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Soil and Water: a larger-scale perspective

Flood risk from modern agricultural practices can be mitigated with interventions

In the face of substantial evidence that modern land use management practices have increased runoff at the local scale, a new study reveals changes in local land use management practices can reduce the risk of local flooding. However, there is little evidence so far that these local increases in runoff culminate in large-scale flooding effects. To address this lack of evidence, the researchers present a model that maps the downstream rate of flow back to its source areas.

Agriculture and land-use management in the UK has changed immensely since the end of the Second World War, driven by UK and EU agricultural policies. In an effort to become more self-sufficient in food production, modern agricultural practices have led to changes such as increased field size, the use of large farm equipment and elimination of buffer zones (areas of land, lying next to a waterway, kept in permanent vegetation) and hedgerows. These changes in farming methods have resulted in more deeply compacted soils, unchecked runoff, lines left from ploughing, and cracks in the soil. Factors such as compaction prevent the soil from being able to hold more water and lines and cracks in the soil concentrate the water flow — therefore speeding up the flow of water on the soil's surface. This in turn increases the volume and speed of water flowing into waterways and heightens the risk of flooding.

These observed changes have prompted a large number of studies on their scope and also on possible mitigation strategies. This study has comprehensively summarised those works to identify best practices. Research has identified several possible interventions to mitigate or avoid small-scale impacts. Examples include the establishment of hedgerows, the creation of natural buffer zones and temporary overland flow ponds. These agricultural practices can decrease the amount of runoff at the farm level, but the appropriateness of a specific intervention depends on soil type and other characteristics.

While research on how local land management affects local-scale flooding is abundant, the same is not true for large-scale flooding. Research has not produced evidence that the local effects of land management combine to have an effect on more large-scale flooding. As the scale gets larger, more variables must be taken into account, which is problematic. It is difficult to test the large-scale effectiveness of farm-level interventions because, among other issues, current models do not account for how soils are affected by interactions with vegetation and soil organisms responsible for maintaining the structure of soil, diurnal and seasonal cycling, freezing and thawing, the stresses imposed by farm animals and vehicles, or various forms of artificial drainage. This is why the researchers warn that a lack of evidence at the large scale does not mean there are no large impacts. Furthermore, although numerous hydrological models are available, there is a lack of agreement among scientists about which are most useful. This contributes to the lack of useful answers about the impacts of land management on the flow, sediment and water quality of large-scale catchments worldwide.

Continued on next page.

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Source: O'Connell, P. E., Ewen, J., O'Donnell, G. & Quinn, P. (2007). Is there a link between agricultural land-use management and flooding? *Hydrology and Earth System Sciences* 11(1): 96-107. DOI: 10.5194/hess-11-96-2007.

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The researchers suggest that this type of large-scale catchment modelling should be the next step in hydrological research and provide an example. Using multiscale data (which is rarely available) from the flooding that inundated the UK city of Carlisle in 2005, the researchers used a 'Source-Pathway-Receptor model' to generate a map. This model tracks 'packets' of water from the source to the site of flooding through a network of channels, and can indicate where most of the water came from for a particular storm peak. This type of catchment experimentation is key to attribute land management practices and public policies to the impacts of floods, the researchers say.

The vast majority of catchment areas in the UK have already been changed by human activity — so the researchers say textbook descriptions of natural hydrological functioning no longer apply. Moreover, interventions at the small scale may have big impacts on the larger scale, but knowledge of these connections is limited. Hence the researchers say that there is a pressing need for new models and approaches that allow flood predictions at multiple scales, and which take into account the role that human activity plays in soil and water functioning. They advise that greater coherence, more definitive standards and a large-scale approach, such as in the 'Source-Pathway-Receptor model', should be directed toward the creation and use of models in hydrological research.

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