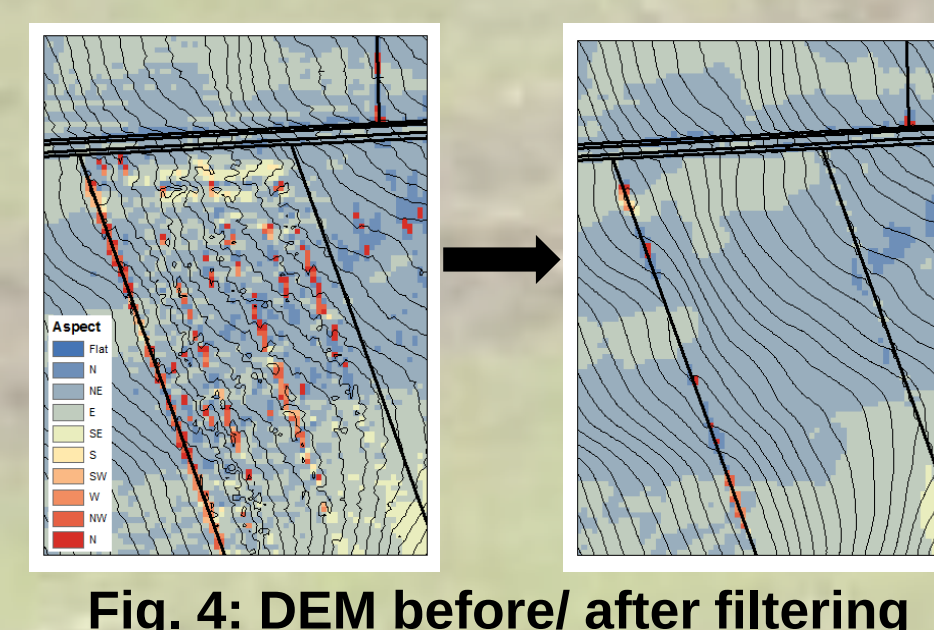


Fig. 4: DEM before/after filtering

Surface state

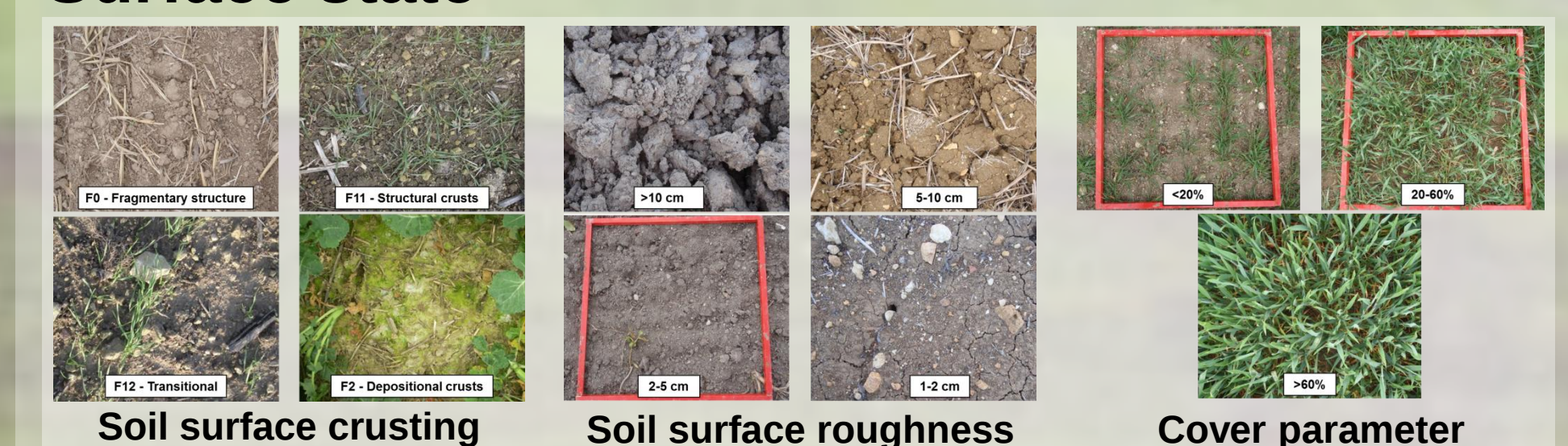


Fig. 5: Surface state classes

6 monthly surface calendars (field observations): 3 main crop types influencing erosion specifically (winter crops (WC), spring crops (SC), oilseed (OS)), 2 soil types.

2 types of crop rotations simulated: WC-SC-WC-SC and WC-OS-WC-SC

Tillage implement and speed: tillage transport coefficients determined according to litterature (Van Muysen *et al.*, 2000).

1 ploughing/3 yrs + 2 stubble ploughings/yr

APPLICATION OF THE MODEL

Differences in elevation

- 35% > 2 cm
- 13% > 5 cm
- 5% > 10 cm

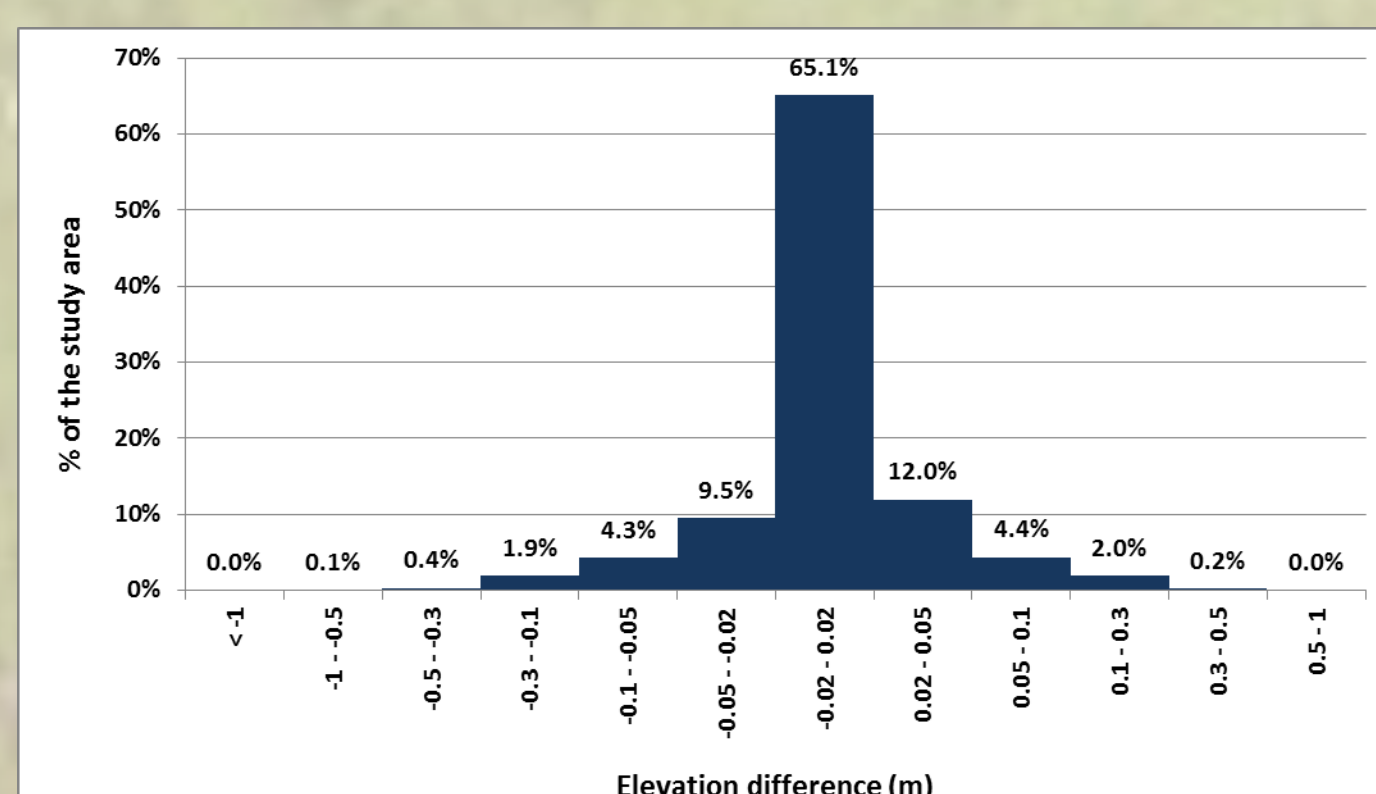


Fig. 6: Histogram of elevation variations

- Erosion area: 33%
- Deposition area: 40%
- Stable area: 27%
- Total sediment export: 212 m³

Spatial structure of variations

Variations spatially structured, showing linear features (Fig. 7), corresponding to current or former field limits that existed before land consolidation. Current field limits: lynchet accretion, regressive towards upslope (Fig. 8). Former field limits: erosion of undulations, accumulation observed immediately below (Fig. 9).

⇒ Redistributions mainly due to tillage erosion, comparable to 'sedimentary waves' within fields.

¹³⁷Cs data comfort this hypothesis (Chartin *et al.*, submitted)

Fig. 7: Map of elevation variations 2010-2100

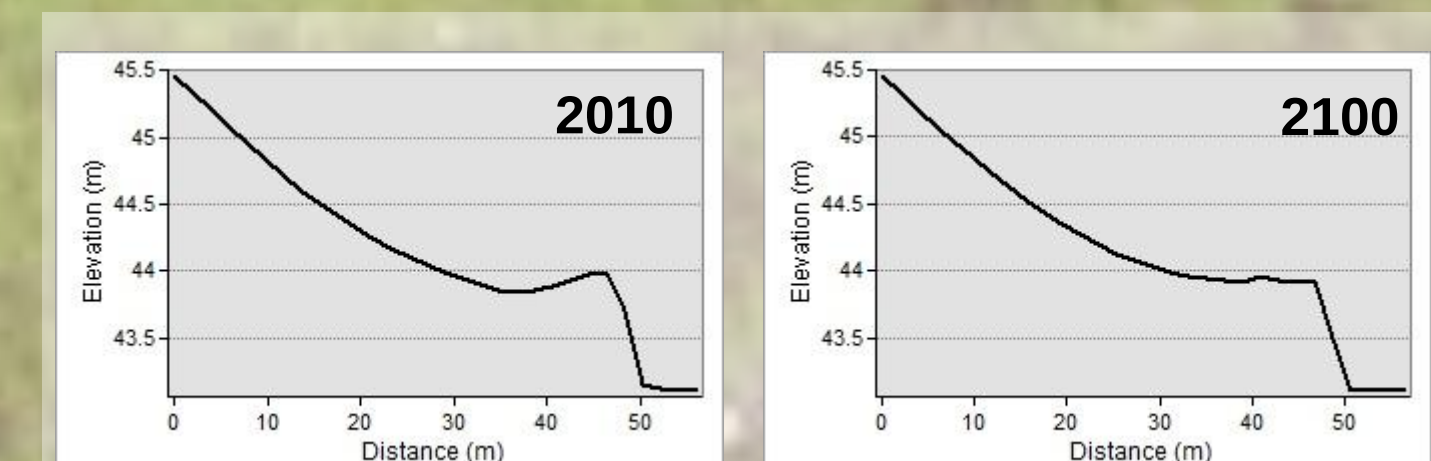
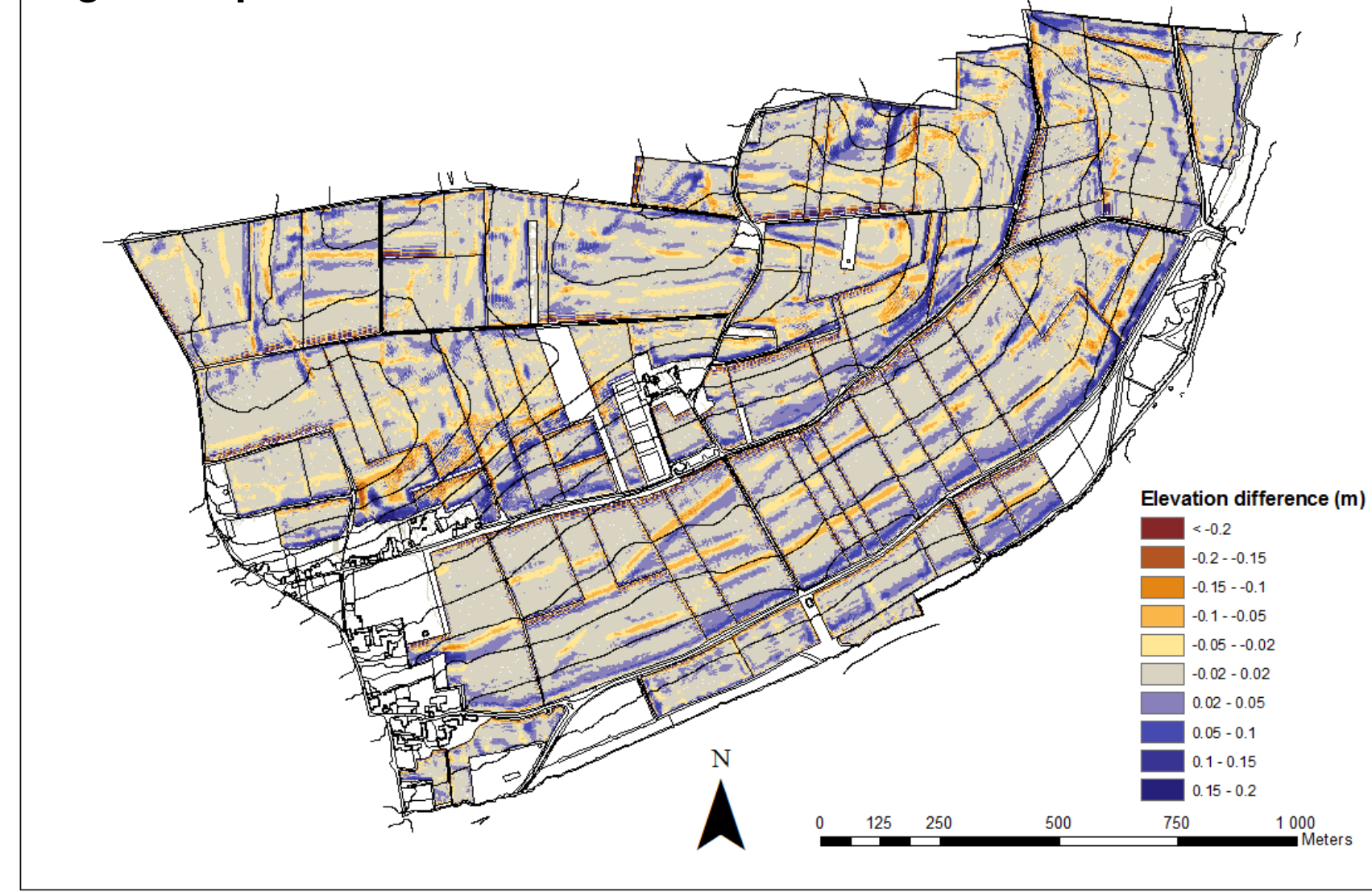


Fig. 8: Lynchet morphological evolution

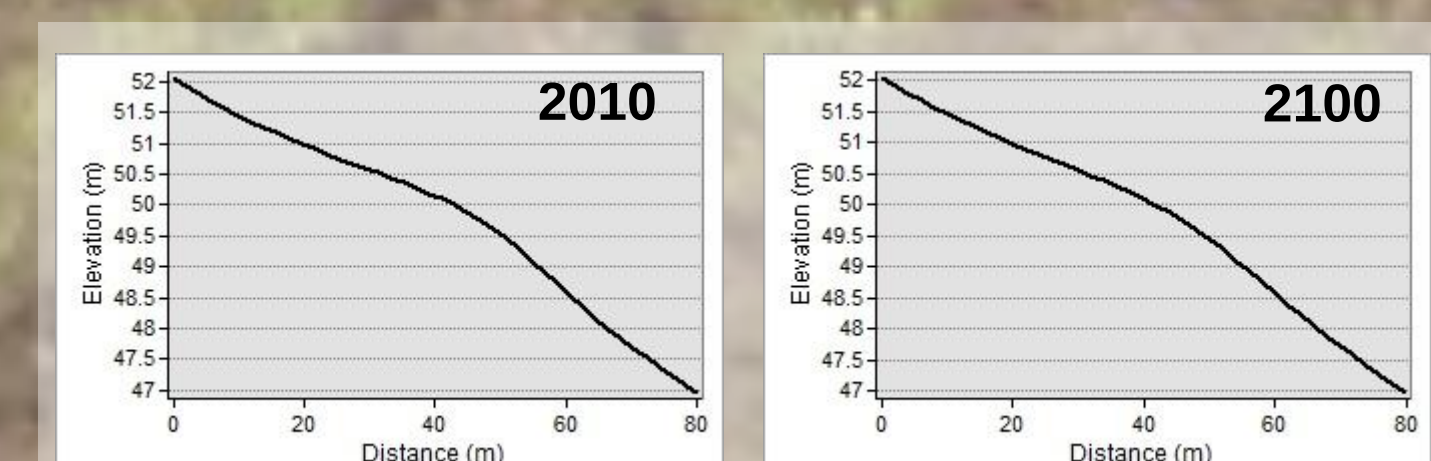


Fig. 9: Undulation morphological evolution

Few morphological erosion features characteristic of water erosion, except in small valleys of NW part (loamy soils, more susceptible to erosion)

Tillage erosion provokes a progressive smoothing of the topographic discontinuities initially created by human activities.

CONCLUSIONS AND PERSPECTIVES

The application of the Landsoil model over a century in an intensively farmed area mainly occupied by crops shows that the morphological evolution of the landscape is mainly governed by tillage erosion, that results in a progressive smoothing of the landscape features causing sedimentary waves. Areas where water erosion is not the main erosion process and where land consolidation occurred should show a similar evolution.

This should cause a significant modification of soil surface horizons properties. Further analyses are expected to show the evolution of organic carbon in relation to soil redistribution by linking the Landsoil model with a model of organic carbon dynamics (Viaud *et al.*, 2010).

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