DEFRA
Department for Environment, Food & Rural Affairs

DEFRA / Environment Agency
Flood and Coastal Defence R&D Programme

ENVIRONMENT AGENCY

R&D Technical Summary W5B-026/TS

Impact of agricultural soil conditions on floods – Autumn 2000

Background to R&D project

The Autumn and Winter of 2000 to 2001 was the wettest in Great Britain since records began in the eighteenth century. It was suggested that many catchments flooded because they were saturated by the early storms in October and were therefore unable to absorb more rainfall. However, it was also known that modern farming and other land management practices can lead to a reduction in soil water storage and infiltration capacity, particularly on certain types of soil. Such "degraded" soil conditions can reduce the ability of soil to absorb rain and thus lead to increased runoff to surface waters, particularly during storm events. However, little quantified data was available to corroborate this effect.

The Environment Agency therefore commissioned the National Soil Resources Institute (NSRI, formerly Soil Survey and Land Research Centre) to investigate the conditions of a range of soils under different cropping systems in selected catchments that had flooded. The large Severn and Yorkshire Ouse catchments and also the smaller catchments of the rivers Uck and Bourne in south-east England were chosen. The Severn and Yorkshire Ouse catchments were too large to investigate in detail, therefore field visits focused on three selected representative 100 km^2 areas within each catchment. Fieldwork was carried out during December 2000 and January 2001.

Results of R&D project

Five cropping / management systems were identified as having the potential to cause problems of soil degradation: *Autumn-sown crops*; *Late autumn harvested crops; Field vegetables*; *Orchards*; *Grassland - both permanent and ley grassland, but not including rough grazing*. Conditions under these systems were investigated in a minimum of 30 fields in each representative area. The amount of soil degradation at each site was then deduced and the results extrapolated to catchment level.

The results show that:

- Enhanced soil degradation associated with a number of cropping systems/management practices is present in all four catchments studied. It occurs on approximately 19 and 27% of the land in the Yorkshire Ouse and Severn catchments respectively, and on approximately 33 and 49 % of land in the small headwater catchments of the Bourne and Uck respectively.
- Severe degradation is mainly associated with late harvested crops such as maize, sugar beet and, at least during Autumn 2000, main crop potatoes.
- Extensive degradation occurred on 55 % of inspected sites on late harvested crops, 25 % of sites under grass, autumn sown crops and field vegetables and 10 % of sites under orchards.
- This degradation restricts infiltration leaving the subsoil unsaturated. Simple calculations suggest a potential increase of up to 20 % in the total volume of runoff during storm events.

The results thus provide strong evidence of enhanced soil degradation resulting when cropping and stock management practices are undertaken in unsatisfactory conditions. It also shows that that this soil degradation has the potential to increase significantly the amount of runoff entering rivers during storm events although the extent to which this occurs is less certain.
The data interpretation and extrapolation was a simple desk exercise. Monitoring experiments undertaken in the US have also demonstrated that soil and crop management practices can have a significant effect on stream response to rainfall. Plot experiments under maize in the UK have demonstrated similar impacts on run-off.
No measured data exists for the UK to establish the connectivity between field-scale runoff and stream

response during storm events. The Technical Report recommends that a national research programme - in collaboration with the other bodies having responsibilities and interests - is initiated to investigate the following topics and to improve predictive modelling:

- Quantification of the hydrological impact of enhanced soil structural degradation on stream response to storm events.
- Field studies to investigate the potential for on-farm control measures to reduce the immediate impact of field-scale runoff.
- Detailed studies of the impact of selected cropping and management practices on soil structure for different soil types and climatic conditions.
- Field studies to investigate the potential for improved crop, pasture and stock management practices to reduce soil degradation and run-off.

R&D Outputs and their Use

The principal output is the R&D Technical Report for Users (below). This provides background information for the flood management practitioner, researcher or policy maker on the impact of soil degradation on runoff. Sections cover hydrological and agricultural background to soil degradation; methodology of research and interpretation of results; recommendations.

An R&D Project Record containing the field observation records for the 410 sites that were investigated provides supporting data. At each site the surveyor recorded cropping, soil surface compaction, soil moisture state, and the characteristics of the topsoil and upper subsoil horizons. Soil properties were observed from small trial pits.

Practical advice on land management measures to control runoff is given in Environment Agency R&D Manual on *Best Farming Practices – Profiting from a good environment* (published 2001).

This R&D Technical Summary relates to R&D Project W5B-026 and the following R&D outputs:

- **R&D Technical Report W5B-026/TR - *Impact of agricultural soil conditions on floods – Autumn 2000.*** Published November 2002
- **R&D Project Record W5B-026/PR - *Impact of agricultural soil conditions on floods – Autumn 2000, Field observation records for investigated areas.*** Published November 2002

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The above outputs are available on the Environment Agency (EA) website (www.environment-agency.gov.uk/floodresearch) Copies are held by all EA Regional Information Centres and can be purchased from the EA's R&D Dissemination Centre, c/o WRc, Frankland Road, Blagrove, Swindon, Wiltshire SN5 8YF (Tel: (+44) 1793-865012; Fax: (+44) 1793-514562; email: publications@wrcplc.co.uk).