The farmers, the fishers, their river and its wildlife

Many factors control where soil ends up, says Ian Douglas.

The water crowfoot in the River Frome in Dorset.

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Fishermen on southern England's last natural salmon river, the Frome, say more and more fine sediment is washing into the streams in the Frome and Piddle water catchment areas, clogging up the gravels where fish spawn. The fishermen blame farmers who plough up pastures to grow maize and other crops. The farmers say they have to manage their land for the best possible economic return, and insist they are sensitive to the fishermen's problems. They try to plough when the weather is dry, but they cannot avoid the occasional heavy storm breaking out over their newly ploughed fields.

So is ploughing really to blame? Researchers from the Lowland Permeable Catchment research programme (LOCAR) have been finding out. And it seems the true story is far from simple.

The programme has investigated how fine soil particles are transported from the hill slopes to the streams around the Frome and Piddle. On grassed pasture slopes, we found that most of the soil that gets eroded by the rain moves only part of the way down the slope. Less than 2.5 per cent of it ends up in the river. But on a cultivated slope, rain erodes nearly seven times more soil, and 70 times more ends up in the river (almost 75 per cent of all the soil that is eroded). So ploughing up pasture for crops like maize can certainly have a big effect.

But what proportion of all the sediment in the rivers actually comes from particular sources, such as ploughed fields, woodlands, pasture or earthworks for roads or buildings? LOCAR researchers used a suite of techniques, known as sediment-fingerprinting, that essentially use the soil's magnetic properties to distinguish where it came from. The team found that only about half the sediment in the River Frome came from cultivated fields. About a third came from riverbanks and below-ground sources, such as soil that had been excavated on building sites. And in the next-door River Piddle, about a third came from pasture areas, 15 per cent from river banks, and about half from cultivated land. When the scientists examined individual tributaries, the picture got still more complex.

Just as much of the eroded soil stays on the fields, some of the fine sediment that enters the rivers stays, at least temporarily, on the riverbed. The researchers sampled 29 sites on ten different occasions to get an estimate of how much fine clay and silt was resting on the riverbed. The answer is about seven tonnes per kilometre on the River Frome, and nine tonnes per kilometre of the River Piddle, but the quantities vary greatly along these rivers. So how and where does it accumulate? Chalk rivers such as the Frome and Piddle often have large aquatic plants, such as water crowfoot (*Ranunculus* spp.), forming big mid-stream stands. The way the plants grow, spread and die back affects the way sediment, plant seeds and organic matter, such as the faecal pellets of water creatures, are trapped, stored or released. The most fine sediment accumulates where water speed remains low throughout the year, for example along the channel edges, particularly where dense stands of plants like branched bur-reed (*Sparganium erectum*) emerge from the water. Branched bur-reed has rigid, vertical stems growing in closely spaced stands. These trap sediment all year round.

Where both mid-channel and marginal plants abound, spring growth slows mid-stream flows. This forces the water towards the sides of the channel where it moves in fast threads between the two plant communities. Sediment transported by this faster-flowing water can then be trapped in the 'dead zone' of slow-flowing water within the marginal plants. Only a relatively modest amount of sediment accumulates in the water crowfoot stands themselves. A patch about 9m^2 can store about half a cubic metre of fine sediment, often mostly sandy particles and varying quantities of organic matter.


Laurie Campbell/NHPA

Branched bur-reed.

Water crowfoot is home to lots of blackfly larvae (the *Simuliidae* family of *Diptera*) that feed by continuously filtering particles and dissolved material from the water, and then excreting what they don't use as faecal pellets. These pellets are often many times bigger than the original fine particles. This change in size can also alter the way sediment moves in the stream. Many small particles stay in the stream longer than they would had they not been eaten. Blackfly larvae thrive in spring and summer, and water plants trap their pellets. Then in autumn, the pellets are released again as both marginal plants and the mid-stream water crowfoot die back and the river flows faster.

Seeds also get carried along with the sediments, and some, including the vigorous and invasive Himalayan balsam (*Impatiens glandulifera*, sometimes called policeman's helmet), can germinate in the water, grow, and slow down the flow. So it's not a simple case of fine sediment from ploughed fields washing into a river and getting trapped among the riverbed gravels. Particles of sediment may be carried some distance downstream, be trapped by first one patch of aquatic plants and then another, or be ingested by a blackfly and then excreted in a pellet that in turn is trapped by other vegetation, only to be swept downstream when the plants die-off in the autumn. It is not easy to say whose activity on the land causes a problem in a particular reach of the river. River managers need to take a close look at this complex system before standing back and managing the system as a whole.

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