Maize, runoff and the risk of muddy flooding with particular reference to South-West England

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Sandy and silty soils in south-west England are prone to erosion. Agricultural activities on these fertile soils often result in poor soil structure, capping and compaction, thus reducing porosity and increasing the risk of muddy runoff and erosion. The growing of maize has greatly increased in the last 30 year in South-West England. Maize fields are at risk of generating runoff and erosion in the early summer following drilling. Also, post-harvest, bare, compacted fields are a frequent source of erosion and muddy runoff. Many villages in the Otter valley, east Devon, have been affected by muddy flooding and recently Shepton Beauchamp in south Somerset, has had metre-deep floods along its roads. The expansion of maize cultivation has increased the risk of flooding as vulnerable soils on steeper slopes have been utilized. Compacted soils, because of heavy agricultural machinery, are a common feature in these flooding incidents. The increase in intense summer storms and wetter winters adds to the flood risk.

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Introduction

Muddy flooding had been recognised in western Europe as an environmental threat for the last 30+ years. It is defined as enhanced runoff from farmers' fields carrying soil and causing local flooding (Boardman *et al.*, 2006). Most commonly, property is damaged and clean-up costs are high. Instances seem to be rising due to the growing of certain crops near to urban areas, and to climate change. The increase in intense rainfall in the summer is noteworthy. Areas with soils particularly susceptible to erosion are vulnerable which include the loess (wind- blown dust) soils of Europe and silty and sandy soils in southern England. Clayey soils with a high silt content over Triassic mudstone are also susceptible, particularly to muddy runoff (Richard Smith, *pers. comm.,* 1st February 2026). These soils are common in the South-West where maize is grown.

In this short paper, the risks of muddy flooding of property in south-west England are reviewed. The recently expanded area under maize, and the risk that this constitutes, is highlighted. The compaction of soils is a widespread problem and both intense summer storm events and post-harvest bare and wet soils are a frequent cause of runoff from maize fields. Flooding associated with the cultivation of maize is discussed with particular attention to the Otter Valley in South-West England.

Maize and flooding in England and continental Europe

Muddy flooding of properties by runoff from arable fields has been a subject of extensive research in western Europe since the early 1980s (Morgan, 1980; Boardman *et al.*, 1994; Evrard *et al.*, 2007, 2010; Prasuhn, 2020). Countries particularly affected have been France, Germany, Belgium, Switzerland and the UK. The areas affected have in common arable land, especially winter cereals, maize, potatoes, on erosion-prone soils, adjacent to urban areas. In South-West England the compaction of soils related to the use of heavy agricultural vehicles, has been identified by the Environment Agency (EA) as an important contributing factor in causing runoff (EA, 2008; Palmer and Smith, 2013).

In recent years the area under maize in England has rapidly expanded from 16,000 ha in 1984 to 241,000 ha in 2025 (Gov. stats. 2025). Much of this expansion has occurred in south-west England with 29% of the national area under maize being in the South-West region (Defra, 2025). The increased production is partly driven by the demand for maize as feedstock in anaerobic digesters. This expansion has pushed maize cultivation onto soils with limited capability, steeper slopes and high-risk locations next to roads, property and sensitive waters. In other countries the expansion of maize has also been driven by the generation of energy from biomass; *e.g.*, Germany with 800,000 ha of land set aside for maize to feed into anaerobic digesters (Soil Association, 2015).

Maize in the Otter valley, Devon

The Otter valley falls into the pattern of vulnerability outlined above. It is historically prone to muddy flooding. Since 2006, 18 villages in the valley have been affected, with runoff from maize implicated at 15 of the sites (Smith and Boardman, 2024).

Serious and widespread flooding in the Otter valley, in May 2023, was due to runoff from bare fields recently planted with maize. Extensive erosion occurred across the area and was exacerbated on maize fields with muddy runoff causing damage to nearby houses, gardens, and roads (Smith and Boardman, 2024). Field hedge-bank boundaries were overwhelmed and failed to prevent runoff reaching valley bottoms. Sandy loams over Triassic sandstone of the Bromsgrove soil association are classified as at high risk of erosion (Evans, 1990), and the affected sites sloping at 3 to 7 degrees were high risk according to Defra (2005) criteria.

Runoff and erosion on 9th May led to flooding of many villages including Venn Ottery and Newton Poppleford. Rainfall of up to 100 mm in about 2.5 hours was recorded – likely to have exceeded a 1% (1 in 100) Annual Exceedance Probability. This was the result of 'a cold front followed by a trough line, and low-level convergence lines, leading to heavy

Figure 1. *The London Road, old A30 near Cranbrook, was under water. Image; Contributed:* East Devon News*, 10th May 2023.*

convection' (Environment Agency). A series of thunderstorms was experienced across Devon and Somerset associated with the same weather phenomenon.

Flooding, damage to property and the severity of the rainfall were reported in local newspapers and television. Of note, was the lack of mention of erosion on the fields and the consequences of the impact of muddy runoff beyond the farmers' fields. Residents of the affected villages captured the damage to their properties and roads on photographs and videos (Figs 1, 2 and 3). Muddy flooding is especially damaging because of the clean-up costs and the potential for ecological damage to freshwater systems.

A detailed report on the flooding in May 2023 was compiled by Devon County Council (2023) with numbers and locations of properties damaged by flooding in various villages: Newton Poppleford 61, Tipton St John 11, Venn Ottery 9 and fewer in another 10 Otter valley villages. Damage to roads was extensive with the impact illustrated by many photographs and reports from local residents. For example, flooding of Tipton St John including the school is described:

'On Tuesday 9th May, Tipton St John, neighbouring village Newton Poppleford and the small seaside town of Sidmouth endured a serious and consistent downpouring of rain and hail over a period of about 5 hours. The deluge was so severe, it resulted in nearby streams and the River Otter itself (which runs right through the centre of Tipton) bursting their banks. Additionally, a pond up at the old quarry site nearby overflowed too, sending a cascade of water hurtling downhill into the centre of Tipton St John.'

The report, however, is entirely focused on the impact of riverine flooding. Apart from two maps there is no mention or discussion of the source of runoff on valleyside arable fields and heathland. The assumption is that rainfall simply causes the rivers to overflow. Smith and Boardman (2024) document the origin of much of the runoff as maize fields and illustrate eroded fields as the origin of the muddy flows that damage the villages of Venn Ottery and Newton Poppelford.

Progress has been made dealing with muddy flooding at Newton Poppleford and Venn Ottery since the May 2023 flooding. Land has been reverted to grassland and legacy soil compaction removed. The capability of the land to absorb intense rainfall was tested during three major storms in winter 2025/26. There was no significant runoff in these areas despite widespread flooding in the Otter Valley and runoff from maize elsewhere in East Devon (Richard Smith, *pers. comm.*, 29th May 2026).

However, it is not only maize fields on sandy soils that generate runoff which leads to flooding in South-West England. A range of crops including potatoes and winter cereals may be responsible, especially where compaction has occurred. Descriptions and illustrations in *Think Soils* (EA, 2008) make this very clear.

In nearby south Somerset, light sandy and silty soils are prone to erosion and the generation of runoff (Colborne

Figure 2. *Hil Pinfold, and her husband, were left counting the cost of the flooding after their Newton Poppleford home was left under water. Image: Hil Pinfold,* East Devon News*, 10th May 2023*

Figure 3. *The clean-up operation on roads in the Otter valley, Devon, following storms on 9th May 2023 which caused flooding (Devon County Council, 10th May 2023)*

Figure 4. *Flooding of Shepton Beauchamp, 25th January 2024 (Image: Tim England)*

and Staines, 1985). The village of Shepton Beauchamp near Yeovil has a long history of muddy flooding (Morgan, 1980; Boardman, 2014). In January 2024, storm *Herminia* delivered 56 mm of rain in 24 hours causing metre deep flooding in the village centre (Fig. 4). Historically, potatoes were the problem; in 2024 it was largely winter cereals on compacted fields following maize that generated the runoff.

Why are maize fields at risk of generating runoff?

There are two periods of risk associated with the cultivation of maize. In the months after drilling (May to July), the lack of crop cover, with rows generally 0.75 m apart, exposes weed-free bare ground to rainfall and runoff. In this period the main danger is high-intensity storms such as that in the Otter valley. A notable similar case was runoff from maize fields around Faringdon in Oxfordshire in May 1993 – again a storm of around 100 mm in 4 hours was responsible (Fig. 5). An estimated £100,000 worth of damage was done by muddy runoff in the town (Boardman *et al.*, 1996).

However, potentially more serious and probably more widespread, is the risk of runoff from post-harvest maize fields. Maize is often harvested late in the autumn when conditions can be wet, particularly in the wetter parts of the country where maize is common, such as the South-West. This has two consequences: structural damage to the soil (compaction) and a reduced ability of the farmer to follow harvesting with some form of cultivation and the establishment of a cover crop. Thus, sufficient mitigation measures to protect the soil surface are not always taken. In the Rother valley, West Sussex, a survey of 18 maize fields in the winter of 2015–2016, showed that on 13 fields there was no protection against runoff: Defra advice was not being followed (Boardman and Vandaele, 2023).

There is overwhelming evidence that maize fields are often compacted. This is because of wet conditions late in the year during harvesting, the use of heavy machinery, particularly loaded trailers, and in some cases, the late establishment of following crops. The result of compaction is low soil porosity, poor infiltration and consequently, runoff. An extensive survey in South-West England of 3243 sites showed 75% of sites had 'degraded structure generating enhanced surface-water runoff' (Palmer and Smith, 2013). Clearly, where such sites are on significant slopes, the risk of damaging runoff is increased. Most of such damaged sites were under late-harvested crops especially maize.

Soil protection to prevent runoff

Advice on prevention of runoff and erosion associated with maize is available from the Maize Growers Association (MGA, undated), Defra (2005), the Environment Agency (EA, undated), Soil Association (2015) and several research and consultancy publications, *e.g.*, Brown (2016). The advice can be summarized:

- Avoid high and very high-risk erosion sites and be aware of slopes and vulnerable soils and downslope locations at risk of flooding and pollution;
- Sow early maturing varieties;
- Avoid compaction when spreading manures and during harvesting, and on seedbeds;
- Post-harvest establish a winter cover crop and break compacted surfaces to improve infiltration; and
- Rough cultivate after harvest to remove wheelings (Defra, 2005).

Large grass buffer areas around maize fields and particularly along the topographically lowest boundaries, will also reduce losses of soil from the field and therefore protect downslope locations. Twenty years of experience of protection of communities from muddy flooding in Flanders (Belgium) strongly suggests that no one measure, but a combination of measures, is needed for significant protection. These measures can be shown to have significantly reduced sediment concentrations over 16 years in a catchment of 30 km^2 (Boardman and Vandaele, 2019).

No-tillage or conservation tillage is often recommended as an erosion control measure *e.g.*, Vogel *et al.* (2016). In South-West England, however, no-till and low soil disturbance following the maize harvest frequently is not sufficient to prevent runoff and does not deal with already compacted fields and is therefore not to be recommended as no-till is adding to the existing compaction (Richard Smith, *pers. comm.*, 19th February 2025). Maize is a global crop and globally an erosion risk (Soil Association, 2015). Indigenous cultivation of maize in many areas has developed conservation techniques based on providing ground cover with the growing crop, *e.g.*, Phillips (2022). However, cultivation on small family farms (*e.g.*, in Mexico), offers a very different challenge to commercial cultivation in southern England. In England, farmer resistance to cover crops is associated with perceived competition for water and nutrients and the costs of drilling the additional crop. Similarly, farmer resistance to removal of sub-surface compaction often relates to the energy costs of sub-soiling. Research on rainfall patterns in the UK under

Figure 5. *Erosion on maize at Faringdon, Oxfordshire, 1993. Image from John Boardman.*

climate change scenarios suggests intensification of winter rainfall will increase even faster than current models predict (Carruthers et al., 2026). Also, increases in short-duration storms of less than a day, has implications for the magnitude and frequency of flash floods (Westra *et al.*, 2014). Burt *et al.* (2015) point to a steady increase in rainfall per rain day in south-east England over the last 100 years likely to lead to an increase in erosion assuming that land use remains much the same. Clearly, changes in the location of maize cultivation have serious implications for erosion in a warming, wetter climate.

Legal aspects

There is no legislation in the UK that deals directly with soil erosion but there is a range that deals with the consequences. Where farmers fail to take precautionary measures and soil erosion causes water pollution, the EA can prosecute farmers, or impose civil sanctions, compliance notices etc., under the Reduction and Prevention of Agricultural Diffuse Pollution (England) Regulations 2018. The EA has taken action against farmers but in the case of the flooding in May 2023 they did not: it was considered that the intensity of the storm was exceptional and confounded by runoff further upstream. Since the May 2023 flooding the EA has issued many warnings to first-time offenders in the Otter valley with the implication that more serious action will be taken if flooding recurs (Richard Smith, *pers. comm.*, 27th April 2026).

The EA have recently successfully prosecuted a Somerset potato farmer for covering a road and polluting a river with potatoes and silt. Fines, costs and compensation totalled over £40,000. The farmer had failed to protect the road and river using silt fencing provided by the local Rivers Authority (EA, Press Release, 24th June 2025).

There have been several cases in Britain where people affected by muddy runoff from farmers' fields have gone down the route of civil litigation using the law of negligence against the farmer. These have usually been as a result of damaging runoff from winter cereals or outdoor pigs; all have been settled out-of-court. In the case of the well-known action by Breaky Bottom Vineyard (East Sussex), two separate incidents led to substantial damages being paid (Boardman, 2020). Legal advice in the latter cases suggest that certain conditions must be met to successfully sue:

- The farmer must have been aware of the risk of flooding to a neighbour – and been made aware because of previous episodes of flooding or pollution;
- The rainfall event was not 'exceptional';
- Farming practices contributed to the degree of risk; and
- Measures were not taken to protect the neighbour.

Institutional Response

The EA is clearly hamstrung by legislation with regard to erosion causing flooding, and only able to intervene where pollution occurs. Where there is damage to roads, local authorities have the power to demand protective action under the Highways Act 1980 – but this has rarely been used. Proving negligence on the part of land managers is problematic and has been at the core of civil actions for damages. EA Press Releases, in response to the Otter flooding, have been clear and strong:

- 'Hazards of growing high-risk crops in South-West England' (EA, Press Release, 19th February 2024)
- 'Preventing soil erosion and runoff from maize and other high-risk crops that can cause pollution and flooding' (EA, Press Release, 25th February 2024)

The following statement is included in the earlier Press Release:

> 'If farmers continue to grow high-risk crops in certain locations, they will need to develop site specific measures to prevent soil-erosion and run-off. The measures must be resilient to heavy rainfall and periods of prolonged wet weather. If a run-off incident occurs because preventative measures have not been taken or fail, the Environment Agency will likely take enforcement action against those responsible.'

Conclusions

The association of maize cultivation with flooding has become a high-profile issue in South-West England. However, the expansion of maize not just in the South-West, threatens to make this a national issue. Maize is now widely grown in areas such as Shropshire and Kent again driven by the demand from an increasing number of anaerobic digesters. The expansion of maize for AD takes land out of food production (Searchinger *et al.*, 2015). The flooding threat is further enhanced by a greater frequency of intense summer storms falling and an increase in winter rainfall on bare and compacted ground with these trends likely to continue into a warmer future. The inability of

the EA to impose restrictions on where maize can be sensibly grown, unless pollution from runoff occurs, is a serious legislative limitation.

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