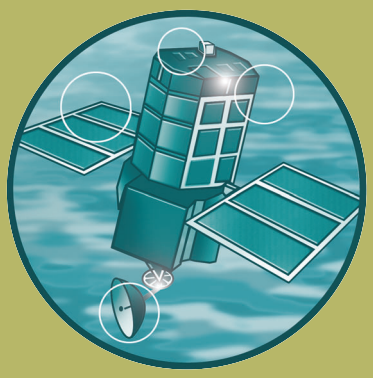
Joint Defra/EA Flood and Coastal Erosion Risk Management R&D Programme

FD2120: Analysis of historical data sets to look for impacts of land use management change on flood generation

A2. Technical appendix for catchment description

R&D Project Record FD2120/PR



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A2 TECHNICAL APPENDIX FOR CATCHMENT DESCRIPTION

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A2.1 Introduction

Within Chapter 2, seven catchments were selected for the modelling based on an analysis of broad scale national data sets. An additional two catchments (Lugg and Irthing) were added, based on feedback from the stakeholder workshop on 28th November 2006 and stakeholder suggestions nm the project's WIKI site.

The data analysis for the Axe catchment described in Chapter 2 indicated increasing areas of late harvested crops, and temporally varying areas of autumn sown cereals and managed grassland. Data for the whole of the Lugg catchment, which straddles the England/Wales border, are only available until 1997. Until that date, the data suggested temporally varying areas of autumn sown cereals, generally increasing area of managed grassland and late harvested crops, and generally increasing sheep numbers.

As a final element of the selection process, interviews were carried out with key informants in two of the shortlisted catchments (Axe and Lugg) were selected to confirm the utility of the catchment selection process and to provide additional contextual information and data for the interpretation of the modelling results.

A2.2 Information from key informants in the Axe catchment

The key informants were from the Environment Agency (x3), local farmers (x 3) and Cranfield University researchers (x2). The farmers had a memory time span of more than 50 years, although their views were largely based on recollection. Informants are anonomysed as EA-1 (e.g. Environment Agency person 1), CU-1 (e.g. Cranfield University person 1), F-1 (Farmer 1) etc.

Rainfall
Since the last decade rainfall patterns seem to have changed: rainfall is more erratic (unpredictable) and rainfall intensity has increased [EA-1, CU-1]. Farmers [F-1 and F-2] also reported more erratic rainfall. And one farmer [F-2] mentioned wetter springs, a second [F-3] mentioned drier autumns and a third [F-1] milder winters.

River flow
Since the 1990s the river flow has changed. Flooding has become more frequent [EA-1 and EA-2] due to rainfall changes [EA-1, CU-1] and more runoff [EA-2]. The river has become more active resulting in more riverbank erosion [EA-2].
According to two farmers [F-1, F-3], river levels have lowered since the 1940s due to decreased rainfall [F-1] or springs that dried up [F-3]. The farmers were all of the opinion that the river floods less often, but it has to be remembered that their memory goes beyond the 30 past years. The farmers had noticed that water 'comes down quicker' (reduced time to peak) because of soil compaction [F-1, F-2, F-3], land drainage [F-1, F-2], increased rainfall

intensity [F-1], increased flow connectivity [F-2] and grassland converted into arable land [F-2].

River management

River management has been reported to have changed, with less management of riverbank trees, including removal by the Environment Agency of fallen ones. Also more diseased alders are falling in / getting washed into the channel and not being dealt with [EA-1].

Since 1986, installation of new flood defences for agricultural land has been stopped. There is quite a lot of blockstone bank revetment in the lower part of the river (particularly below the Axe/Yarty confluence) installed by previous authorities to prevent river bank erosion. This is no longer maintained or installed by the Environment Agency and there is a presumption against allowing landowners to do this sort of work. So, for example, when an oxbow began to develop below the A 3052 at the head of the estuary, despite requests from land owners and angling clubs, EA did nothing about it and the oxbow has been allowed to develop completely [EA-3]. Farmers confirmed that there has been a substantial decrease in vegetation control [F-1, F-2, F-3] and a decrease in embankment construction [F-2, F-3].

Runoff

Overland flow has increased in amount [EA-1, EA-2] and speed [EA-1] due to changes in:

- rainfall [EA-1, CU-1],
- land use – primarily due to changes in agricultural practices such as increased stocking rates, increased winter cereal growing, increased maize growing and consequent areas of bare / compacted land throughout winter months – [EA-1, EA-2],
- soil compaction [EA-1, EA-2], and;
- field drainage [EA-1].

The three farmers also had noticed an increase in the amount of runoff, due to increase in runoff from hard surfaces [F-2, F-3], land use change (increasing arable area) [F-1, F-2] and soil compaction [F-1, F-2]. The farmers had also observed a decrease in waterlogging, because of field drainage [F-1], drier winters [F-1], and less animals being kept outdoors all winter [F-2].

Land use changes

There has been a slight increase in urban land use [EA-1], but the increase in arable land and consequently decrease in grassland is more significant [EA-1, EA-2].

The farmers reported a considerable increase in urban land use, a considerable decrease in grassland and an increase in arable land. One farmer [F-1] mentioned that grassland had increased and arable decreased, but he was referring back to the 1940s.

Farming systems

Because of devolution, no spatial land use data were available post 1997, hence the interviewees are mostly likely describing changes that have occurred since then. Dairy farms have rapidly decreased in number, and been replaced by beef and sheep enterprises (since 1995), outdoor pigs (since 2000) and arable enterprises [EA-1].

The farmers had contradicting statements on changes in farming systems, but this is probably due to different time horizons used. They reported on an increase of beef and sheep farms [F-1, F-2], a decrease in outdoor pigs [F-2, F-3], arable [F-1, F-3] and orchards [F-1, F-2].

Farming practices

Since 1995, dairy stocking rates have increased (from 80 cows per farm to 180 cows per farm) and the grazing season extended because of new paddock grazing system [EA-2]. The intensification of the dairy sector led to more soil compaction [EA-2]. Recently, stock numbers of dairy cattle have decreased, but those of beef and outdoor pigs increased [EA-1].

The acreages of the following crops have increased over time: maize, winter wheat, winter barley, oilseed rape. The cultivation of the following crops has decreased: spring wheat, spring barley, potato. [EA-1]. Gradually in time, more contractors are used [EA-1], especially for harvesting and fertilisation [EA-2]. In terms of soil cover there has been an increase in maize stubbles [EA-2] – accompanying the increase in maize cultivation. But there has also been an increase in bare soils, plastic coverage and cereals undersown with grass [EA-1]. The use of the mouldboard plough has decreased, but the powered cultivator has been used instead increasingly during the past 20 years [EA-1]

The farmers mentioned that a main cause of the current problems in the catchment is the disappearance of mixed farms. They were narrating that in the past cows were kept outdoors all year, but as numbers went up this became unfeasible because of winter feeding. The typical grazing season for cattle is now from April until September or October. For the last 10 years, cattle have been out for a bit longer because of good, dry autumns. Since the 1960s cattle and sheep have increased gradually [F-1], but more rapidly since the 1990s [F-2].

The farmers all reported on substantial increase of acreage of maize, but also of increases in winter wheat and oilseed rape. Crops such as barley, spring wheat and potato have decreased in acreage. The farmers reported an increase in the use of contractors for field operations, except for the spreading of fertilisers and spraying of pesticides.

In terms of machinery, the heavy disc is used less, but the powered cultivator and the rigid tine cultivator are used more. The combination drill is also used less.

Since the mid 1990s, the timing of field operations has changed slightly in the autumn because of drier and milder weather. Primary cultivation for grass and winter wheat has been delayed from September until October [F-2, F-3]. Maize is now harvested in September instead of November because of earlier maturing varieties [F-2]. One farmer [F-2] mentioned that winter barley is harvested in mid July instead of August, but another [F-3] said that wheat is now harvested in August instead of July.

With time, less crop stubbles have been left in the fields over winter, and the practices of undersown grass and leaving soils bare after primary cultivation have decreased as well. Since the last few years (2000), plastic is increasingly used to cover the soil.

Palmer (2004) carried out 137 soil structural assessments (representing an observation density of 1 per 3.25 km^2) during a soil structural survey of the catchment. The observed soil structural degradation observed in maize sites showed that maize cultivation can cause environmental problems unless soil management standards are very high. Only 20% of permanent grass sites had low levels of structural degradation. Most of the remaining permanent grass sites were only moderately degraded but 20% of sites on the Greensand/Lias sand and Triassic mudstone landscape were highly degraded. Over 60% of autumn sown cereal sites in the clay landscapes suffer from high or severe structural degradation.

A2.2.1 References

EA (2004) Catchment fluvial geomorphological audit of the Axe Catchment. Detailed geomorphological survey (report B). Babtie Brown and Root. Environment Agency

Palmer, RC (2004) Soil structural conditions in the Axe and Char catchments during March 2004. Final report. NSRI Contract no. YSR 9127V
Project Cycleau (2004) Axe and Char catchments profile. Technical summary (http://www.cycleau.com/index.asp)

A2.3 Information from key informants in the Lugg catchment

The only respondents in the Lugg catchment were from Natural England (NE) and a UK researcher, now based at Wageningen University in the Netherlands (WU)

Rainfall
Since the mid 1990s rainfall has become more erratic – or unpredictable – and rainfall intensity has increased [NE].

River flow
Since 2000 the river shows more fluctuating levels caused by the more erratic rainfall patterns [NE].

River management
The Environment Agency reduced the levels of management for the main Lugg watercourse in favour of a more natural system. The River Board only started to implement intense management in the 50s-70s, so the River Lugg only had 30-40 years of intense management, and the channel is now slowly returning to the pre-1970s state. [WU]
The river Lugg is heavily engineered, and at present, the conservation department of the Environment Agency contemplates removing weirs to improve the habitat for salmon. This removal will accelerate the river flow [NE].

Runoff
Overland flow has increased in amount due to changes in [NE]:
- rainfall, and
- land use – intensive arable farming (potato) and soil degradation due to decreasing input of organic matter.

Land use changes
Since the early 1990s, grassland has been replaced by arable land, in particular in the lower parts of the catchment. This is mainly driven by the fact that large arable agri-businesses have taken over family farms [NE].

Farming systems
Since the early 1990s, dairy farms and beef farms have decreased in number significantly, and been replaced by arable enterprises [NE].

Farming practices
Recently, sheep and in some cases beef cattle are kept outdoors during winter time to reduce the production costs. Though stocking densities have increased since the 1990s to keep livestock farms viable, this is counteracted by the decrease in numbers of livestock farms [NE].
In the past two years, there has been a decrease in the acreage of maize and sugar beet crops, but an considerable increase in the acreage for potato and strawberries (under plastic) [NE].

Contractors are increasingly used for all field operations, in particular for silage making and potato lifting [NE].
Minimum tillage is increasingly being applied in recent years, as the heavy soils are suitable for minimum tillage, and it enables arable farms to reduce production costs [NE].
As less areas of maize are cultivated (due to decreasing number of dairy farms), there is also less maize stubble over winter. The practice of leaving bare soils over winter (potato) and the coverage of soils with plastic (strawberries) are becoming more common [NE].
As livestock farms decline in numbers, the input of organic matter (farmyard manure and grassland) into the soils is declining, resulting in degradation of soil structure [NE].

A2.3.1 References

Wade, A.J., Butterfield, D., Griffiths, T., and Whitehead, P.G. (2007) Eutrophication control in river-systems: an application of INCA-P to the river Lugg. Hydrol. Earth Syst. Sci. 11(1): 584-600

A1.4 Summary of implications of agricultural change

Information has not been obtained regarding the detail of farm mechanisation practices in the Axe, and Lugg catchments, and how these have changed over time. However, a number of observations can be made on the basis of insights provided during interviews with key informants and the contextual information provided in Appendix 1.

In the Axe catchment, the major changes in cropping over the last 30 years have involved a reduction in the area of grassland and in grass forage production particularly for dairy production. There has been an increase in winter wheat, oilseed rape and forage maize for dairy. There has been an increase in farm specialisation, with reduced number of crops and livestock enterprises per farm. Cropping systems have been simplified, towards cereals and oil seeds. This has tended to increase aggregate peak work loads during busy periods, involving increased use of machinery contractors. Ploughing continues as the dominant cultivation method. There has been a reported increase in secondary power harrowing and rigid tine cultivations and a decrease in heavy disc and combination drilling. It is possible that milder conditions in recent autumns have allowed this transition , also allowing later sowing than previously. There has been an increase in the use of plastic cover for field vegetables in some areas, which can increase runoff. However, it is not clear the extent to which these changes exacerbate or alleviate the risk of compaction and/or capping.

In the Lugg catchment, there has been an increase in arable farming, with land taken out of grassland. After a period of expansion of forage maize, this has decreased recently with the reduction in dairy farming. Sugar beet production has declined very recently, but the area of potatoes and strawberries under field scale plastic has increased. There has been a reported general increase in the use of contractors for field operations, and an increase in the use of reduced tillage systems. These changes could have varied effects on compaction risk and potential for runoff, depending on local circumstances and prevailing climate and soil conditions. It is not possible to determine the extent of this influence without more detailed field level assessment.

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