Rural Land Management and Flood Risk Management:

Stakeholder and Policy Analysis

WP 7.2

October, 2006



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Executive summary

There is growing concern that extreme flood events will occur more frequently in future in the UK due to changes in land use and climatic conditions. In this context, consistent with Defra's strategic review of flood risk management- Making Space for Water, it is possible that controlling runoff of rainwater from farmland, as well as the storage of floodwaters in lowland rural areas, could contribute to the management of flood risk, especially reducing flood damage to urban properties.

This summary reviews the aim, approach and findings of surveys of farmers and other interested parties carried out in selected catchments in England and Wales to explore perceptions of the links between land management and flood generation. The work was part of Work Package 7.2 on Policy and Stakeholders in Rural Areas, conducted during 2005/06 by Cranfield University as part of the Flood Risk Management Research Consortium (FRMRC), funded by the Engineering and Physical Sciences Research Council (EPSRC).

Aim and Objectives

The broad aim of the research is to help to develop methodologies that can inform sustainable flood management solutions. More specifically the research seeks to:

- appreciate the link between agriculture as the dominant rural land use and flood risk,
- define the drivers which influence agricultural and rural land use and management decisions, and how these might change in future, and
- identify potentially beneficial rural land use and management practices and how best to encourage the adoption of these by land managers.

Methods

Following a review of research literature, the Drivers-Pressure-State-Impact-Response (DPSIR) framework was used to examine the diverse interactions between the causes and effects of flooding associated with rural land use. A review was carried out of agricultural policy over the previous 50 years, together with an analysis of possible future scenarios as they might affect land use and flood risk management .

Five sub-catchments in England and Wales were selected for study, covering a range of climate, landscape and farming characteristics. Within these sub catchments, clusters of farmers operating in areas with potential for runoff generation were identified. In-depth semi-structured interviews were carried out with a total of 36 farmers in order to derive an understanding of their perceptions of factors influencing land management decisions and flood risk management. These subcatchment areas were: Pontbren (Upper Severn) in Montgomeryshire (Wales), Eden in Cumbria, Ripon (rivers Laver and Skell) in North Yorkshire, Hampshire Avon in Wiltshire and Parrett in Somerset).

An analysis of stakeholders with interests in and influence over the interaction between rural land and flood risk management was carried out in the Ripon area,

north Yorkshire. This included a workshop attended by key stakeholders that used a specially constructed decision support tool, FARM-Tool, to achieve a shared understanding of the links between rural land management and flood generation.

Actions that can be taken by land managers to reduce runoff from farmland were reviewed, together with an assessment of ways of promoting these. Alternative land management practices were screened for suitability according to fitness for purpose and acceptability to the user community. Alternative policy instruments, such as regulation, voluntary arrangements and economic incentives were assessed in terms of likely cost effectiveness.

Results

Discussions with farmers confirmed the findings of research literature that there has been considerable intensification of agriculture during the past five decades, mainly driven by production oriented agricultural policies. As a result, the rural landscape has changed with relative increases in arable cropping, intensification of grassland, increased field sizes, reduced field boundary features such as hedgerows, and realigned watercourses. It is thought that these changes have increased the degree and rate of rainfall runoff from farmland.

During interviews, farmers reported that they have responded positively to the incentives provided by agricultural policies and prices. Many farmers intensified, specialised and expanded their farms during the 1970s and 1980s when agricultural policies promoted agricultural production. However, in the last 10 years, as farming has become less profitable, many farmers reported that they have adopted more extensive practices, pointing also to the increasing the number of farmers leaving the industry. This trend is likely, in their view, to continue as very few youngsters are willing to take over farm businesses. It was apparent that some farmers have switched to farm enterprises that have lower production costs (e.g. from dairy to beef) or have become more self-sufficient through diversification, such as on farm production of animal feeds. Farmers thought that the recent CAP-reforms are likely to facilitate this process of extensification.

The rate of structural change of the farming sector has increased in the last ten years, with reduced numbers of farms, greater specialisation of crop and livestock systems, and declining and more variable farm incomes. The trends evident in published statistics were bone out by farmer interviews. It is apparent that farming has polarised into large-scale specialist agribusinesses on the one hand and relatively small, diverse farm holdings on the other. Within the latter, there is a growing cohort of 'life-style' hobby farmers that has consequences for the composition of rural communities and the degree of financial dependency on land as a source of income. This has implications for the use and management of rural land, affecting, for example, the importance given to recreational or conservation interests.

Farmers expressed the view that the polarisation of farming will potentially increase the pressure on land in intensively farmed areas, but relieve pressures in others where farms become smaller, extensive and more diversified. Diversification into farm-based, non-farming activities is especially evident in areas with a market for rural

services, as shown by the North Yorkshire and Wiltshire cases. Farmers envisage that the polarisation of farming will continue in future, resulting in a farming community consisting of two main groups distinguished by size and degree of commercialisation as referred to above. These changes may reduce pressure on marginal agricultural land in lowland areas as well as reducing stocking rates in some upland areas. This could reduce the probability of runoff commonly associated with intensive agriculture. However, continued intensification of agri-business operations could exacerbate problems in other areas.

Evidence from scientific literature showed that the impact of rural land use on flood generation is difficult to quantify and model. The impact of runoff generation at field-scale in upland areas on flood generation at catchment-scale remains uncertain. Anecdotal evidence suggests that agricultural land use can generate 'flash', often called 'muddy' floods caused by local heavy rainfall events. However, land use appears to be much less important at the catchment scale when long periods of high rainfall cause large-scale flood events.

The physical and financial impacts of flooding (and water logging) on agricultural land is reasonably well known. The impacts of flooding on farmland depend on the value of the crops that are damaged or displaced, either temporarily or permanently, and the indirect effects on other operations within the farm business. Farmland in lowland areas often acts as a receptor area for floodwater storage. In some cases, sacrificial 'washlands' and impoundment areas on farmland are designed to reduce flooding elsewhere.

Although different individuals, groups and organisations have different degrees of interest in and influence over the management of rural land as it relates to flood risk, there is potential to join these up to support an integrated approach to controlling runoff from rural land. Stakeholder Analysis for the Ripon case revealed that many stakeholders have complementary objectives which interact directly or indirectly with flood risk management. These include supporting farm incomes and the rural economy, reduction of diffuse pollution, enhancement of wildlife habitats, river restoration and flood risk management. It is apparent, however, that some stakeholders that have most interest in controlling runoff may not have most influence, and vice versa. Although farmers may have influence as land managers, they may have little interest in adopting runoff control measures especially when changes land practices appear to negatively impact on farm incomes and the benefits of their actions pass to others without compensation. Farmers are sometimes disinterested because they perceive they have little influence individually because solutions to flooding problems require collective action which is not guaranteed. Furthermore, they may be more interested if they become more aware of the damage to their soils associated with excessive runoff.

It is apparent that the control of runoff from farmland is best achieved by pursuing multiple and complementary objectives, especially joining up measures to control diffuse pollution, soil conservation and flood risk management. This requires mobilising and 'joining-up' relevant stakeholder interests and influences, including collaboration and strategic alliances amongst stakeholders to pursue mutually enhancing objectives. Seeking ways of jointly achieving biodiversity targets (for

example of interest to Wildlife Trusts and Natural England), improved water quality (e.g. Yorkshire Water), good agricultural practices (e.g. Defra), reduced flooding (e.g. Environment Agency) and improved farm incomes (e.g. Country Landowners Association) is an example.

Environmental and agricultural policies remain fragmented despite recent attempts to join them up. Flood risk management, diffuse pollution control, and biodiversity are the subject of different policy regimes which typically fail to join up either actions or funding at the local and catchment scale. The compliance requirements of the new Single Farm Payment Scheme and the Entry and Higher Environmental Stewardship Schemes provide opportunities for better integration. New regulations such as the Water Framework Directive provide a further impetus to 'join-up' various elements of policy as they relate to land and water management. In this context, Defra's Catchment Sensitive Farming is a welcome initiative. Similarly, Defra's strategic review of flood risk management - Making Space for Water - recognises the importance of an integrated approach in which rural land management has an important part to play. However, evidence from stakeholder analysis reported below showed that it has proved difficult to bring these initiatives and funding streams together at the local level.

Farmers commonly felt that it was unreasonable to hold them to account for flooding problems when, in their view, many of the processes responsible for flood generation were beyond their control. During interview, farmers generally felt that more frequent heavy rainfall, road runoff and property development in floodplains were the main factors associated with perceived or actual increase in flood risk. Although some farmers acknowledged that land drainage and soil compaction on farmland may have led to flood generation, none felt responsible for possible increased flood risk, that is, for flooding that results in damage. Many felt that flood risk may have increased due to factors that were beyond their control, such as climate change and increased building in the catchment. They particularly thought that building in the floodplain had made things worse, both in terms of generating runoff and causing damage when flooding occurred.

Farmers felt generally more responsible for diffuse pollution and soil erosion problems which could be directly attributed to land management practices than they did for flooding problems. The latter, in their view, were less directly associated with land management. In the Parrett catchment, however, well publicised threats of prosecution to compensate for damages due to mud-laden runoff from farmland had increased awareness amongst farmers of the need to manage such environmental risks. It was clear, in this case and others, that farmers are willing to accept responsibility for flooding problems where there is a clear link with land management practices. In the Parrett case, free advice and technical assistance provided by the local Farming & Wildlife Advisory Group (FWAG) helped to change attitude and behaviour amongst farmers in ways which have alleviated localised flooding problems. It also seems that measures that can simultaneously alleviate problems of runoff, soil erosion and pollution are likely to gain more acceptance by farmers than those which focus solely on runoff control.

A conceptual model, constructed from farmer interviews, confirmed that farmer decision-making on land management is influenced by a composite set of drivers such as Government policies, markets and prices for agriculture products, personal characteristics, physical assets and available technology. Economic incentives, provision of the appropriate technology, and awareness-raising amongst farmers and opportunities for farmers to enhance their public reputation were shown to be factors that are likely to increase farmer willingness to implement runoff control measures. As the farming community changes, and different types of farmers respond to different drivers, new and diverse policy interventions might be needed to involve the entire farming community in flood risk management.

The likely effect of land use and farming practices on runoff generation can be assessed in terms of the effect on infiltration capacity of soils, and the degree of connectivity between flows from the field and the receiving watercourses. In areas with low infiltration (due for example to soil compaction), practices such as improved soil management, rough seedbeds, low stocking rates and housing of livestock during wet periods can increase the infiltration capacity and thus reduce flood generation. In areas with high flow connectivity, practices that intercept surface runoff on the hillslope such as hedgerows, woodlands, buffer strips, contour-bunding, retention ponds, and surface interceptor and retention drains can help to reduce flood generation.

A simple, visual decision support tool, called FARM-Tool, was developed that enabled farmers and other stakeholders to quickly appreciate the relationship between topography, soils, land management and the probability of runoff which could cause flooding. This tool proved extremely effective for developing informed discourse amongst key stakeholders, helping to identify actions for controlling runoff which are acceptable to stakeholders.

A sample of good land management practices that help to reduce runoff, soil erosion and diffuse pollution, identified by Defra and the Environment Agency, was assessed against a set of criteria in order to evaluate multiple benefits and likelihood of adoption. Discussions with farmers and other stakeholders showed that practices that are simple, low-cost, clearly effective, reliable under a range of conditions, and can address multiple objectives are more likely to gain acceptance and be adopted by farmers than practices which do not have these features. Practices such as conservation of existing hedgerows and stonewalls, field margins and buffer strips are particularly attractive because of their multiple benefits. For the most part, however, hedgerows and stonewalls are existing landscape features and their improved maintenance, though beneficial, may not result in significant alleviation of run-off. However, awareness-raising combined with technical assistance could increase the uptake of other beneficial practices such as buffer strips, cover crops and rough seedbeds. Incorporating them into environmental compliance and enhancement regimes could further promote their adoption.

Changing priorities with respect to farming and the countryside have encouraged, at least in theory, a commitment to integrate policy in pursuit of 'multi-functional agriculture' that delivers ecosystem services. Under this new paradigm, opportunities arise for farming and rural land use to achieve a range of objectives simultaneously,

such as agricultural production, protection and enhancement of the natural environment and wildlife, flood risk management, public access to the countryside and sustainable rural livelihoods. In this respect, flood risk management is one of a number of 'ecosystem services' provided by rural land management that are useful and valuable to a range of stakeholders. It is important to recognise the contribution of rural land management to flood risk management and the extent to which it complements or conflicts with other ecosystems services.

A review of four future scenarios (World Market, Global Sustainability, National Enterprise and Local Stewardship) revealed that the degree and intensity of agricultural land use, and consequently flood risk, is likely to vary by 2050 under the different scenarios. This variation has implications for the probability of runoff generation from farmland and the opportunities for flood risk management. Current trends appear to be promoting a Global Sustainability type scenario, that is, an internationally competitive agricultural sector, but with a commitment to environmental protection through agri-environment and compliance with good farming practices. Such a future would emphasise multifunctional rural land use through a mixture of regulatory and economic instruments, incorporating flood risk management with other strategies to achieve sustainable land and water management at the catchment scale.

In the near future, however, it is likely that a mixture of policy measures will be needed to reduce runoff from farmland. For the most part, voluntary measures, supported by economic incentives, are deemed most appropriate to address runoff from diffuse sources. However, in areas where there is a clear link between land management and flood risk, stronger measures that regulate high risk processes may be called for.

It is important to develop tailor-made interventions to reduce flood generation for individual catchments, as each catchment differs in topography, soil type, land management and hydrology. Blanket prescriptions are unlikely to prove effective, efficient or fair when pursuing an integrated, multiple-objective approach. In this respect, the study showed a need for a risk-based decision support tool to systematically assess the risk of runoff from farmland allowing for spatial variation in topography, climate and soil type. This would support policy making and implementation of integrated interventions at the catchment and sub-catchment scale. It would also help to engage key stakeholders in understanding the links between rural land use and flood risk management, and assessing possible solutions.

Conclusions,
The main conclusions of the study are as follows:

- *After a period of intensification in agriculture, many farmers have reduced the intensity of their production systems in response to declining profitability and policy reforms*. This is likely to result in decreased pressure on rural land, especially in areas of relatively low productivity, including upland areas where stocking rates are decreasing. This could help to alleviate runoff and flood generation in these areas. In some areas, however, large scale intensive farming methods could exacerbate runoff problems.

- *A range of stakeholders needs to be brought together at an early stage in order to achieve an integrated approach to flood risk management*. It is important to map key stakeholder interests and influences, and the extent to which these are in harmony or conflict, in order to inform an approach to integrated rural land management, of which flood risk management is part.
- *There is a need to promote land management practices which simultaneously achieve multiple benefits such as soil protection, runoff control, pollution control, enhancement of wildlife and sustainable rural livelihoods.* This is likely to significantly increase farmer and other stakeholder interests in taking action to control runoff. The new agri-environment schemes are potentially useful instruments to achieve this, but some aspects may require better targeting.
- *A mix of policy interventions is required to influence farmer decision-making*. In most cases, voluntary measures, supported by economic incentives will be appropriate. The latter can be linked to compliance with good practice, as well as rewarding actions which enhance the provision of flood management services. In some areas, however, it may be appropriate to regulate land management practices to avoid unacceptable risks.
- *An integrated approach will only be effective if it is tailor-made to suit local catchment conditions.* In many cases, generic guidance on good practices that can achieve multiple purposes, supported by incentives and technical assistance, may be sufficient. In areas where runoff generation from farmland can result in serious flooding problems, there may be need for specific, targeted measures.

Recommendations

The following recommendations are made for further research:

- *Evidence of the link between agricultural practices, runoff and flooding*. Further research is required to confirm the relationship between land management at field scale and flood risk at catchment scale in areas where it is perceived that changes on the former could make a difference.
- *Appraisal of management practices*: An advanced multi-criteria analysis is recommended to determine the suitability of runoff-controlling measures according to the preferences of various stakeholders, including farmers, in order to strengthen policy interventions to promote these measures. Practices can be assessed against their performance to achieve multiple objectives (e.g. runoff retention, prevention of diffuse pollution and soil erosion, habitat creation) and against the criteria that stakeholders use to assess the suitability of these practices (e.g. low-cost, effectiveness, simplicity to implement).
- *Action Research – monitoring the flood risk aspects of CAP-reform.* The impacts of practices promoted by cross-compliance and Environmental Stewardship on runoff generation, conservation management, pollution control and farm livelihoods should be closely monitored in potential high risk catchments in order further to develop an integrated approach to flood risk management.
- *Agricultural Runoff Decision Support Tool*. It is recommended that such a tool is to developed to support the assessment of the link between land management and the probability of flood generation, improved stakeholder understanding of and participation in flood risk management, and policy design and implementation.
- *Action Research – stakeholder engagement.* Effective means for stakeholder engagement should be identified through action research, in order to achieve

participation as a basis for sustainable solutions. Given the shared responsibility at the sub-catchment scale, this should adopt the theoretical framework of collective choice which can help to explain why and how stakeholders come together to pursue a common goal.

- *Targeted catchment studies*. It is strongly recommended that the above research proposals are brought to together and applied in the context of a number of selected catchments/sub-catchments where there is a good chance that changes in land management practices can make a difference to runoff generation and flooding problems. Such as research project would combine stakeholder analysis, hydrological modelling, the use of the flood risk FarmTool, multi-criteria analysis, and the design and evaluation of programmes of measures to control runoff from rural land which are likely to appeal to major stakeholders.

Acknowledgements

The researchers thank the many farmers who took part in the study, the participants of the Ripon workshop, and others who have supported the enquiry at various stages. The assistance of the following persons is appreciated: Fergus Sinclair and Tim Pagella of Bangor University for the Wales case study, Glyn Vaughan of the Environment Agency for the Eden case study, Melissa Robson of the Environment Agency for the Wiltshire case study, Ben Thorne and Jo Oborne of FWAG for the Parrett case study, and Deirdre Murphy of Defra for the Ripon case study. The support of Caspar Hewett and Paul Quinn of the University of Newcastle on Tyne during the stakeholder workshop is warmly acknowledged.

Thanks are expressed to our Work Package and Research Theme colleagues, especially Joe Howe, Queen's University, Belfast and Iain White, University of Manchester. The support of the FRMRC programme and EPSRC are acknowledged.

The interest and guidance given by David Richardson, Flood Risk Management Division, Defra, is gratefully acknowledged.

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1 Introduction

1.1 Background

Climate change, perceived increase in flood incidence and changing priorities in the countryside have led to a growing concern that changes in land use in rural areas have increased the exposure of urban settlements to flood risk, not only at a local level but also at the catchment scale. This has led to calls for interventions to reduce the potential runoff from farmland and in some cases to reduce the degree of protection afforded to farmland in order to provide temporary storage of flood waters. It is also claimed that reducing runoff from farmland could reduce diffuse pollution from agriculture. Furthermore, the creation of flood storage areas could provide opportunities for wetland creation and enhanced biodiversity.

In this context, it is perceived that measures to control runoff from farmland could make an important contribution to reducing flood generation and associated risks. Given the current climate of policy reform, this might be achieved in ways which simultaneously deliver benefits to the rural environment and those people who live and work in it.

Flood risk is defined as the probability of a flood event occurring times the damage costs that is caused by the flood event. When discussing the link between rural land management and flooding, only the effect of rural land management on the frequency of flooding is considered. Therefore, the terms flood generation and flood risk are distinguished in this report. The term flood generation is used to indicate the runoff processes that contribute to the probability of a flood event occurring. The term flood risk includes the damage caused by flooding.

1.2 Aim and objectives

The broad aim of this work package was to develop and apply methodologies to help inform sustainable flood management solutions in rural areas, under possible future land use scenarios.

The specific objectives were:

- To appreciate the link between rural land use and flood risk, both as a pathway and a receptor;
- To define the drivers which influence agricultural and rural land use and management decisions as they relate to flood generation and risk;
- To identify and evaluate rural land use and management practices that can contribute to the management of flood risk and the factors that are likely to influence their adoption by land managers;
- To identify and evaluate policy mechanisms that can be used to promote adoption of appropriate land use and management practices;
- To determine the extent to which flood risks and associated management solutions are likely to vary according to possible rural land use futures.

1.3 Methodology

In pursuit of these objectives, the Drivers-Pressures-State-Impact-Response (DPSIR) framework was used to capture the diverse interaction between the causes and effects of flooding associated with rural land use and assist in the design and implementation of appropriate management interventions. As part of this process, the following research activities were undertaken:

- A literature review was undertaken to identify key elements of the DPSIR framework, including:
    - Indicators to assess social, economic and environmental performance of rural and flood management options;
    - Drivers affecting land use with particular reference to agricultural and agri-environment policy, and agricultural commodity markets and prices;
    - Land use and management practices and implications for runoff and flood generation;
    - Flood management standards and implications for land use and management;
    - Adoption and diffusion of land management practices by land managers;
    - Costs and benefits of flood management in the rural sector;
    - Opportunities for flood management and other objectives, including bio-diversity, amenity, water resources and rural economy;
    - Rural land use futures using scenario analysis; and
    - Policy analysis and choice of policy mechanisms.

- The key stakeholders in flood risk management at national level were identified based on the literature review. A stakeholder analysis was carried out at catchment scale for the Ripon catchment in North Yorkshire in order to identify key stakeholder interests and influences concerning agricultural land management and flood risk. This analysis helps to identify synergies and conflicts between objectives of different stakeholders, and strategies to keep stakeholders involved.

- Land use and farm management surveys: Farmers have been interviewed in five selected catchments throughout the UK. In this way, a variety of situations are taken into account, including upland and lowland areas, and from arable and livestock farming. The five catchments are located in (see also Figure 1):
    - Montgomeryshire (Wales) – the Pontbren catchment, which is part of Upper Severn basin,
    - Cumbria – the upper part of the Eden catchment,
    - North Yorkshire – the Ripon catchment (comprising the rivers Laver and Skell),
    - Wiltshire – the Hampshire Avon catchment (upstream of Salisbury), and
    - Somerset – the Parrett catchment.

  These catchments were chosen in order to have a geographical spread of case studies, for the known problems with flooding, soil erosion or diffuse pollution, and because of existing contacts with agencies such as EA, FWAG and Defra.

Interviews were held with farmers in the five catchments. In each catchment six to nine farmers were selected randomly. The snowball-sampling technique[1] was used to come into contact with other farmers. The interviews were semi-structured, constructed around topics such as drivers of past and future changes in farming, the CAP-reform and agri-environment schemes, and runoff-related issues such as flooding, soil erosion and diffuse pollution. If relevant for a certain farmer, a particular topic was explored more in detail. An interview normally took between 60 and 90 minutes. The interviews were recorded, unless the farmer objected to be recorded. The interviews were all transcribed and content analysis was carried out using the software ATLAS.ti. For the purpose of the Ripon-MOP, additional interviews were held in Ripon covering topics such as land management practices, decision making and attitudes towards runoff control. Also a stakeholder workshop was organised in Ripon, to bring different stakeholder groups together to discuss sustainable land and water management in the Ripon area, using the FARM-tool as a support tool for the discussion.

Figure 1 Location of the five catchments selected for farmer interviews

- Farmer adoption behaviour: drawing on literature review and the results of the interviews, a conceptual framework to represent the process by which farmers adopt particular land use and management practices and the factors influencing their decisions (as they affect flood management) was drawn up.

- A menu of interventions measures was drawn up containing techniques that can be adopted to reduce the probability of runoff from farms. These were evaluated against sustainability indicators and the decision criteria derived from farm interviews. The effectiveness and efficiency of these measures was assessed, with particular reference to fitness for purpose, acceptability to the user community and likely adoption.

- Review of agricultural and land use futures: Scenarios were developed for the business as usual case based on the reform agenda for the Common Agricultural Policy (CAP) as it is currently mapped out until 2012. Alternative scenarios are generated for agriculture using the Foresight Futures framework. These scenarios

[1] After each interview, the interviewee was asked whether he knew other farmers in the area who might be useful to talk to.

vary in terms of the extent to which UK agriculture is exposed to international competition and the degree of commitment to social and environmental objectives in the development agenda. The DPSIR framework can help to define possible rural land use futures and the implications for flood management.

– Policy analysis: The relative advantages of alternative policy mechanisms, namely regulation, economic instruments, voluntary codes and other support methods such as research and extension were ascertained. Opportunities to build in mandatory codes of good practices as part of the compliance required to qualify for farm income support were explored, as well as the scope for management options within agri-environment schemes.

2 Rural Land Management and Flood Risk

The extreme flood events in different parts of Europe in the mid 1990s raised concerns about the consequences of flooding (Savenije, 1995; Bronstert, 2003; O'Connell et al., 2004; Pfister et al., 2004). There is a general belief that such flood events will occur more frequently in the future. This is attributable to predicted changes in climate which can affect the duration and intensity of rainfall events. Flood frequency is also associated with changes in land use which, along with the features of natural and man-made hydraulic systems, can not only affect the movement of water through the landscape, but affect the scale of damage to people and property when flooding occurs (Reynard et al., 2001; Brown and Damery, 2002; Fowler and Kilsby, 2003; Penning-Rowsell et al., 2005; Borrows and Bruin, 2006). The flood events in the late 1990s showed that flood 'defence' was no longer sufficient to cope with such natural hazards, but that a more diverse and integrated approach to flood risk management at the catchment scale is needed (Savenije, 1995; Brown and Damery, 2002). This approach, represented in the case of England and Wales by Defra's 'Making Space for Water' (Defra, 2004), recognises the importance of controlling development in flood prone areas as well as controlling runoff from rural catchments where this can be shown to make a difference.

Sections 2.1 and 2.2 of this chapter present the main points of the literature review on land management and flood risk. A review of literature can be found in Annex 1. The stakeholder analysis described in section 2.3 is based on literature and secondary data, and applied for the Ripon catchment in North Yorkshire. Section 2.4 gives an overview of relevant policies for flood risk management.

2.1 Drivers affecting land use and management

Agriculture accounts for approaching 75% of the total land use in England, and is thus the main use of rural land. Important drivers affecting agriculture and land management are: agricultural policies, prices and subsidies, and demographic changes. After the Second World War, the UK government committed itself to an intensified and modern agriculture and its policy instruments included price subsidies, ploughing grants and capital grants (Dobbs and Pretty, 2004). As a result, rural land use underwent major changes as agriculture became more intensive. The pre-war landscape with small fields, hedgerows and natural meandering rivers, was transformed into a post-war landscape with larger fields, compacted soils due to machinery, land drains and aligned rivers and channels (O'Connell et al., 2004).

From the 1960s until the 1980s, European agricultural policy continued the promotion increased production of and self-sufficiency in food and fibre, simultaneously supporting farming income through price policies (Ogaji, 2005). The subsidies provide incentives to farmers to intensify agricultural production through more intensive use of inputs, generating environmental impacts such as water pollution, land degradation and biodiversity loss (Mayrand et al., 2003).

In the mid 1980s, a substantive change occurred in British agricultural policy as a modification in the Common Agricultural Policy (CAP) allowed the creation of agri-environment schemes. These schemes are policy instruments which provide financial incentives to farmers to adopt practices that protect and enhance the farmland environment and wildlife. The Environmentally Sensitive Areas (ESA) and the Countryside Stewardship scheme (CSS) were the two main agri-environmental interventions, introduced in 1987 and 1991 respectively. In 2005, a new CAP-reform came into force, decoupling financial support to farmers from their agricultural production. Direct production subsidies were reduced and income support payments, based on historical entitlements, are linked to compliance with standards (Cross Compliance rules) which protect the environment, animal health and welfare. The environmental burden of farming is expected to reduce by the changes of the CAP-reform, through a mixture of extensification of farming, increased compliance, and wider participation in agri-environment schemes (O'Connell et al., 2004).

Recent demographic change in the rural population is likely to change rural land use as well. Net incomes from farming have declined, as well as the number of farmers (see Annex 1). Many farm households have diversified their income by multiple job-holding by family members. It is expected that the farming community will continue to diversify, ranging from the diversification of income on- or off-farm to the replacement of farmers by 'life-stylers' (Lobley and Potter, 2004). This change in the (financial) relationship between the rural inhabitants and the rural land is likely to cause changes in the use and management of the land as well.

2.2 Agricultural land management and flood generation

It is assumed that the intensification of agriculture has resulted in increased flood generation (Bronstert, 2003; O'Connell et al., 2004; Evans, 2005). The Environment Agency (2002; cited by: O'Connell et al., 2004) suggests that 25% of major flood events over the period 1970 to 1990 were associated with runoff from hill slopes, and that 57% of these events have been linked to erosion and deposition. Though there is no firm evidence, the Agency concludes that 14% of flood damage costs in England and Wales are attributable to hillslope floods and to agriculture, equivalent to £115m per year. Two key messages arise: first, the costs of erosion and related runoff from farmland are mainly felt off-farm (for the most part in the immediate vicinity); and second, the incentives for farmers to adopt erosion and runoff control measures are limited.

Despite the advanced modelling techniques, it appears difficult to quantify the impact of agricultural land use on flood generation, as climate change and urbanisation also have a large influence on flood risk and it is difficult to disentangle the different factors.

There is consensus among scientists that at the large scale (e.g. national level) the effects of climate change (that is, increasing winter rainfall) and to a lesser extent urbanisation are the main drivers of increasing flood risk. At the local scale, however, agricultural land use can have an important impact on local flood events, especially during intense storms in summer resulting in flash floods (Niehoff et al., 2002; Hall et

al., 2003; O'Connell et al., 2004; Pfister et al., 2004). Land use changes can reduce the infiltration capacity of the soil, causing rapid runoff generation like Hortonian overland flow[2] (Naef et al., 2002). This occurs when the soil surface is sealed through erosion processes, or the soil has compacted layers. Soil compaction due to intensification of agriculture and erosion-inducing crops are important contributors to such local flood events (Evans, 1990). For example, conversion of grassland into arable land resulted in local muddy floods in the South Downs in England (Boardman, 2003). Also increased stocking rates in upland areas have reportedly increased runoff and (winter) discharge due to soil compaction and reduction in vegetation cover (Sansom, 1999).

Peatland catchments tend to have flashy hydrological regimes as there tends to be limited storage capacity: small amounts of rainfall are enough to raise the water table to the surface (Holden, 2005). Drainage of peat and moorland in the uplands might also have contributed to increased flood generation as storm runoff is discharged faster through the drains (Robinson, 1985; Stewart and Lance, 1991; Sansom, 1999).

Agricultural land can also be the receptor of flooding. Either flood defence can prevent agricultural land being the receptor, or measures can be taken to induce agricultural land being a receptor in order to protect downstream urban areas. It depends on the location and quality of the agricultural land which option is preferable. When farmland on floodplains is used to store flood waters temporarily in order to reduce the flood risk downstream, there is scope to integrate flood risk management objectives with those of conservation management, extensive farming and rural livelihoods through the creation of riverine washlands (Morris et al., 2005b). The new Environmental Stewardship scheme includes a component for inundation grassland for this purpose. The impact of changes in flooding on a given part of a farm can have an effect at farm scale. The losses to the farm differs from the losses on the flooded field, due to 'knock-on' effects on farm operations which depend on the internal organisation, availability of production resources, and the farmer's objectives (Pivot et al., 2002).

2.3 Stakeholder mapping

In Figure 2 the flood management organisation for the UK is presented. Currently there are three main bodies involved in the management of flood risk at the national level: Department of Environment, Food and Rural Affairs (Defra) for England, the Welsh Assembly (WA) and the Environment Agency (EA). Defra and WA have the overall responsibility and set the general targets for flood and coastal defence policy. The EA is the principal operating authority, and supervises all matters regarding flood risk management for main rivers. The Regional Flood Defence Committees (RFDCs) and Local Flood Defence Committees (LFDCs) were created under the *Environment Act* 1995. These committees consist of member appointed by the EA and of elected members from constituent councils, and have executive powers to sanction flood defence works and to raise the necessary funds (Brown and Damery, 2002).

[2] Hortonian overland flow happens when runoff starts without the soil being saturated, for example when the sealing or crusting of the soil surface occurs.

The Internal Drainage Boards (IDBs) and Local Authorities have the responsibility for flood risk management for 'ordinary watercourses'. The IDBs manage land drainage in lowland areas of 'special drainage need', and undertake flood defence works where necessary. The Local Authorities are empowered to construct flood defence works on ordinary watercourses outside IDB districts, are responsible for the control of development within their jurisdiction and, in a flood event, coordinate emergency planning and community aid (Brown and Damery, 2002). These organisations thus carry out their respective functions in order to deliver acceptable standards of flood defence and land drainage to their 'client', end-user communities, namely individuals, groups and organisations whose interests are at risk of flooding and poor drainage. At the same time, there is a requirement to meet these needs without compromising the interests of others who may be affected now and into the future by the choice of flood risk management solutions. The latter consideration implies that flood risk management solutions are 'sustainable' in terms of social, economic and environmental criteria.

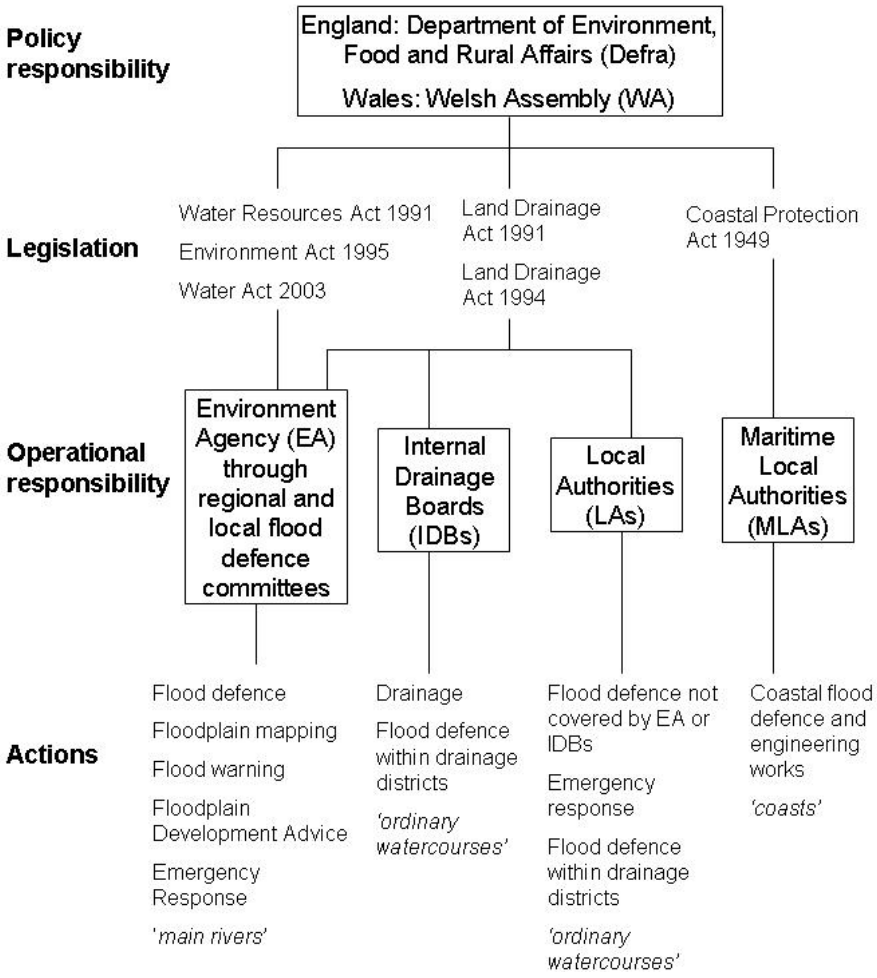

Figure 2 Flood defence organisation and responsibilities (after: Brown and Damery, 2002; Howarth, 2002)

Besides the above-mentioned stakeholders, there are more stakeholders that have an interest in flood risk management, either because floods affect their operations or their

activities have an impact upon flood risk. These secondary stakeholders comprise land users, residents at risk of flooding, NGOs such as National Trust, River Trusts, Wildlife Trusts and English Nature, enterprises such as water companies or industries situated in floodplains, and insurance companies.

A detailed stakeholder analysis was carried out for the Ripon catchment in North Yorkshire (Posthumus et al., 2006). Annex 2 gives a short description of each stakeholder, many of which are involved in the Ripon Multi-Objective National Pilot Project[3] (Ripon-MOP). Table 1 presents a summary of the interests and attitudes towards flood risk management of the stakeholders. The stakeholders and the links between them and flood risk management are summarised in Figure 3.

The EA and Harrogate Borough Council (HBC) are most directly involved in flood risk management in the Ripon area. The EA tries to reduce the probability of flooding by means of catchment management plans in general and, more specifically, the proposed Ripon flood alleviation scheme. The HBC focuses more on the reduction in damage, by responding to flood emergencies (e.g. providing sandbags). The Parish Councils are the intermediaries between the residents at risk of flooding and HBC.

Other stakeholders also have an interest in flood risk management. Since the majority of the land is used for agriculture, land managers and land owners (including the owners of moorland) have a role to play if land is used for retention of runoff in order to reduce flood generation. However, the main objective of land managers is to achieve a viable farm enterprise, which might not always coincide with the objective of reducing flood generation. The NFU and CLA are representatives of land managers, and often act on their behalf, but not all land managers associate with these two organisations. The National Trust is another important land owner with 333 ha in the catchment. It also controls the water levels of the water gardens of Fountains Abbey, through which the river Skell flows.

Another group of stakeholders (comprising Nidderdale AONB, English Nature, Yorkshire Wildlife Trust and Yorkshire Dales River Trust) is mainly concerned with nature conservation in the area. They have considerable interest in river restoration and wetland creation, which provides opportunities to increase the water storage capacity of the catchment, especially along the rivers. The Forestry Commission and the Yorkshire Water have an indirect interest in flood risk management in the Laver and Skell catchments, because they have potential to contribute to or may be affected by interventions to reduce flood risk in the area.

[3] The Ripon-MOP started in 2004 and aims to demonstrate that links can be made between diverse objectives and funding streams so identifying solutions to address a range of issues within a catchment including flood management, biodiversity, pollution control, land management and public amenity. (See http://www.defra.gov.uk/environ/fcd/policy/wetlands/riponmop.htm for more information)

Table 1 Stakeholder analysis in Ripon catchment, North Yorkshire

Stakeholder	Interest/ objectives	Impact FRM on interest	Attitude to FRM	Influence on FRM	Interactions with FRM
Inhabitants at risk of flooding	• Low risk of flooding	+	+ +	Low	• Risk of damage to property
Land managers	• Agricultural production • Income / viable farm enterprise	+ / – –	+ / –	Low	• Decision-making on land management
Defra	• Provide guidance for FRM • Agricultural production • Viable rural communities	+ + + / – + +	+ +	High	• Making Space for Water • Catchment Sensitive Farming • Environmental Stewardship
Environment Agency	• Flood defence main rivers • Awareness raising and warning of public • Nature conservation (wet habitats)	+ + + + + / –	+ +	High	• Catchment Flood Management Plans • Flood risk maps • Flood forecasting & warning
Forestry Commission	• Protect and expand forest and woodlands in UK	+	+ +	Medium	• Woodland planting in floodplains and upland areas to retain water
Harrogate Borough Council	• Flood defence smaller watercourses • Emergency planning (response to flooding) • Development planning (incl. floodplain)	+ + + + –	+	Medium	• Deploy men and materials to risk areas • Developing community based plans • Raising awareness within local communities
NFU	• Representing farmers' interests • Successful and responsible agriculture	+ / – + / –	+	Medium	• Active promotion of measures to reduce diffuse pollution
CLA	• Representing rural land users and managers	+ / –	+ / –	Medium	• Made own action plan for FRM policy
Nidderdale AONB	• Conservation of areas of natural beauty	+ / –	+ / –	Low	• Intervene in land use upper part of catchment
English Nature	• Conservation of wildlife and wild places	+ / –	+	Medium	• Provide agri-environment schemes
Yorkshire Wildlife Trust	• Conservation and enhancement of wildlife	+ / –	+	Low	• Promote river restoration and creation of wetlands
Yorkshire Dales River Trust	• Conservation of rivers and wetlands	+	+ +	Low	• Promote river restoration and reduction of diffuse pollution
Yorkshire Water	• Drinkwater extraction	+ / –	+	Low	• Is interested in clean water, also land owner
Fountain Abbey (National Trust)	• Conservation of Fountain Abbey and water gardens	+	+	Medium	• Large land owner, regulates water levels in the river Skell

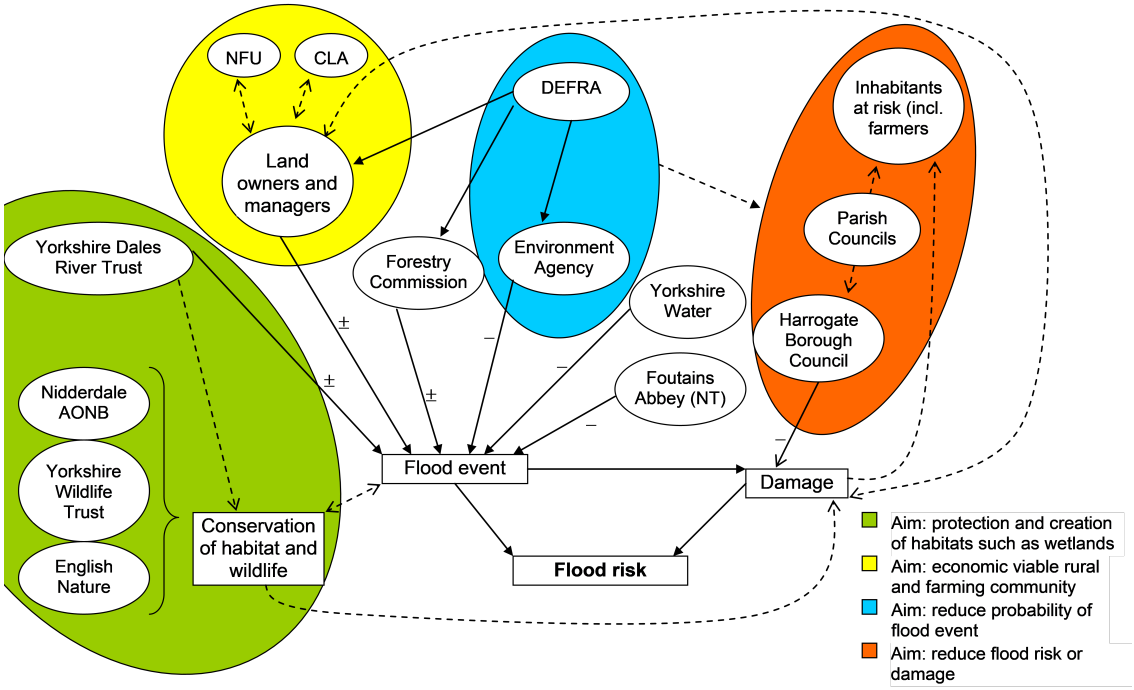

Figure 3 Stakeholder map of flood risk management in Ripon

Though flood risk management is not the main objective of the majority of the stakeholders, most appear to be in favour of interventions that increase the water storage capacity of the catchment and reduce flood generation, as multiple benefits can be achieved. Examples of multiple benefits are enhancement of wet habitats (interest of nature conservation oriented organisations), reduction of water pollution (interest of Yorkshire Water), reduction of flood damage (interest of HBC), and possibly a more constant flow in the rivers (interest of Fountains Abbey). The main conflict arises with the objective of viable farm enterprises of the land managers, if an intervention means that investments (without direct returns) have to be made on farmland.

Based on Table 1, the stakeholders can be located in a power/interest matrix (Figure 4) that classifies stakeholders in relation to the power they hold and the extent to which they are likely to show interest in flood risk management. Obviously, the key players in flood risk management are the Environment Agency and Defra, but also English Nature, especially once it is reorganised into Natural England. The position of the land managers in Ripon on the stakeholder map depends on the approach towards flood risk management. If structural measures such as flood defences in Ripon are considered, the power of the land owners is low as their land is not affected. However, if measures are to be implemented on farmland in order to reduce the flood risk, the power of the land owners becomes very high as they are the final decision-makers with regard to implementation (assuming the government does not use compulsory purchase orders).

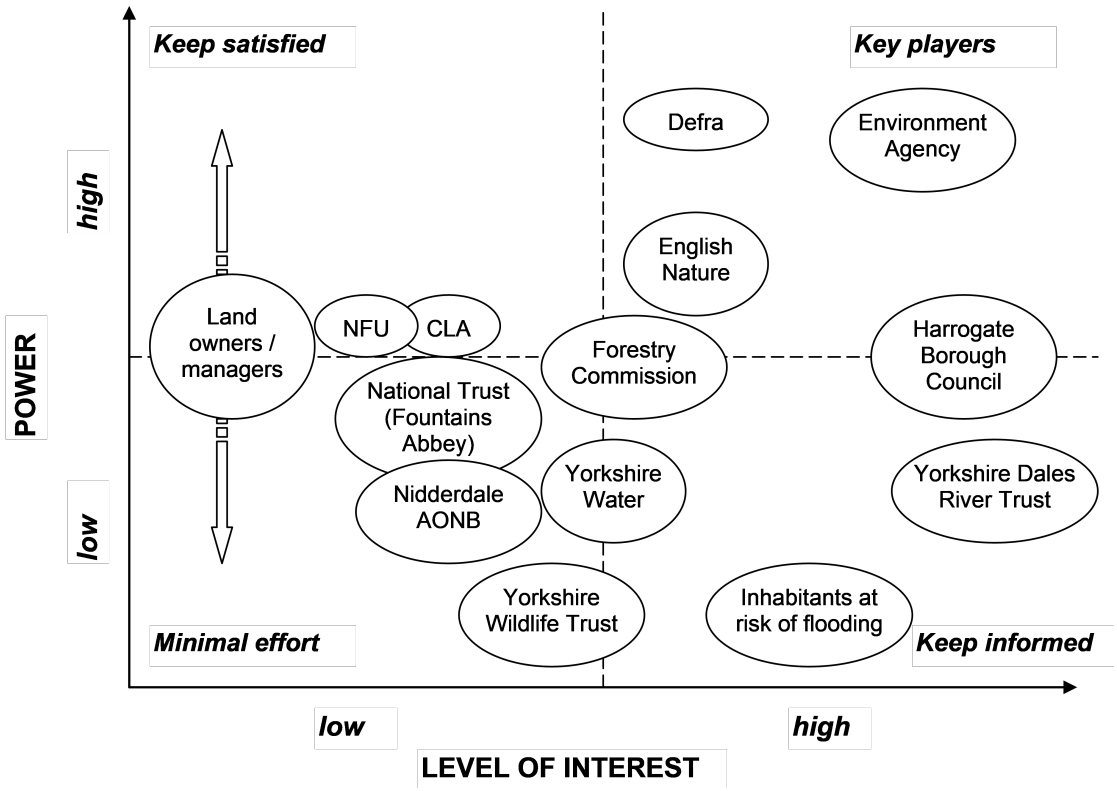

Figure 4 Stakeholder mapping with regard to flood risk management in Ripon

Thus the challenge is to increase the interest of land managers and owners, and their representatives so that they become key players. It should be realised though that, especially with the increasing diversity of land owners, different types of land owners can be distinguished. Some land owners are more environmentally oriented than others, and some might be affected by flood risk themselves, and therefore more interested in flood risk management than others. Stakeholders with high interest but low power might find it advantageous to collaborate with key players to meet their objectives. Figure 3 also shows the strategy that might be adopted by Ripon-MOP to manage stakeholder relations, namely, keeping satisfied, keeping informed and minimal effort. All the other stakeholders lie between the classes of 'minimal effort' and 'keep informed'. A common ground of interest should be developed by including issues such as catchment management, wetland creation and diffuse pollution, in order to mobilise the interest of stakeholders who currently have a low interest, but would be useful as key players to achieve the objectives of Ripon-MOP. The concept of multi-purpose project, such as the Ripon-MOP is promising as it creates a platform for all stakeholders to negotiate and exchange. In practice, however, these projects appear to be quite a challenge.

2.4 Policy review

Several national government policies and EU Directives influence rural land use and flood risk management. A brief overview is given below.

UK Legislation for water management

The Water Resources Act 1991 gave the National Rivers Authority (NRA, now Environment Agency) comprehensive control powers over 'main rivers' (Kampen-Brouwer et al., 2004). Some of the duties include:

- supervisory duty over all matters related to flood defence
- surveying duty in areas in which EA carries its flood defence functions
- executive powers to maintain existing flood defence
- powers to provide flood warning systems
- regulatory powers with respect to flood and water level control

The Land Drainage Act 1994 imposed duties on the authorities responsible for flood defence to further conservation, enhance natural beauty and take account of the effect of their work on the beauty and amenity of any affected area (Kampen-Brouwer et al., 2004).

The Environment Act 1995 provided for the establishment of the Environment Agency and outlines its duties and powers for flood defence and other functions, including water level management (Kampen-Brouwer et al., 2004). The EA took over the responsibilities of the NRA

The Water Act 2003 enhances the Environment Agency's supervisory duties and powers to carry out flood defence and drainage works. Furthermore, it provides new powers to allow the establishment and abolishment of Regional Flood Defence Committees (RFDCs) and to revoke local flood defence schemes and drainage works.

EU Directives

Most environmental regulation in the UK is now the product of EU Directives. The Nitrates Directive aims to reduce diffuse water pollution by nitrate from agricultural sites. The Directive requires member states to either apply an Agriculture Action Program or to create Nitrate Vulnerable Zones (NVZ). New NVZs now cover 55% of England. The potential to cause nitrate pollution of surface or ground water depends on local climatic conditions, physical characteristics such as soils and topography, and farming practice. In some cases pollution risk is linked to runoff-induced flooding. Runoff-retaining measures have potential to alleviate diffuse pollution as well as flood generation.

The Habitat Directive is concerned with the conservation of natural habitats for selected species of flora and fauna, promoting biodiversity while taking into account economic, social and cultural requirements as well as regional and local characteristics. The directive has led to the creation of a network of ecological sites known as 'Natura2000' which is also linked to the *Wild Birds Directive*. The Habitats directive is partly implemented through Biodiversity Action Plans, which focus on key habitats and direct interventions and funding accordingly (UKBAP, 2006). There is a need for data and knowledge to help exploit the opportunities to integrate flood management and biodiversity in floodplains, including integration of funding mechanisms.

The Water Framework Directive (WFD) came into force in 2000 to improve the ecological status of the water environment and encourage sustainable water resource management. The WFD also includes mitigation of the impacts of flooding as a subsidiary objective (Morris et al., 2004). The WFD incorporates other EU Directives as they relate to water resources and environment, such as those pertaining, for example, to Nitrates, Drinking Water Quality, Freshwater Fisheries, Bathing Water Quality, and Habitats. Where farming can be shown to have an effect on the achievement of water quality objectives in a given catchment, it is possible that measures will be introduced to control these effects. The interest in runoff from farmland under the WFD is mainly driven by potential effects on water quality due to diffuse pollution, erosion and sedimentation, and changes in hydro-morphology. The interest in flooding is an indirect one, but could be important where intensive land use has potential, via runoff and soil erosion, to damage water quality and generate flooding problems. It in these circumstances that there is opportunity to integrate a number of policy objectives, associated with for example, CAP-reform, WFD, Biodiversity Action Plans and the new strategic approach to flood risk management apparent in Making Space for Water (Defra, 2004).

The Soil Framework Directive (SFD) is still under construction, but it aims to establish a common strategy for the protection and sustainable use of soil, based on the principles of integration of soil concerns into other policies, preservations and soil functions within the context of sustainable use, prevention of threats to soil and mitigation of their effects, as well as restoration of degraded soils to a level of functionality consistent at least with the current and approved future use (CEC, 2006). Within this Soil Directive, attention will also be paid to soil erosion, which is linked with runoff and flooding.

Changing policies for flood defence

Over the last 50 years, three key phases of water management can be distinguished in England and Wales, namely: land drainage, flood defence and flood risk management. The transitions from one phase to the other were driven by changing values and beliefs in society, governmental priorities and flood events (Johnson et al., 2005).

In 1947, riverine floods inundated large amounts of properties and agricultural land. Especially the prime agricultural region East Anglia was badly affected and agricultural damage was widespread. The fact that the national economy was under stress and dependent on domestic agricultural production justified flood prevention measures on agricultural land (Johnson et al., 2005). Since then, public investments in flood alleviation and arterial drainage have been an important element of government support to agriculture in the UK in the past. These drainage schemes enabled rapid land use intensification and change from pasture to arable (Morris, 1992).

The 1953 East coast floods resulted in large investments in raised flood defences especially along the coast, investment in research to understand and forecast floods, and the development of warning systems. After several decades without any widespread flooding events, society had become complacent about flooding. During Easter 1998 another widespread riverine flooding occurred after exceptional rainfall.

The flood highlighted the need to plan for extreme flood events, but also that structural flood defences cannot provide protection for all potential flood risks. Similar riverine floods occurred again in autumn 2000, resulting in the perception that the exceptional floods in 1998 were not so exceptional after all. This reinforced the view that it was essential to plan for extreme events which might occur as a result of climate change. Attention shifted towards non-structural approaches: e.g. stricter regulations on property development in floodplains (Johnson et al., 2005).

The lessons learned in 1998 and 2000 resulted in the present policy that has moved away from flood defences to flood risk reduction. In order to deliver the UK government's policy aim of reducing flood risk, the Environment Agency has now adopted a strategic approach to flood risk management, targeting and prioritising investment and resources at those areas where flood risk can most effectively be reduced. Increasing the probability of flooding in some locations (where impacts are beneficial to the environment and do not impact adversely on people) is one of the adopted strategies to achieve a net reduction in flood risk (EA, 2003b). This means that floodplains used for agriculture are specifically under review for restoration of the natural floodplain functions. Under the holistic approach 'Making Space for Water', it is suggested that greater use has to be made of rural floodplains to reduce flood risk, for example by creating wetlands and washlands, river corridor widening and river restoration (Defra, 2005).

Agricultural policies: agri-environment schemes

As mentioned earlier, agri-environment schemes are part of the second pillar of CAP, promoting environmental-friendly agricultural land use to protect and enhance biodiversity and natural resources. Before the recent CAP-reform, the ESA and CSS were the main agri-environment schemes. These schemes have been replaced by the Environmental Stewardship recently.

The objective of the ESA was to protect the landscape, wildlife and historic interest of specific areas of England. Farmers received an annual payment for based on income foregone for entering a 10-year agreement which required them to farm according to prescribed management practices. Each ESA had its own environmental objectives tailored to the specific area, and existed of at least one tier. Agreements were voluntarily and non-competitive. The CSS had the following objectives:

- Sustain the beauty and diversity of the landscape;
- Improve and extend wildlife habitats;
- Conserve archaeological sites and historic features;
- Improve opportunities for countryside enjoyment;
- Restore neglected land or features;
- Create new habitats and landscapes.

Voluntary CSS agreements with landowners and farmers intended to fulfil as many scheme objectives as possible. The agreements lasted 10 years during which farmers received financial support to implement the agreement. The CSS was a competitive scheme, meaning that agreements were awarded to applicants with the highest scores or additionality (Carey et al., 2005). The ESA and CS came to an end in 2004, though existing agreements are still running. In total, 653,172 ha were under agreement in

ESAs and 531,280 ha under CS (RDS, 2006). In total this accounts for about 6.5% of the total agricultural area of England.

The Environmental Stewardship comprises the new agri-environment schemes, namely the Entry Level Scheme (ELS), the Organic Entry Level Scheme (OELS) and Higher Level Scheme (HLS), that came into force with the CAP-reform of 2005. The scheme is intended to build on the recognised success of the ESA and CS schemes and its primary objectives to:

- ✓ Conserve wildlife (biodiversity)
- ✓ Maintain and enhance landscape quality and character
- ✓ Protect the historic environment and natural resources
- ✓ Promote the public access and understanding the countryside

If (O)ELS is taken up across large areas of the countryside, it will help to: improve water quality and reduce soil erosion, improve conditions for farmland wildlife, maintain and enhance landscape character, and protect the historic environment. Within the primary objectives, the HLS also has the secondary objectives of genetic conservation and flood management (RDS, 2005).

The ELS is a whole farm scheme open to all farmers and land managers who farm their land conventionally. Acceptance is guaranteed provided the farmer meets the scheme requirements. OELS is similar to ELS and open to farmers who manage all or part of their land organically and who are not receiving aid under the Organic Aid Scheme (OAS) or Organic Farming Scheme (OFS). HLS, which will be combined with ELS and OELS options, aims to deliver significant environmental benefits in high priority situations and areas. ELS provides a straightforward approach to supporting the good stewardship of the countryside; it aims to encourage large numbers of farmers and land managers across England to deliver simple yet effective environmental management that goes beyond the Single Payment Scheme (SPS) requirement to maintain land in Good Agricultural and Environmental Condition (GAEC). OELS takes a similar approach but is geared to organic and organic/conventional mixed farming systems. HLS is designed to build on ELS and OELS to form a comprehensive agreement that achieves a wide range of environmental benefits across the whole farm. HLS concentrates on the more complex types of management where land managers need advice and support and where agreements will be tailored to local circumstances (RDS, 2005).

The ELS (and CSS in the past) stimulate the conservation of landscape features such as hedgerows, stonewalls and buffer strips. It is important to conserve and enhance these landscape features in order to slow down runoff in its pathway and as such reduce flood generation. Buffer strips will further reduce runoff, and filters sediments from the overland flow reducing diffuse pollution. HLS might be used to target areas with a high risk of runoff, for example by creating wetlands.

Key messages chapter 2

- The intensification of agriculture during the past five decades has been driven mainly by governmental policies promoting production of food and fibre commodities. As a result, the rural landscape has changed and the environmental burden has increased. The introduction of agri-environment schemes in the early 1980s was a governmental response to this, aiming to protect and enhance the farmland environment and its wildlife.
- As profitability of agriculture declined during the past decade, the farming population has aged and young people are less interested in farming. Farming is polarising into large-scale commercial production units at one end and relatively small, diversified farm holdings on the other. There is a growing cohort of 'life-style' hobby farmers which changes the composition of rural communities and their financial dependence on the land.
- It appears difficult to quantify and model the link between rural land management and flood risk at catchment scale. However, agriculture practices which affect the rate that water runs off farmland and joins the network of watercourses seems to affect the incidence of local flash floods caused by short but intense rainfall. This process is often associated with soil erosion and muddy floods.
- It appears that artificial drainage in upland areas has increased flood generation by discharging runoff faster into watercourses.
- There is a range of stakeholders with interests and influences in flood risk management. It is important that ways are found to bring them together to find mutually acceptable solutions to flooding problems. There is scope here for joint and collective action, whereby interested parties are supported by government and other agencies that have influence.
- The stakeholder analysis for the Ripon area revealed that the objectives of many stakeholders are complementary (e.g. flood risk management, river restoration, enhancement wildlife habitats, reduction diffuse pollution), creating opportunities for integrated flood risk management that can address multiple benefits. Stakeholders with high interest but low power (e.g. nature conservation trusts) may be able to collaborate with key players (e.g. farmers) to meet their objectives, for example through the promotion of management agreements which deliver multiple objectives.
- The main challenge is to line up these objectives with those of rural land managers seeking to retain viable businesses and livelihoods. A particular challenge is to increase the interest of land managers (and owners) so that they become key players in flood risk management. In their role as land managers, farmers are the main agents of runoff control in rural areas. As such, they have potential influence on outcomes which is presently not mobilised for a variety of reasons. At present, farmers do not perceive runoff control to attribute to the viability of their farm, nor do they appreciate that they can individually make a difference.

Key messages chapter 2 (continued)

- UK legislation, flood management policies and EU Directives addressing management of water and environment have become more integrated over time, but there is considerable scope to do more. Policies (and funding) to promote biodiversity, protect the environment and natural resources, control flooding and support rural livelihoods remains fragmented. Although Making Space for Water provides a promising strategic vision, the mechanisms to deliver it are not yet in place.
- In this latter respect, changing priorities in farming and the countryside promoted by agri-environment schemes and other initiatives, can encourage key stakeholders to come together to seek solutions to achieve multiple objectives, of which flood risk management is one. The Ripon-MOP is an example of this.

3 Farmer Perspectives on Rural Land Management in the UK

If rural land is to be used for integrated flood risk management, farmers form an important group of stakeholders as they are the principal users and managers of rural land. This chapter provides an overview of farmer perspectives on and understanding of changes in rural land use and flood risk. It is based on the results of the semi-structured interviews with farmers. Though the sample of interviewees is small and not representative for the entire UK farming community, general views and attitudes could be extracted from the interviews. Annex 3 provides summaries of the farmer characteristics and the results of the interviews per catchment. Section 3.1 summarises the views of farmers on the drivers and pressures of past, present and future changes in rural land management. In section 3.2 this is extended to the link between rural land management and flood risk. Section 3.3 summarises farmers' behaviour towards land management into a conceptual model.

3.1 Changes in rural land use and management

As already mentioned in Chapter 2, agriculture has undergone major changes in the last five decades associated with changes in agricultural policies, markets for agricultural commodities, and technology.

During the interviews, farmers were asked to identify the main changes in their farm circumstances (e.g. farm size) and practices (land use and management practices) over the past 30 years up to the present day. They were also asked to identify the main drivers that influenced these changes. They were then asked about present drivers and their response to these drivers. Farmers were also asked to how drivers might change in future and the possible consequences. Throughout the discussion particular attention was paid to factors which could affect the probability of flood generation from farmland. Figure 5 summarises the results of these discussions, based on a content analysis of the interview transcripts. Though the sample is not representative for the UK farming population, general trends can be detected from the analysis.

Figure 5 confirms evidence from literature that the majority of farmers responded to the agricultural policies involving price support, subsidies and technical assistance in the 1960s, 1970s and 1980s by improving, expanding and intensifying their farms. During this process of intensification, the interviews showed that farmers specialised into one or two farm enterprises. Personal skills and preferences, and suitability of farmland, defined the type of farm enterprise. The case studies in Pontbren, Eden and Ripon showed that in upland regions large areas were drained in order to improve pasture land. The cases in Parrett, Ripon and Avon revealed the removal of hedgerows and trees in mixed and arable areas (Table 2). This resulted in changes in the pathway of overland flow, which might have led to an increase in flood generation.

Social, mainly peer group, pressure appeared also to be an important driver of the intensification, besides the agricultural policy. If farmers were not improving and expanding their farms, they were not perceived to be a 'good farmer'. Several farmers

referred to the 1970s and 1980s as a period of following the 'carrot held out by the government', chasing the subsidies and expanding farms to keep them viable. Simultaneously, the workload increased as the total number of employees tended to fall. As commodity prices declined in real terms and financial margins became smaller, several farmers said they saw no other option than increasing the production in order to keep a stable net income.

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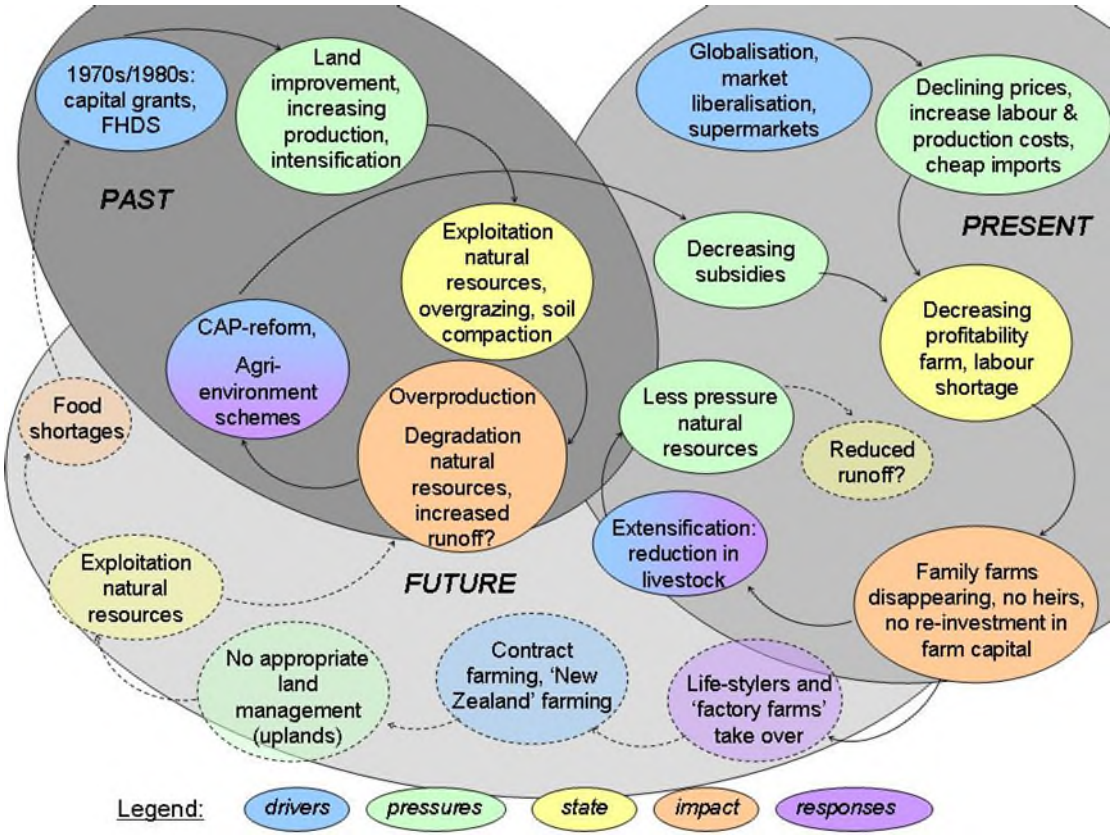


Figure 5 DPSIR-framework according to farmers

Table 2 Past changes in agriculture reported in farmer interviews

	Pontbren	Eden	Ripon	Avon	Parrett	Total
Main farm type	Sheep/beef	Dairy/ sheep/ beef	Dairy / sheep/ beef	Dairy/ beef/arable	Dairy/ beef/arable	
No. of farmers	9	6	8	6	7	36
Decreasing profitability	8	6	5	3	6	28
Less farm labour	5	4	4	5	2	20
More paperwork	5	3	3	5	4	20
Dairy farms disappearing	2	4	4	4	4	18
Land improvement (drainage)	9	4	6	1	2	17
Intensification	6	3	4	3	3	16
Expansion	2	2	4	3	4	15
Less youngsters to take over	4	3	4	2	2	15
Removal of hedges / trees	1	0	4	2	5	11
Specialisation	0	0	3	3	5	11

During the interviews many farmers commented that in the last 10 years farming has become less profitable because the output prices have failed to keep up with input prices. Farmers reported that dairy farms have decreased in number, as dairy farmers could not afford the investments needed to keep the dairy unit up-to-date, especially regarding new milking parlours. Some dairy farmers switched to beef enterprises, others to arable, depending on the region. They also remarked that, as the profitability decreased and the workload increased, young people have expressed less interest in becoming a farmer.

It is noted that, when talking about past changes, farmers reported mainly on recent changes that had a negative impact on their lives, such as the decreasing profitability and increasing workload. There was limited reporting of 'good times' in the 1980s, but farmers recognised the support they received from the Government.

It was apparent from the regional cases that some of the underlying structural changes in farming have been hasted by other events and processes. Farmers in Cumbria and Wales were struck by Foot and Mouth Disease (FMD) in 2001. Although many lost their stock, the received compensation payments gave a welcome financial boost and an opportunity to reflect on farming futures. For example, some dairy farmers in the Eden invested in new dairy units whereas others went into other enterprises such as beef and calve rearing.

Many farmers were still uncertain about the future impacts of the recent CAP-reform at the time the interviews were held, but there was a general consensus that the amount of financial support for agricultural production will continue to decrease in the near future, making it more difficult for many farmers to survive financially. Most farmers are looking for ways to keep their farm enterprise viable (see Table 3). The majority of the interviewees, especially in Wales, said they are likely to opt for extensification (that is, reducing inputs and consequently outputs) in the near future, often combined with Environmental Stewardship. The agri-environment schemes are an attractive opportunity for many to earn some extra income, which explains the popularity of the ELS. Some look for opportunities to diversify into non-farm activities. Only a minority of the interviewees said they would continue to rely on farming as a viable business in the near future, either by producing high-quality products for a niche market or through further expansion, exploiting economies of scale and specialisation. All except one of these interviewees have a son who will take over the farm enterprise. The long-term future of an individual farm depends mainly on the presence and interests of the successor. Farmers without successors and approaching retirement tend to extensify their farms before eventually selling them.

It was also apparent from the regional cases that the choices open to farmers to attract or exploit farm-based, non-farming opportunities varies considerably according to the proximity to urban areas. Farmers in Wiltshire and North Yorkshire reported that old farm houses and barns converted to residences had been acquired by city-dwellers. 'Life-stylers' and part-time and hobby farmers now form an increasing part of the rural community. As a result, a new rural service industry has emerged in the Ripon area, with farmers running horse liveries and renting out farm buildings for workshops and accommodation. In other remote areas such as Pontbren and Eden,

small farmers continue their struggle to survive from farming, facing small margins and a lack of affordable farm labour. More and more farmers depend on subsidies, on their partners' salaries, or other non-farm activities (e.g. contractor business, tourism) to finance the farm enterprise. With the new CAP-reform, these farmers tend to reduce production costs and thus become more extensive whilst relying on the single farm payments for their income. The diversification and extensification of agriculture will reduce the pressure on the land, especially in the uplands with high stocking rates.

Table 3 Intended future strategies of farmers by catchment as reported in farmer interviews

	Pontbren	Eden	Ripon	Avon	Parrett	Total
Main farm type	Sheep/beef	Dairy/ sheep/ beef	Dairy / sheep/ beef	Dairy/ beef/ arable	Dairy/ beef/ arable	
No. of farmers	9	6	8	6	7	36
Extensification	7	2	4	1	2	16
Environmental stewardship	4	1	2	0	2	9
Non-farm diversification	0	2	3	2	1	8
Niche market	0	1	0	2	1	4
Expansion	1	0	0	1	2	4

Farmers predict further polarisation in farming on the long term, with small-scale hobby farmers on one end and large-scale factory farms on the other. In the longer term, farmers raised the spectre of food insecurity, due to reduced domestic production and over-reliance on imports which could, for a variety of reasons, be at risk. It was therefore suggested by several farmers that future food shortages will lead to another cycle of agricultural policy promoting intensification and production maximisation "history repeats itself").

3.2 Farmer perceptions of land use and flood risk

The interviewees were also asked about flood risk in the area and whether flooding occurred on their farm. They were also asked about overland flow, erosion or diffuse pollution on their farmland. Furthermore they were asked whether they had observed any changes in these processes, and if so, what might have been the causes. Some farmers were also provoked by asking them to comment on a possible link between intensified agricultural land use and flood risk.

During the interviews, different views were expressed by farmers concerning flood risk in general. Some thought it had increased recently due to changing rainfall patterns, others that it had decreased due to improved flood defences. However, there was consensus amongst the interviewees that heavy rainfall, property development in floodplains and road runoff are the main causes of flooding. Beyond this, views varied (Table 4).

A number of farmers, especially in the Eden and Ripon cases, thought that lack of river maintenance had affected flooding incidence. For example, perceived lack of river dredging, whereby rivers have limited bank-full capacity and show an increased tendency to overtop, was mentioned as a factor associated with increased flooding on farmland. Dredging to reduce river bed levels is for the most part a solution for local waterlogging and flooding. However, it can, if combined with vegetation clearance and re-profiling, change the flow characteristics of channels resulting in increased flooding downstream. It is apparent that farmers tend to view the management of rivers and land drainage at the local level, rather than at catchment scale.

Table 4 Farmer perceptions on causes of increased flood risk as reported in farmer interviews

	Pontbren	Eden	Ripon	Avon	Parrett	Total
Main farm type	Sheep/beef	Dairy/ sheep/ beef	Dairy / sheep/ beef	Dairy/ beef/ arable	Dairy/ beef/ arable	
No. of farmers	9	6	8	6	7	36
Changes in rainfall pattern	5	3	7	0	3	18
Runoff hard surfaces (incl. roads)	4	1	5	0	4	14
Property development in floodplains	1	2	5	0	4	12
Soil compaction	5	0	2	0	3	10
Field drainage	5	0	1	2	0	8
Lack of river dredging	0	3	2	0	1	6
Drainage upper part catchment	0	0	6	0	0	6
Forestation drainage	2	0	1	0	0	3
High tides	0	3	0	0	0	3

Farmers had different opinions on whether land management influences flood generation. A number of farmers, and especially those in Pontbren, mentioned that the increased stocking rates led to soil compaction resulting in increased runoff. Others, however, disagreed that current farming practices cause soil compaction. At present, field research is undertaken in Pontbren to study the effects of soil compaction on runoff, which explains why more farmers mentioned this factor.

Some farmers thought that land drainage might have increased flood generation as water is evacuated quicker into watercourses. Others, however, argued that artificial drainage allowed land to dry out quickly, which otherwise would remain saturated following rainfall events. As a result, the water storage capacity of the land available for subsequent rainfall events was increased, reducing the probability of flood generation.

The likely impact of land drainage on flood generation depends on the scale of assessment. Land drainage (in the form of under drainage and open ditches, supported by pumping in Somerset) is designed to reduce flooding and waterlogging on fields, and this is the main concern of the farmers. The effect of land drainage on flooding at

the catchment-scale depends on how it affects the time taken for rainwater to reach watercourses via overland flow or subsurface flow. If, in the absence of artificial drainage, soils are commonly saturated, overland flow can be high during rainfall events. If this water connects quickly to the main watercourses, flooding can be the result as the discharge into the network of watercourses exceeds its capacity. Here, subsurface land drainage might reduce flooding by delaying the time for the water to reach the watercourses. However, if surface flows are not normally well connected to the main watercourses due to micro-topography or field boundary features such as hedgerows, artificial land drainage can increase subsurface flow connectivity and flood generation at the catchment-scale may increase.

During the stakeholder workshop in Ripon (Annex 5), the participants were asked to identify the three major causes of increased flood risk using 'post-it' stickers. These collected and grouped as shown in Figure 6. The views held by the stakeholders were highly consistent with those mentioned by farmers during interviews.

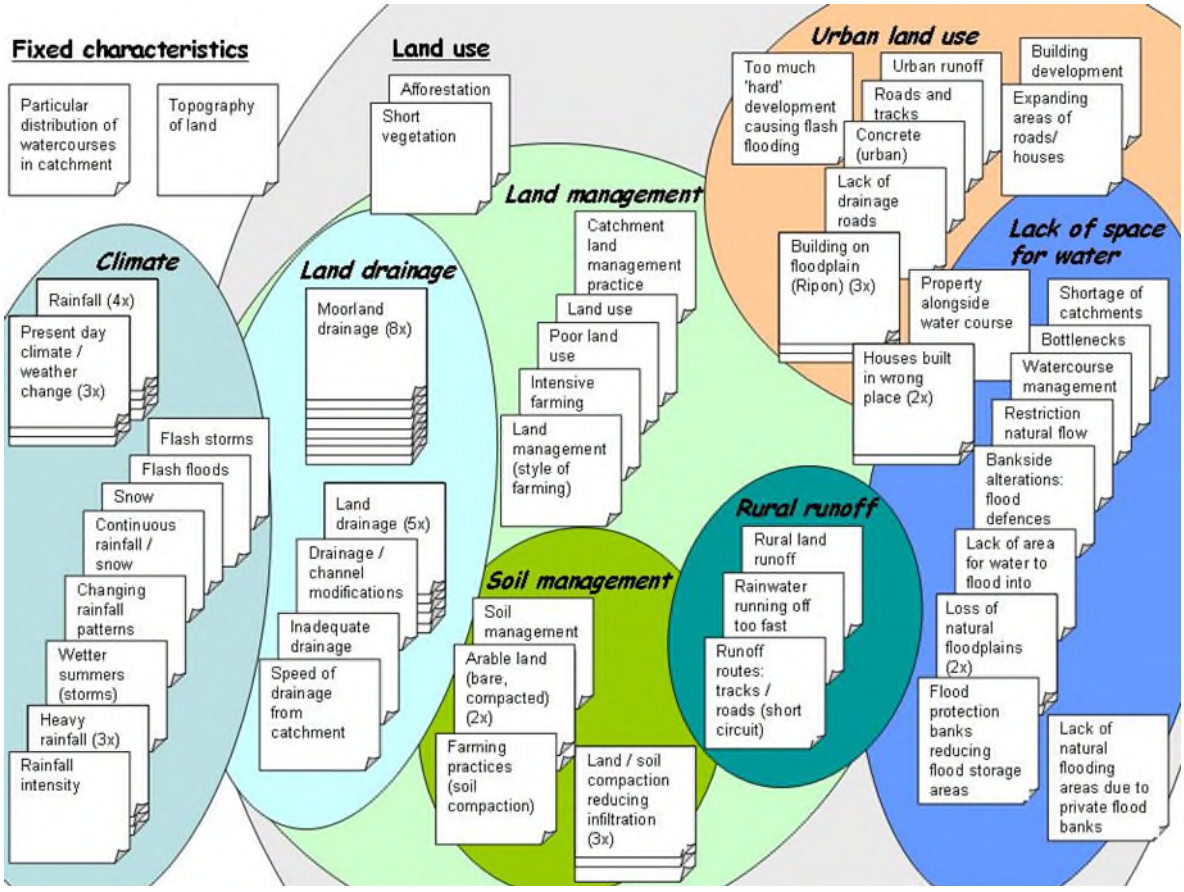


Figure 6 Factors contributing to flooding problems in the Ripon catchment as reported during the stakeholder workshop

Of the farmers who suggested during the interviews that flood generation has probably increased due to soil compaction and land drainage caused by conventional agricultural practices, most tended to blame government policies that had motivated them to intensify. Farmers do not feel responsible for changes in flooding probability in downstream areas, as they refer to overland flow as a 'law of nature'. As several

farmers pointed out, 'water runs downhill, and we cannot make it crawl back up again'. Despite a refusal to acknowledge responsibility, it was clear that many farmers are willing to contribute to solutions to reduce flood risk where it can be shown they can make a difference, the solution is feasible from a farming viewpoint and adequate compensation is offered. The majority of farmers spoken to are willing to consider the storage of floodwater on their farmland, though many thought that their land would not be suitable for it.

Interestingly, farmers in the Parrett catchment do, however, feel responsible for diffuse pollution and soil erosion. The recent policy interventions on diffuse pollution have raised awareness among farmers, and many now acknowledge that they should be careful with the storage and application of manure. In Somerset, soil erosion has been a particular problem. A campaign by FWAG targeted high-risk farmers as part of the Parrett Catchment Project[4] and discussed problems with them and gave them advice. This intervention was very successful, raising the awareness and willingness of farmers to prevent soil erosion by changing their farming practices.

Table 5 presents the views of the Somerset interviewees on soil erosion and flood risk. Farmers were of opinion that the drivers of these processes are beyond their control. However, the farmers did acknowledge that they have control over the pressures causing soil erosion (soil management and crop rotation), but not over the pressures causing increased flood risk (urbanisation). By providing farmers with free advice and financial support (through agri-environment schemes) to change farming practices, as well as using the threat of prosecution for inappropriate farming practices if muddy floods occurred, soil erosion on farmland has been reduced.

Table 5 DPSIR of soil erosion and flood risk according to Somerset farmers

	Drivers	Pressures	State	Impacts	Responses
Soil erosion	• Increased rainfall duration and intensity (climate change)		• Increased runoff	• Loss of nutrients • Siltation of rivers • Sedimentation on roads • Damage to farmer reputation	
	• Subsidies • Social pressure • Farm improvement capital grants	• Inappropriate soil management • Removal of hedgerows • Crop rotation	• Soil erosion • Diffuse pollution		• Prosecution by EA • FWAG project • Change in soil management
Flood risk	• Increased rainfall duration and intensity (climate change)		• Increased runoff	• Flooding of and damage to farmland	• Land drainage
	• Urbanisation • Road construction	• Property development in floodplains • Runoff from hard surfaces (incl. roads)		• Flooding of and damage to urban areas	• Pumping schemes • Flood defence • Flood water storage

[4] See http://www.somerset.gov.uk/somerset/ete/pcp/ for more information

Most of the immediate benefits of soil erosion control have been off-farm in terms of reduced incidence of muddy floods affecting roads and properties and silting-up of watercourses. Farmers acknowledged that they have derived immediate benefits in terms of enhanced reputation and longer term benefits associated with soil conservation (Ben Thorne – FWAG, personal communication 2006).

Many farmers made it clear that it is important to look at the 'bigger picture' when discussing flood risk. Climate and urban developments are big contributors to flood risk. Many farmers interviewed regularly experience flooding on their farmland and have reconciled themselves with this and learned to live with it.

3.3 Explaining farmers' attitude towards land management

As farmers explained themselves, they have responded in the past to the direction and incentives provided by the government. In the 1960s and 1970s they were encouraged by the government to improve their land (through land drainage, seeding modern grasses, removal of hedgerows) and intensify their farming system in order to increase food production. In doing so, farmers were proud to be responsible for 'feeding the nation'. Several farmers now feel let down by government and the general public who now accuse them of being environmental polluters. Although some farmers acknowledge that the intensification probably went too far, with overstocking and soil erosion as a result, and changes in farming practices have been needed to reduce environmental damage, they do not think it is fair to blame them solely for the environmental changes that occurred in the countryside due to modern farming methods. Many argued that they responded positively to the policy drivers at the time: which was to produce more.

The discussions with farmers showed that decision-making on land management depends on various factors: policy, prices, technology, physical assets and personal preferences (Figure 7). Land management is closely linked with farming systems and the type and mix of crop and livestock enterprises within them.

'Conventional' farmers for whom the farm is their livelihood are primarily responding to policy and prices in their decision-making, which explains the past intensification of agriculture and the recent extensification. As the farmer population changes – with increased number of life-stylers and hobby farmers –attitude to land management is changing as well. The land management community has become more diverse, in which professionally run specialist farm businesses ('factory farms') exist alongside a variety of multifunctional businesses, as well as holdings occupied for purposes other than agricultural production, such as lifestyle, retirement or leisure (Lobley and Potter, 2004).

Farmers on family-run farms expressed concern during the interviews that managers of specialist, large-scale commercial farms as well as life-stylers might be less interested in keeping the land in good condition (that is, ploughed, well drained, grazed, and no weeds) as they will use contractors to carry out field operations. The extent to which this is true is unclear.

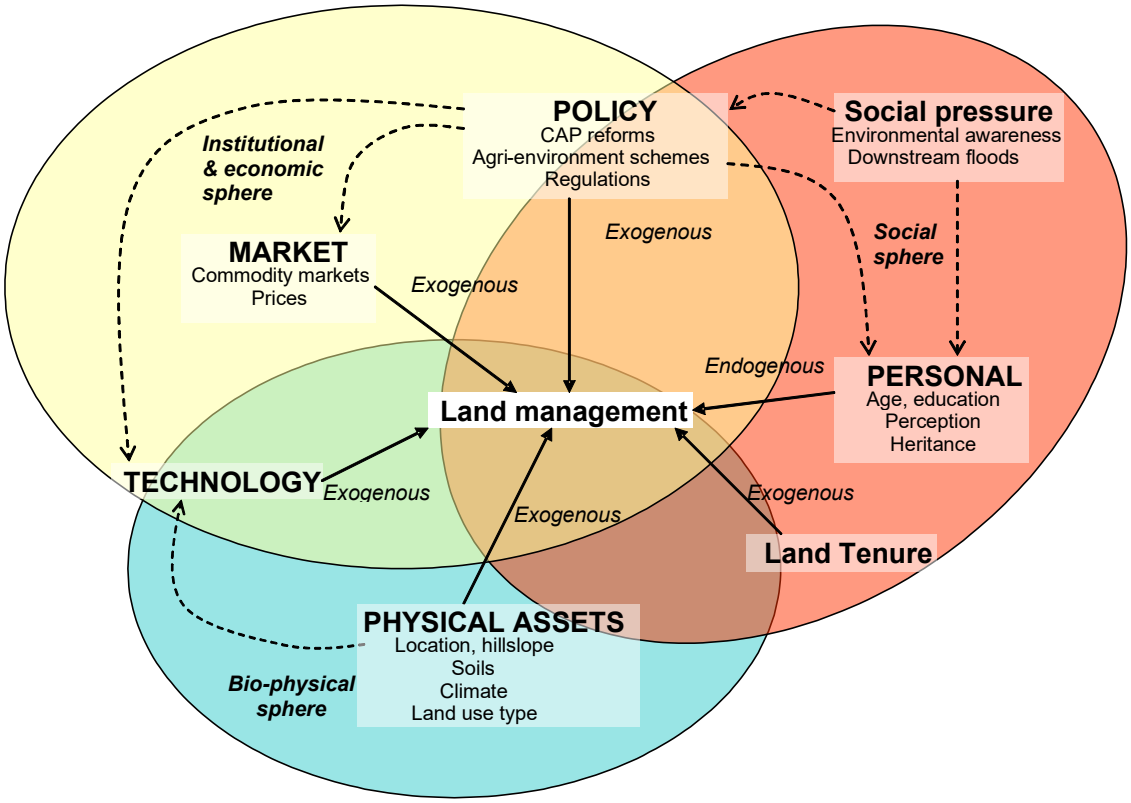


Figure 7 Drivers of farmer decision-making on land management

Key messages chapter 3

- Farmers confirmed that in the past government policies had encouraged them to intensify their farming systems. This was consistent with evidence from the literature.
- Farmers are now responding to new government policies, consisting of the Single Payment Scheme and the renewed agri-environmental schemes. Livestock farmers in particular have shown an inclination to extensify, because of declining profitability, reinforced by the CAP-reform.
- Simultaneously, the farming community is changing, with an increasing number of part-time hobby farmers and large-scale production units, whereas the typical family farm is declining in number.
- These changes in the farming community are reflected in land use, ranging from extensively managed grassland to intensively farmed areas. As the pressure due to intensive farming decreases, there will be more scope for runoff retention (e.g. retention ponds, wetlands) in uplands and floodwater storage in lowlands.
- During the interviews many farmers expressed their fear though that in future food shortages could arise, which could change governmental priorities again, switching back to the production oriented policies of the 1970s.
- Although some farmers acknowledged that land drainage and intensification of agriculture may have caused soil compaction leading to flood generation, none felt responsible for possible increased flood risk, that is flooding resulting in damage. Many felt that flood risk was increased due to factors that were beyond their control (such as climate and urbanisation). The findings of the literature review confirm this perception.
- Farmers appear more willing to take measures to control pollution and soil erosion and sedimentation, partly because these can be more directly attributable to farming (although not necessarily to individual farmer actions). These processes are linked with runoff. Measures that tackle these processes together are thus more likely to be accepted by farmers. This reinforces the plea for an integrated approach.
- A set of socio-economic and bio-physical factors influence farmers' behaviour towards land management. If farmers are to contribute to flood risk management, agricultural policy should not contradict this process. Economic incentives, provision of the appropriate technology, awareness-raising amongst farmers and the general public in a positive manner will increase farmers' willingness to implement runoff control measures.
- It must be realised that the composition of the farming community is changing. Life-style hobby farmers are likely to respond to different drivers than larg-scale commercial farmers, and different policy interventions might be needed to involve all groups in flood risk management.

4 Land Management Practices and the Runoff Control

Uncontrollable factors such as climate, topography and soil type largely define the probability of flood generation in a given catchment. Land use, and at field-scale land management, can either aggravate or alleviate the probability of flood generation. Although land management practices are thus not the sole driver of flood generation, it is possible that they can influence runoff at field-scale. Defra and the Environment Agency have identified several agricultural practices that might contribute to a reduction in runoff and other related problems such as diffuse pollution and soil erosion. Annex 4 presents an overview of these 'good practices' that are currently promoted. Although no experiments have been carried out to provide empirical evidence, this chapter attempts to evaluate the likely effectiveness of these practices and the likelihood of their adoption by farmers.

4.1 Overview of land management practices to control runoff

For a given rainfall event, two factors define the probability of flood generation on rural land: the infiltration capacity of soils which affects potential surface runoff, and flow connectivity, which is the degree to which surface, and to a lesser extent sub-surface flow, is connected without impedance to main water courses. For a given rainfall event, there is a relatively small chance of flood generation if infiltration rate is high and flow connectivity is low, there is little chance of flood generation. By comparison, however, there is a relatively high chance of flood generation if infiltration rate is low and flow connectivity is high (Figure 8) Evaluating land management practices in terms of their likely impact on infiltration and flow connectivity provides a framework for identifying best practices. Figure 9 contains such a framework, based on the FARM-tool[5] (O'Connell et al., 2004) that was used in the stakeholder workshop in Ripon to facilitate the discussion on land management and flood generation (Annex 5).

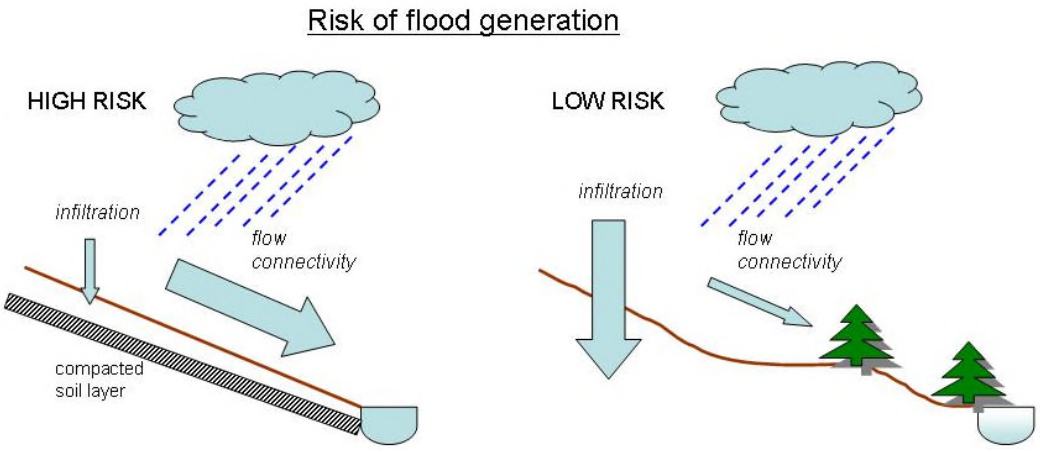


Figure 8 Risk of flood generation defined by infiltration and flow connectivity

[5] This decision support tool was developed for the FD2114 project by Newcastle University. See: O'Connell, P. E., K. J. Beven, J. N. Carney, R. O. Clements, J. Ewen, H. Fowler, G. L. Harris, J. Hollis, J. Morris, G. M. O'Donnell, J. C. Packman, A. Parkin, P. F. Quinn, S. C. Rose, M. Shepherd and S. Tellier (2004) *Review of impacts of rural land use and management on flood generation*. R&D Technical Report FD2114. London, DEFRA

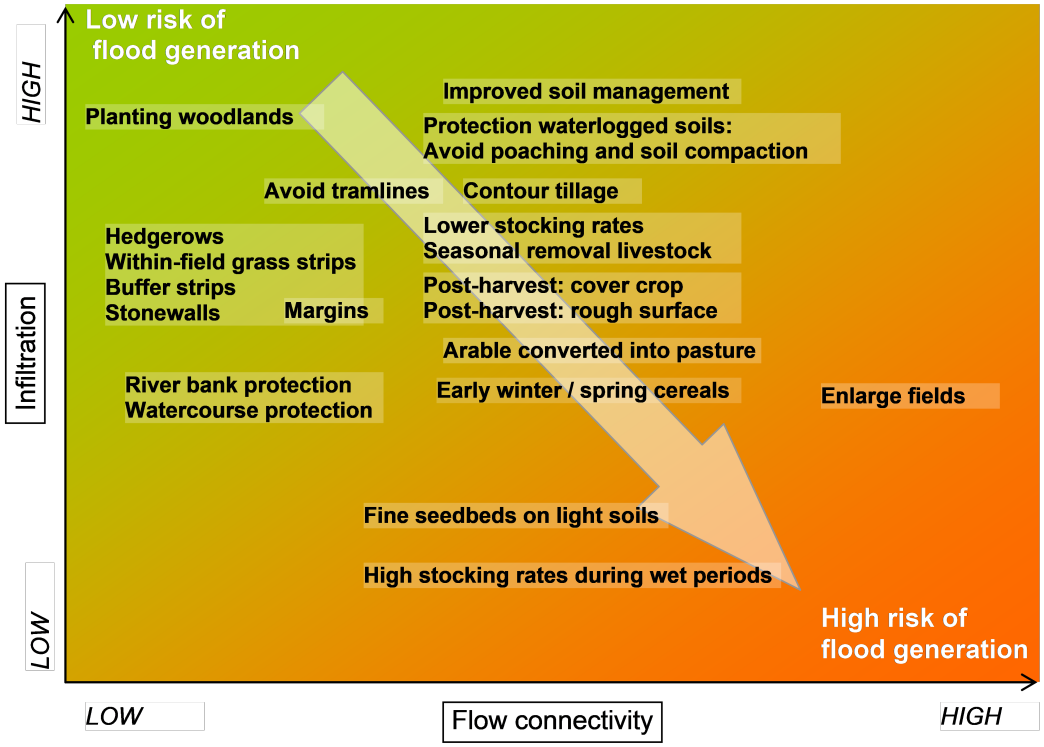


Figure 9 Impacts of selected land management practices on flood generation

Practices which reduce soil compaction and improve soil structure enhance the infiltration capacity of the soil and thus facilitate the movement of water into and through the soil profile. These practices include among others: low stocking rates, grazing management, seasonal removal of livestock to avoid poaching of soils, low ground pressure tyres on field machinery, avoidance of field operations in wet conditions, soil improvement measures including conservation tillage, and under drainage whether using pipes or temporary 'mole' drains.

Practices which control runoff by influencing the rate at which water from fields discharges into watercourses, that is the degree of flow connectivity, include those concerned with checking flows within fields and those on the boundary of fields. Within-field measures which 'break' the slope include contour ploughing, artificial bunding and retention ponds. These are particularly effective if combined with measures to improve infiltration. Field boundary features to reduce connectivity include hedgerows, stonewalls, field margins, buffer strips and woodlands. O'Connell et al. (2004) give a comprehensive overview of the impacts of agricultural land uses and management practices on flood generation.

The suitability and effectiveness of these measures varies considerable according to local conditions. In areas that are liable to soil compaction due to livestock (Pontbren, Wales) or arable field operations (Parrett, Somerset), controlled stocking rates and soil improvement may help to alleviate flood generation. A heterogeneous rural landscape with relatively small fields, many field boundary features such as hedgerows, stonewalls and woodlands, and a mosaic of cropping patterns, has typically a low surface flow connectivity. If surface flow has sufficient opportunities

to infiltrate into the soil or to be retained temporarily at particular places, the peak flows in watercourses will be attenuated. The conservation and introduction of field boundary features are thus generally for runoff control.

The landscape in the Ripon catchment in North Yorkshire is also very heterogeneous containing different land uses and many boundary features. However, more might be needed as the watercourses in these catchments are naturally quick in their response to rainfall. Appropriate targeting of practices, interventions and policies at regional and catchment level is the key to flood risk management. The farmer interviews revealed that the current Environmental Stewardship scheme is not likely to meet these requirements as most farmers participating in the scheme were eligible because of existing boundary features and farm practices rather than any new measures (see Annex 3).

4.2 Multi-criteria analysis

A stakeholder workshop held in Ripon (see Annex 5 for a full report) revealed a clear preference amongst the stakeholders, including farmers, for practices that are:

- simple to understand, install and maintain,
- compatible with the main land use and farming system,
- low-cost,
- effective, work well and clearly beneficial, and
- achieve multiple objectives such as soil protection, reduction of diffuse pollution and enhancement of wildlife habitat, where possible.

Farmers expressed the view that practices must be able to work under changing or uncertain conditions without unduly putting them at risk. It must be possible to modify practices in the event of unforeseen circumstances, such as, for example, when climatic conditions in some years require a modification in cultivation operations.

Drawing on secondary data such as the FD2114 report (O'Connell et al., 2004), EA guidance on soil management (EA, 2003a) and English Nature review on mechanisms to control diffuse pollution (Dwyer et al., 2002), a range of possible practices are assessed against these criteria. The impact of each practice on runoff generation at field-scale is assessed, rather than on flood generation, which applies at the catchment scale. This list is not intended to be exhaustive but rather to show examples of possible practices which can alleviate field runoff. A more complete technical review of the impact of land management practices on runoff-related problems has already been done elsewhere (see for example: O'Connell et al., 2004).

Table 6 contains a summary of the expected impacts of selected ‘good’ practices (see Annex 4 for more details). The impact is positive when it has potential to achieve a desirable outcome, such as reduction in runoff or diffuse pollution. In some cases the impact might be either positive or negative (indicated as + / -), depending on the specific situation. Indeed, the efficacy and suitability of these practices will vary

considerably according to circumstances such that it is difficult and dangerous to generalise.

Table 6 Assessment of practices potentially controlling runoff against multiple criteria

Good practices	Soil protection	Diffuse pollution control	Wildlife habitat	Fits farming system	Costs	Observable effect on runoff
High infiltration and low flow connectivity						
Woodlands	+	+	+	–	High	+
Avoid tramlines	+	?	None	–	Low	+?
Low flow connectivity						
Stonewalls	+	+	+	+	Med	+
Hedgerows	+	+	+	+	Med	+
Buffer strips	+	+	+	+	Med	+
Field margins	+	+	+	+	Low	+?
River bank protection	–	+	+	–	Med	+
Watercourse protection	–	+	+	+ / –	Low	+
High infiltration						
Drainage	+	None	–?	+	Med	?
No field operations on waterlogged soils	+	?	None	+ / –	Low	+
Contour tillage	+	None	None	+ / –	Low	+?
Post-harvest: cover-crop	+	+	+?	+ / –	Low	+
Post-harvest: rough surface	+	+?	None	+	Low	+?
Arable reverted into pasture	+	+	+?	–	High	+
Spring cereals	+?	–	None	+ / –	Med	?
Early sowing winter cereals	+	?	None	+ / –	Low	+
Improved soil management	+	+	None	+	Low	?
Low stocking rates	+	?	None	+ / –	H / L	+?
Seasonal housing of livestock	+	?	None	+ / –	Med	+?
Mobile livestock feeders	+	?	None	+	Low	?

The practices that appear to satisfy most criteria are field boundary features (such as stonewalls, hedgerows, buffer strips and field margins), but also practices such as improved soil management, rough surface seedbeds, and cover crops. Based on the assessment in Table 6, farmers are likely to prefer practices such as: stonewall and hedgerow conservation, buffer strips, field margins, no field operations on waterlogged soils, cover crops, rough surface seedbeds, early sowing of winter cereals, seasonal removal of livestock and mobile livestock feeders.

The assessment in Table 6 appears to be largely consistent with the results of the Farm Practices Survey (Defra, 2006), which was undertaken by Defra in order to quantify the uptake of practices to alleviate diffuse pollution (Table 7). Practices such as hedgerow conservation, buffer strips, improved field drainage, and reversion of arable land into pastures appeared to have the largest uptake amongst farmers. Livestock-related practices such as not spreading slurry during wet periods, keeping manure away from watercourses, taking stock off land to avoid poaching and using mobile feeders to avoid soil damage were most commonly practiced.

Table 7 Uptake of practices to maintain water quality

Agricultural practices	**Undertaken** (% of holdings)	**Planned** (% of holdings)	**Potential runoff control**
Hedgerow conservation	41%	11%	+
Buffer strips	32%	8%	+
Improve field drainage	28%	9%	+
Reduce arable cultivation	26%	7%	+
Woodland conservation	19%	5%	+
Revert arable land to grassland	14%	6%	+
Change timing of cultivation	12%	3%	?
Contour cultivation	11%	3%	+
Switch from autumn to spring cropping	10%	4%	?
Wetland creation	7%	3%	?
Beetle banks	5%	3%	?
Sow grass strips across slope	3%	2%	+
Livestock-related:			
Not spreading manure/slurry at high risk times	79%	4%	None
Site solid manure heaps away from watercourse	66%	2%	None
Take stock off land to avoid poaching	65%	6%	+
Delay putting stock out to avoid poaching	56%	4%	+
Move feed and water troughs regularly	48%	4%	+
Fence water courses	38%	11%	+
Reduce stock densities	30%	11%	+

Source: Defra statistics 2006

Though it seems there is a promising overlap between good practices and farmer preferences, several of these practices (e.g. stonewalls and hedgerows) are implemented already and will therefore make no difference with the current situation, unless of course they are in need of repair or maintenance. Field margins have been recently introduced through the cross-compliance, but little is being done to monitor uptake and impacts. Winter cover crops and rough surface seedbeds are relatively uncommon practices, because farmers have considered them incompatible with other farming practices. The initiatives by FWAG in the Parrett catchment show that awareness raising and communication are important ways of gaining acceptance of these practices among farmers.

Key messages chapter 4

- The likely effect of land use and farming practices on runoff generation can be assessed in terms of the effect on infiltration capacity of soils as it affects surface flow, and the degree of connectivity between flows from the field and the receiving watercourses and channels.
- Practices which reduce infiltration and which increase connectivity tend to increase the probability of flood generation from farmland.
- Practices that are simple, low-cost, clearly effective, reliable under a range of conditions, and can address multiple objectives are more likely to be adopted by farmers and promoted by other stakeholders than practices which do not have these features.
- Farming practices and actions that meet these criteria are readily available but, for a variety of reasons, are not applied as widely as they could be. Awareness-raising, combined with technical assistance, will help to promote these practices. Incorporating them into environmental compliance and enhancement regimes will further promote adoption.

5 Policy Management

In the previous chapters it is argued that an integrated approach towards flood risk management, involving nature conservation and agriculture, is likely to be beneficial as multiple objectives can be achieved. If the agri-environment schemes are further integrated into flood management policies, farmers (the principal land managers in rural areas) can be involved as well. In this chapter we will further develop policy recommendations for this purpose. Section 5.1 discusses the concepts of multi-functional agriculture and how this can be used for an integrated approach. Section 5.2 discusses how different future agricultural scenarios might affect land management and flood risk management. Section 5.3 gives some suggestions for policy tools and interventions for the near future.

5.1 Integrated approach and multiple objectives

Agriculture is inherently multi-functional. It not only produces food, fibre and bio-energy, but can also produce a range of public goods and services such as carbon sequestration, tourism and amenity, flood control, shaping and maintaining landscape and countryside, as well as a number of public 'bads' such as soil erosion, water pollution, ammonia and methane emissions and damage to wildlife (Pretty et al., 2001; EA, 2002; EFTEC/IEEP, 2004).

For much of the post-war period, rural development in Britain consisted of agricultural modernization and productivism. Developments in the last decades such as declining family farm incomes and increased pressure from tax payers and consumers for environmental services has led to a new paradigm which focuses on the multi-functionality of agriculture (Figure 10).

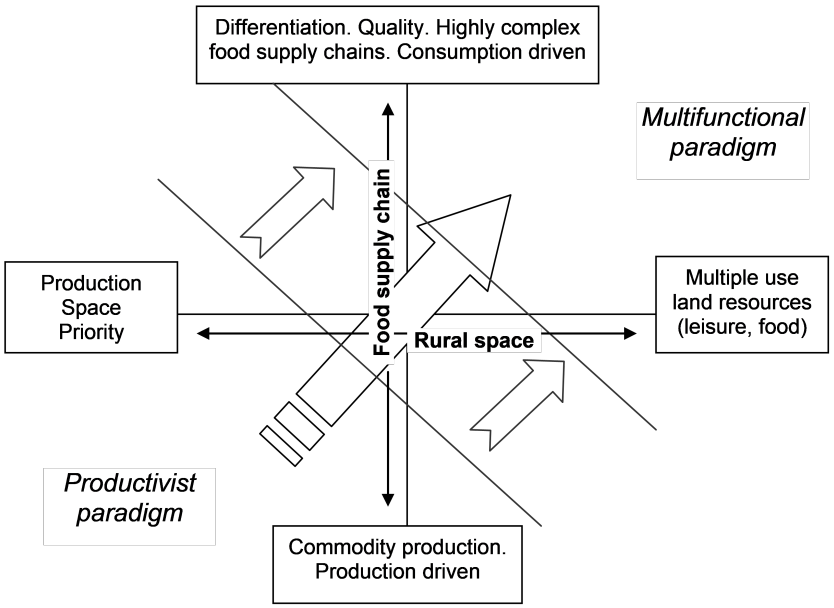


Figure 10 Repositioning of agriculture within the food chain and in rural space (Banks and Marsden, 2000)

The legitimacy of any support to agriculture increasingly reflects this new contract between agriculture and the wider society and emphasize the role of farm businesses as environmental managers and guardians as well as food producers (Banks and Marsden, 2000; Defra, 2002; PCFF, 2002). The concerns within the European Union about the possible impacts of removal of agricultural subsidies on biodiversity, landscapes and rural communities has further stimulated the development of the multifunctional paradigm and the justification of related agri-environment payments (Potter and Burney, 2002).

Large-scale, specialist production units tend to thrive under the productivist paradigm as production efficiency is evaluated without concern for the externalities of intensive agriculture, that is, its negative effects on the environment. This process threatens the existence of family farms, potentially resulting in a loss of some of the positive effects of traditional small-scale and diversified agriculture. In the meantime however, consumers, and the population at large, have become increasingly aware of the externalities of agriculture, and demand 'safe' and local food, as well as environmental services from agricultural producers (Moxnes-Jervell and Jolly, 2003). Within the multifunctional agriculture paradigm there are more opportunities for family farms to survive, if policy recognizes and supports multifunctional agriculture, than under a predominantly single purpose policy regime.

One way of supporting multi-functional agriculture is to pay farmers for the environmental services they deliver. Examples of environmental services could be carbon sequestration by planting trees or rewetting peat and moorlands, runoff retention and floodwater storage to reduce flood risk, open access of managed farmed spaces to the general public (amenity), or enhancement of habitats for wildlife.

The ecosystems functions, uses and values approach can be used to develop a valuation framework. Ecosystem functions and services can be thought of as the capacity of natural processes and components to provide goods and services that satisfy human needs (Groot et al., 2002). Five main functions are defined (Groot, 2006):

- *Production functions*: the capacity to provide resources such as food, fuel, fibre and water.
- *Regulation functions*: the capacity of (semi-) natural systems to regulate essential ecological processes and life support systems.
- *Habitat functions*: unique habitats are provided, which are essential for the conservation of genetic species and ecosystem diversity.
- *Carrier functions*: the capacity of (semi-)natural systems to provide space and suitable substrate or medium for human activities (e.g. habitation, recreation).
- *Information functions*: functions which contribute to human well-being through knowledge and experience.

Each function can support a set of uses (goods and services). Table 8 gives some examples of goods and services that can be provided by rural land in order to achieve an integrated approach to flood risk management. The goods and services can be valued, resulting in a total economic value of the particular semi-natural system.

Table 8 Functions, goods and services of semi-natural eco-systems (adapted from: Groot, 2006)

	Functions	Uses (goods and services)
Production	Food	Agricultural production
	Raw materials	Energy crops for bio-fuel
		Fodder
		Fibre
	Genetic resources	Improve crop resistance to pathogens and pests
	Medicinal resources	Pharmaceutical inputs
Regulation	Climate regulation	Influence on climate
	Water regulation	Land drainage
		Flood water storage
		Runoff retention
		Prevention of diffuse pollution
	Soil retention	Maintenance of soil fertility
		Prevention of soil erosion
Habitat	Refugium function	Maintenance of biological and genetic diversity
	Nursery function	Maintenance of commercially harvested species
Carrier	Habitation	Living space
	Cultivation	Production of food and raw materials
	Energy conversion	Energy facilities (e.g. hydropower, wind energy)
	Tourism	Tourism activities
Information	Aesthetic	Enjoyment of scenery
	Recreation	Eco-tourism, leisure
	Spiritual and historic	Use of nature for spiritual or historic purposes
	Science and education	Use of nature for scientific research
		Use of natural systems for educational visits

If rural land is used for floodwater storage (lowlands) or runoff retention (uplands), it might loose some of its other functions, because they are not compatible. However, most functions can be realised simultaneously as they are complementary. For example, putting more emphasis on the water regulation function, will reduce the potential for production, but might increase information and habitat functions.

5.2 Future rural land use scenarios

Agriculture in the UK and Europe as a whole is experiencing unprecedented change as the drivers which have hitherto shaped the characteristics of the farming sector are realigned. The farmer interviews undertaken as part of this work, confirm the high degree of uncertainty felt by farmers themselves about the future direction of agriculture and rural land use. They confirm that factors external to farming have been the main drivers of change, notably government policy, markets and prices, patterns of international trade, technology and the organization of the food chain. How these factors will change in future is difficult to predict. Scanning medium to long term

horizons for agriculture is useful if it can help us prepare for, and indeed influence, that future.

As discussed earlier, rural land use affects flood risk through its role as potential generator of runoff that can contribute to flooding. It also can help to retain and store potential flood waters to prevent flooding elsewhere, especially in urban areas. Rural land is defended from flooding where it has high agricultural value, such as in the fenlands of East Anglia.

Given that agriculture is likely to remain the dominant rural land use, factors which affect agricultural land use, policy and markets, are also likely to influence its role in flood risk management.

A number of studies have explored possible futures for agricultural land use in England and Wales. Projections have been made of agricultural outputs for 2015 (University of Cambridge, 2004) drawing on an extrapolation of past trends. The predictions suggest some small changes in overall land use, associated with a decline in dairying, root crop and vegetable production, likely changes in the intensity of land use management, and continued movement of land out of agriculture. The assessment noted the uncertainty surrounding possible farmer response to the Single Payment regime and the implementation of cross compliance. There is likely to be important spatial variation in land use change such that the implications for flood risk management need to be considered at the catchment scale.

Taking a longer perspective, the Foresights Programme (Berkhout and Hertin, 2002; OST, 2002) identified possible future scenarios for UK through to the year 2080, with implications for flood risk management (Evans et al., 2004). This included the assessment of the role of rural land, both as a pathway and as a receptor.

Figure 11 shows the analytical framework used by Foresight, which assumes that agricultural futures are shaped by a combination social values and governance. Social values range from individualistic consumerism to community oriented conservationism. Governance ranges from local/regional autonomy through to global interdependence. These two dimensions result in four quadrants, each of which is a distinct scenario: World Markets, Global Sustainability, National Enterprise and Local Stewardship. These scenarios have implications for agriculture and for the management of flood risks in rural areas. Annex 6 gives a more comprehensive overview of likely policy interventions and flood risk management options under the four scenarios. Cost-effective food production is the main aim of agricultural policies under the World Market and National Enterprise scenarios, resulting in large-scale production units and increasing undesirable externalities. Under the Global Sustainability and the Local Stewardship scenarios, multifunctional agriculture thrives as a result of government intervention and social preference. Elements of multi-functional agriculture are driven by market forces under the World Market scenario.

For example, under the World Markets scenario agriculture and rural land use are entirely market-driven. It is characterised by outward looking, internationally competitive, large-scale intensive farming. This is likely to exacerbate the probability of runoff and soil erosion in intensively farmed areas and catchments. It is likely,

however, that arable production on marginal land will no longer be justified and some low grade land will no longer be farmed. These changes could alleviate flood generation in some areas, especially uplands.

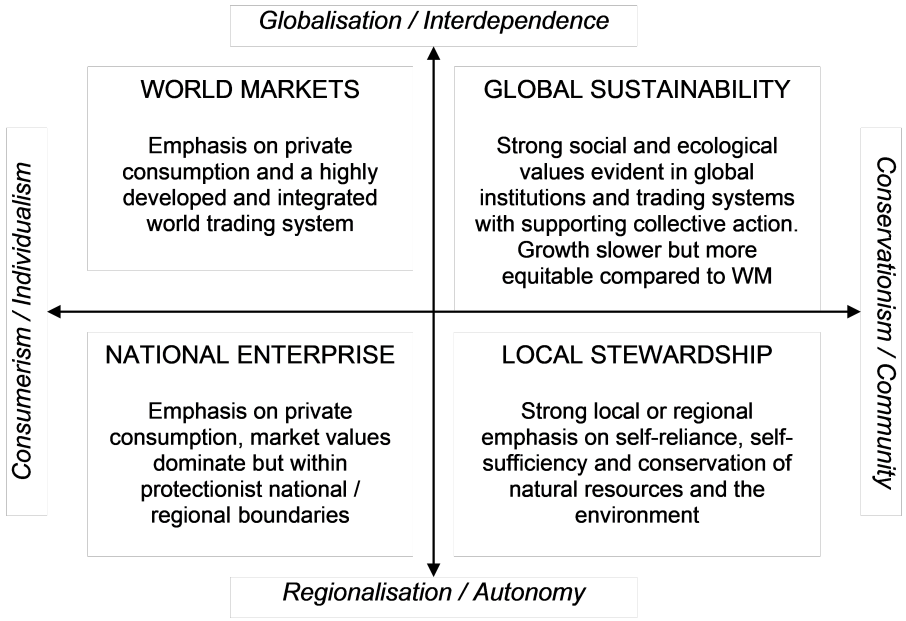


Figure 11 Possible future scenarios (OST, 2002; Morris et al., 2005a)

Under Global Sustainability, the market orientation of farming is moderated by a strong commitment to environmental protection, with a reinforcement of the agri-environment and compliance initiatives. Flood generation would generally reduce under this regime, and floodplains would be managed to provide natural storage.

The National Enterprise scenario reflects a change to a productivist and self-sufficiency focus for agriculture with a comprehensive regime of direct subsidies for production and a high level of protection from external competition. The probability of flood generation is high, and the off-farm costs borne by third parties are significant.

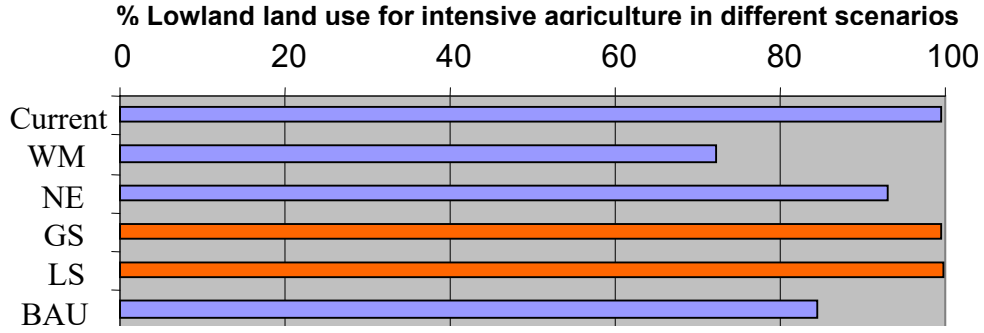
By comparison, Local Stewardship involves relatively extensive, small-scale farming, local area produce, and greater self-sufficiency in food, with a high level of environmental protection and enhancement. Nature conservation, including managed wetlands, is a key feature, with farmers, encouraged by a mix of regulation and payment schemes, providing environmental services, including possibly flood storage on washlands. Flood management decisions will be made at local level.

These four future scenarios have been modelled for UK agriculture through to the year 2050 (Morris et al., 2005a), together with implications for the environment. The agricultural future scenarios were distinguished in terms of demand for agricultural commodities (including bio-energy), commodity prices, agricultural subsidies, farmer motivation and of crop and livestock yields.

A critical assumption concerning agricultural futures is the extent to which the UK is self-sufficient in food or dependent on imports. This depends on two main factors:

government policy on self-sufficiency as a strategic target (relatively important under National Enterprise and Local Stewardship) and conditions in world commodity market with respect to trade flows and commodity prices (relatively important under World Market and Global Sustainability scenarios). Whether the UK is a net exporter or importer in a relatively free world market regime depends on whether it has comparative cost advantage in agricultural commodities relative to other countries, and the potential scale of international trade flows (for example whether China is a major importer of food in future and whether the CIS states are major exporters, as they once were).

Drawing on modelled estimates for England and Wales, Figure 12 contains estimates of the lowland areas suited to agriculture that are used for intensive production under the different scenarios. It is apparent that under World Market and National Enterprise scenarios, land is released from intensive lowland agriculture, with potential to convert to extensive farming or be taken out of agricultural use all together. This is also the case under a Business as Usual Scenario in which current observed trends are extrapolated. By comparison, Global Sustainability and Local Stewardship, with relatively lower yields and a greater commitment to environmental protection in farmed areas, retains a high level of agricultural occupancy in lowland areas.



Current = current situation
WM = World Market
NE = National Enterprise
GS = Global Sustainability
LS = Local Stewardship
BAU = Business As Usual

Figure 12 Agricultural land use in lowland areas for different future scenarios

Estimates were also derived for agricultural land use in the uplands, classified as above 240m. Uplands are assumed to meet that part of the demand for domestic beef and sheep which cannot be met by land in the intensive lowland sector, which has a natural comparative advantage. Of course, there may be specific policy interventions to support farmers and communities in these 'Less Advantaged Areas'. Table 9 shows estimated stocking rates (expressed as an index of current average rates) for regions with important upland areas in England and Wales. Stocking rates associated with beef systems appear to decline in all major upland regions under World Market, Global Sustainability, and National Enterprise Scenarios, increase marginally under Business as Usual, but more than double under Local Stewardship. Similar, but less dramatic patterns of change are apparent for sheep systems under the different scenarios.

Table 9 Upland stocking rates of beef cattle and sheep in 2050, by future scenario (expressed as index of current stocking)

	North East		North West		South West		Wales	
	Beef	Sheep	Beef	Sheep	Beef	Sheep	Beef	Sheep
Business as Usual	140	78	116	65	101	56	116	65
World Market	56	70	44	55	37	47	40	50
Global Sustainability	61	102	61	102	61	102	63	105
Natural Enterprise	110	172	73	114	73	114	80	124
Local Stewardship	253	128	253	128	253	128	253	128

(Source: Morris et al., 2005a)

It is interesting and seemingly paradoxical to note that the Local Stewardship scenario, given its emphasis on high levels of food self-sufficiency and relatively low input-output farming methods, does appear to increase some aspects of environmental burden compared to other scenarios, notably in terms total land take and pressure on uplands. By comparison, the World Market scenario tends to focus production in intensively farmed areas, releasing less productive areas, including lowland wetlands and uplands, for other purposes.

These alternative futures for agriculture and rural land use have important implications for flood risk management. Furthermore, the different scenarios, given their association with different rates and patterns of economic growth, are linked to different predictions of climate change due to different levels of emissions: highest for the World Market scenario and lowest for the Local Stewardship scenario (Evans et al., 2004). These climate change 'signals' further shape the role of rural land management under each scenario. Critically, of course, the scenarios are associated with different rates and patterns of urban development, which have major implication for the flooding when it does occur, and the value of the contribution that rural land management can make to its alleviation.

Table 10 summarises the main components of the DPSIR framework applied to rural land use and flood risk management through to 2050. It is apparent that the extent and intensity of farming varies under each scenario. This has implications for the probability of runoff from farmland and the feasibility of options for the retention and storage of potential flood waters. Furthermore, the scenarios vary in terms of the type of responses. World Market promotes the use of economic instruments to penalise or encourage farmer the behaviour of land managers. National Enterprise provides a high level of protection for agriculture through government subsidies. Global Sustainability promotes multi-functional rural land use, incorporating flood risk management with other strategies to achieve sustainable land and water management at the catchment scale (along the lines of the Water Framework Directive). Local Stewardship, promotes a general extensification of land use of which runoff control and flood storage are part, mainly through regulatory and voluntary measures, but as previously mentioned there may be tensions amongst achieving such objectives at the local scale.

Table 10 DPSIR framework for flood risk management in future agricultural scenarios 2050

	Drivers	Pressures	State	Impact	Responses
World Market: free market, very high economic growth, high emissions	Free trade in agricultural commodities Environmental goods and services are market-driven, including flood management.	large-scale intensive agriculture in productive areas. Reduced pressure from farming in marginal areas and uplands. Accelerated climate change. Increased value of assets in lowlands (flood-prone areas)	High runoff (incl. erosion and pollution) in farmed areas. Reduced environmental impacts from farming in marginal areas and uplands. Loss of managed landscape features and services.	High flood risk in urban areas. Reduced flood generation in marginal areas and uplands	Private agricultural flood defence drainage solutions. Market payments for flood water storage and runoff retention and other services on wetlands released from farming.
Global Sustainability: strong ecological and social values, moderate economic growth, low emissions	Internationally competitive agriculture, targeted compliance. Integrated agri-environment schemes.	Diverse land use. Sustainable land management practices to reduce environmental effects in intensively farmed areas.	Moderate runoff, managed through targeting of interventions, including sacrificial storage areas.	Moderate flood risk in intensively farmed areas.	Mix of regulatory and economic instruments for catchment-wide flood risk management, incl. land use regulation, creation of wetlands, storage in floodplains, runoff retention in uplands. Integration with other environmental objectives
National Enterprise: protectionism, high economic growth, medium – high emissions	Market protection, commodity price, investment and technical support for agriculture to increase self-sufficiency.	Mainly production-oriented landscapes. Broad-based, high input-output farming. relatively intensive mixed farming systems, high stocking rates maintained in marginal areas. Climate change	High probability of runoff (incl. erosion and pollution) in farmed areas. Maintained occupancy of uplands. High land utilisation in lowlands Increased value of assets in lowlands (flood-prone areas)	High flood risk in rural and urban areas.	Funding and operation of agricultural flood defence and land drainage for agriculture in lowlands, coastal areas and uplands. Limited other controls of land use. Increased expenditure on flood defence.
Local Stewardship: protectionism and ecological values, low economic growth, medium – low emissions	Self-reliance policy. Community agriculture emphasising social and environmental objectives	Low intensity farming with low environmental risk, but high occupancy of land. Multifunctional agriculture, family-based farming units. High land usage. Increased stocking rates in uplands.	Sustainable soil and water management embedded in agriculture. Moderate runoff in lowlands, high runoff in uplands.	Moderate flood risk in rural and urban areas. Floodplains restored for wetland farming systems.	Mainly regulatory and voluntary measures to achieve sustainable flood management, including land drainage, although fragmented and selective controls at the local scale.

5.3 Suitable policy interventions to promote multi-functional rural land use

As identified above, the Global Sustainability and Local Stewardship future scenarios show a high commitment to multi-functional agriculture but in different ways. The current CAP reform appears to be pursuing a Global Sustainability type approach, reducing direct support to farming, increasing international competitiveness of farming, encouraging market orientation, and building in measures to protect and enhance the environment.

In the short term, it seems many purposes can be served by stimulating multi-functional agriculture, including flood risk management. A combination of intervention measures, regulation, voluntary codes and economic incentives are probably required to reduce the environmental impacts such as diffuse pollution, soil erosion and runoff generation:

- *Regulatory measures* comprising mandatory command and control methods which specify permissible inputs, practices and processes, and outputs. These might include restrictions on land use and farming practices which have proven links with runoff in high risk areas. Regulation may include adoption of specific mitigation measures such as cover crops or interceptor drains in high risk areas. The avoidance of 'bad' practices and the adoption of 'good' ones could be specified as conditions of compliance in order to qualify for income support.
- *Economic instruments* involve the use of payments, charges, taxes, subsidies, or market instruments such as tradable permits to provide incentives to adopt or reject particular behaviour. Examples include payments to farmers to adopt runoff-reducing land use such as arable reversion to grassland or to establish and maintain field boundary features, and use land for temporary flood storage. Such arrangements are evident in current agri-environment schemes.
- *Voluntary measures* include the adoption by land managers of Codes of Good Agricultural Practice, membership of agri-environment schemes, and adoption of externally verified environmental management and auditing systems such as Linking Environment and Farming (LEAF).
- *Other measures* include actions by government associated with technology research and development, extension and training, and the promotion of improved soil and water management practices amongst land managers.

To date there has been a preference in rural land management towards a non-regulatory approach, with emphasis on a mix of voluntary measures (such agri-environment schemes), supported by economic incentives to farmers, with advice on improved environmental practices. This is evident in the current compliance requirements and the Environment Stewardship programme.

In the case of interventions made to reduce runoff from rural land, it is critical that evidence clearly demonstrates a link between particular practices and flooding and other environmental damage. It is important that interventions target the offending practices and make a difference: that is, they are effective. The review reported here suggests that although the link between land management and local, especially muddy floods can be made, this is not the case for infrequent catchment-scale flood events. In this study, farmers asked for evidence that agricultural practices led to increased flooding and that changes in practices can deliver the claimed benefits. It was strongly

expressed by many that practical demonstration at the field- and farm-scale is needed to address this lack of practical evidence.

Indeed, particularly given the diffuse nature of runoff from rural land, voluntary transition towards the adoption of sustainable practices is perceived to be the best strategy (Pretty et al., 2001). This will stand a better chance of sustained adoption of these practices once other measures to encourage these practices, such as 'compensation'-based agri-environmental payments, decline or are discontinued.

It is critical to support this voluntary transition through developing social capital amongst all the stakeholders with interests in rural land management, that is developing good relationships of trust, reciprocity and exchange amongst stakeholders, and improving the connectedness of networks and institutions (Pretty et al., 2001). The Ripon stakeholder workshop confirmed that social capital in the form of knowledge exchange, stakeholder interaction and an improved relationship between the farming community and the general public would particularly improve farmer attitude and willingness to provide environmental services for society.

A key question raised in discussion with farmers concerned where responsibility lay for runoff control. Though reluctant to accept responsibility for exacerbating runoff, farmers were willing to adopt measures to mitigate it providing they were, in their mind, adequately compensated. Perhaps with the exception of situations were inappropriate land management clearly leads to soil erosion and muddy floods, generic compliance with good practice which can reduce runoff generation should be promoted as part of income support regimes to farmers (assuming the latter continues). The Environment Stewardship schemes can be used to promote specific measures where there is advantage to do so. In areas where potential contribution to flood generation is high and attributable to particular management practices there may be a call for more targeted compliance and enforcement. The current agri-environment schemes are beginning to stimulate multifunctional agriculture, with links, albeit tenuous, to runoff control, especially in the Higher Level Scheme.

The five case study catchments showed that runoff-related problems and therefore appropriate solutions vary considerably according to topography, hydrology, soils, and land use. An integrated approach, which seeks to achieve multiple benefits associated with pollution control, natural resource protection, enhancement of biodiversity, sustainable livelihoods and flood risk management, must be tailor-made for each catchment. Given the degree of spatial variation, blanket prescriptions are unlikely to prove effective, efficient or fair.

In this context, there is a need for a systematic approach to assessing, for given local and catchment conditions, the degree to which land use and management is likely to contribute to generate runoff with consequences for flood generation. Such an approach would also help identify the potential efficacy of measures to control runoff and thereby contribute to the management of flood risk.

Figure 13 contains a conceptual framework for such an approach which combines 'fixed' factors such as altitude, climate and soils, with land use to determine the suitable of land management practices from the point of view of runoff generation.

According to circumstances, it would be possible to identify 'red' (bad) practices that should be banned (that is, not allowed under compliance conditions), 'amber' (good) practices that should be complied with (e.g. under the current compliance requirements and ELS) and 'green' (beyond good) practices that will achieve multiple benefits (under HLS or similar incentive arrangements). These three groups of measures are associated with different policy regimes: polluter pay (red), current income support/compliance regimes (amber), and provider gets (green).

The conceptual framework could be developed to provide general guidance on best practice for specified local conditions. Alternatively, it could be developed to provide a decision support tool, into which generic routines and local data could be fed.

Such a tool would be helpful to policy makers designing programmes of measures for flood risk management and to those charged with their implementation. It would be particularly useful as a participatory learning tool, helping to share an understanding of the link between land use and flood generation among local stakeholders, including farmers, as well as identify and discuss possible solutions. The framework could also explicitly link measures to control flood generation with other objectives, such as pollution control, at the catchment-scale. It could also identify, given local farming systems and farmer motivation, the best balance of regulation, voluntary and economic instruments. The approach could also explicitly include the range of ecosystem functions associated with farm land, particularly those associated with the regulation of runoff and flooding.

The advantage of such an approach is that it clearly recognises spatial variation, it is risk focussed and targets interventions that are likely to be most cost-effective. The existing FARM-tool developed by Newcastle University and successfully used in the Ripon stakeholder workshop, is indicative of the type of tool which could be further developed.

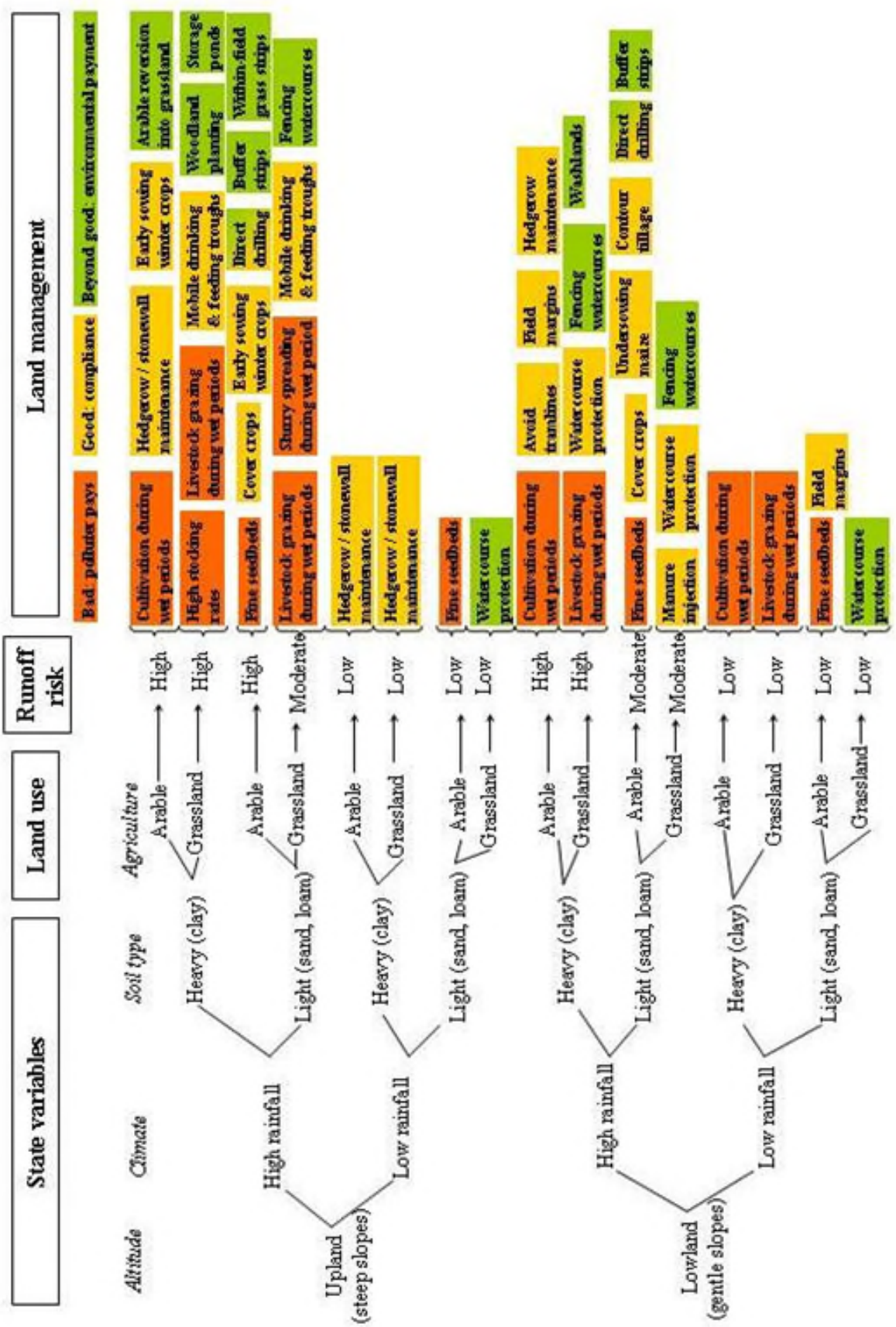


Figure 13 Conceptual draft for a decision support tool for integrated flood risk management

Key messages chapter 5

- There is a shift in social preferences and policy towards a multifunctional paradigm for agriculture. Within this new paradigm, there are opportunities for farmers to deliver a range of environmental services, including integrated flood risk management.
- The ecosystems services approach is a useful framework for identifying and evaluating the environmental services provided by rural land management, including the regulatory functions associated with runoff control and flood risk management.
- The degree and intensity of agricultural land use could vary under different future scenarios, with implications for the probability of runoff generation from farmland and the need for and feasibility of alternative solutions to flood risk management. Current trends in agricultural and environment policy are promoting a Global Sustainability-type scenario, which promotes the principle of multi-functional agriculture. It is not clear, however, how farmers will react to the recently modified policy regimes.
- It is likely that a mixture of policy measures will be needed to reduce runoff from farmland. For the most part, voluntary measures, supported by economic incentives are deemed most appropriate to address what is mainly a 'diffuse 'problem'. However, in areas where there is a clear link between land management and flood risk, stronger measures regulating high risk processes may be called for.
- There is scope for a risk-based decision support tool to systematically assess the risk of runoff from farmland allowing for spatial variation in topography, climates and soils. This would support policy making and implementation. It would also help to engage key stakeholders in understanding the links between rural land use and flood risk management, and assessing possible solutions.

6 Conclusions

This chapter concludes the report by presenting the main conclusions, the risks and uncertainties of this research project, and recommendations for further research.

6.1 Main conclusions of the research project

The main conclusions of this research project are:

- *Policy change and extensification*: After a period of intensification of agriculture, resulting in increased pressure on rural land, the current trend in agriculture is extensification, which is accelerated by the recent CAP-reform. It is likely that his will result in a decreased pressure on less productive lowland areas and in upland areas where stocking rates are already reducing. This could potentially contribute to the alleviation of flood generation, especially if opportunities are taken to use the land released from intensive farming to contribute to integrated flood risk management.

- *Engaging stakeholders*: The key players in flood risk management are mainly governmental bodies responsible for the design and implementation of policy which affect land use decisions. Involving other stakeholders that have complementary objectives can be beneficial for the development and implementation of an integrated approach for flood risk management. A main conflict arises with the objective of rural land managers to have viable farm enterprises, if measures are to be implemented on farmland in order to reduce flood generation. Increasing the interest of land managers (and owners) by involving them in the design of an intervention and promoting practices that address multiple objectives and meet farmers' criteria are needed, so they also become key players in flood risk management. Agri-environment schemes are useful instruments to establish this integration between agriculture and flood risk management.

- *Joining up measures*: The interviews revealed that farmers are more willing to reduce diffuse pollution and soil erosion than runoff. Runoff-controlling practices, however, address these three problems simultaneously. This confirms the point made earlier that there is a need for measures that achieve several benefits. These multiple benefits should also be made clear to farmers, preferably in a way that allows them to observe these effects. Demonstration farms and farm walks are useful tools to achieve this.

- *Farmer acceptance and motivation*: Farmers' decision-making is influenced by a set of socio-economic and bio-physical drivers. Policy interventions must take these drivers into account and design a variety of approaches (such as economic incentives, regulation, awareness-raising, willingness to take collective action) to promote runoff-controlling measures.

- *Location specific*: An integrated approach will be more effective if it is tailor-made to a specific catchment. This allows targeting of high-risk areas of runoff

generation, as well as suitable areas for measures with multiple benefits. The development of a decision support is suggested, which can facilitate the discussion between catchment management officers and other stakeholders to come to a general understanding and agreement of an integrated approach.

6.2 Risks and uncertainties

This research project is subject to a number of uncertainties:

- The small sample of 36 farmers that were interviewed for this project is not necessarily representative for the British farming community.
- The insights presented here are based on qualitative data was collected during personal interviews. Large quantitative data sets are not available to provide statistical evidence to infer these findings to a larger population.
- There is considerable uncertainty about the impact of field-level farming practices on flood generation at catchment scale. To verify the assumption that agricultural intensification has increased flood risk, the impact of field-scale practices on the catchment hydrology needs to be understood. There are gaps in this understanding at present.

6.3 Recommendations for further research

Based on this research project, the following recommendations are made for further research:

- *Quantification of farmers' attitudes and behaviour*. The farm surveys were semi-structured and open-ended in order to fully appreciate farmers' perceptions, understanding and concerns of rural land management and flood risk. Based on the results of these interviews, general statements can be formulated, which can be used for a follow-up survey with a larger sample, in order to generate statistical evidence on farmers' attitudes and factors influencing their behaviour towards land management.

- *Evidence of the link between agricultural practices, runoff and flooding.* There is a need for better understanding and evidence between runoff generating land management practices at field scale and flood generation at catchment scale, in order to justify the implementation of any runoff-controlling land management practices in order to manage flood risk. This should also make specific reference to the aim to mitigate the effects of flooding contained within the Water Framework Directive.

- *Advanced multi-criteria analysis.* It is recommended that methods of multi-criteria analysis and choice modelling are used to determine the suitability of land management practices to control runoff according to the preferences and motivations of various stakeholders, including farmers. Using multi-criteria analysis techniques, practices can be assessed against their performance to achieve multiple objectives (e.g. runoff retention, prevention of diffuse pollution

and soil erosion, habitat creation). Choice modelling reveals the criteria (e.g. low-cost, effectiveness, simplicity to implement) that land managers and other stakeholders use to decide whether or not to adopt particular practices. Land management practices should also be assessed against these choice criteria in the multi-criteria analysis. This is required to strengthen policy interventions that are designed to promote the adoption of new land management practices.

- *Action Research – Monitoring the flood risk aspects of CAP-reform*. A sample of catchments where there is perceived to be a high risk of runoff from farmland should be monitored to assess the impact of CAP-reform measures (e.g. cross compliance practices and Environmental Stewardship) on runoff generation and the extent to which there is synergy or conflict in the way policies are being implemented, especially links between flood risk management, conservation management, pollution control and farm livelihoods. Such monitoring could integrate with other research activities proposed here.

- *Agricultural Runoff Decision Support Tool.* The feasibility and justification for a risk-based decision support tool to assess the risk of runoff from farmland allowing for spatial variation in topography, climates and soils should be explored. This would support policy making and implementation. It would also help to engage key stakeholders in understanding the links between rural land use and flood risk management, and assessing possible solutions.

- *Action Research – Stakeholder Engagement.* The Ripon case study clearly shows the potential advantage of stakeholder participation achieved through, amongst other things interactive workshops, followed though with farm visits and demonstration trials. There is a need to identify the most effective means of achieving participation as a basis for sustainable solutions, through a programme of action research, focussing on a selected number of 'high risk catchments' where changes in land management can make a difference to flood risk. This process could include some of the research approaches referred to above, including the use of multi-criteria analysis and a decision support tool.

- *Collective Choice*: Collective action is often required to address flooding problems. This might involve individuals or groups giving up some personal freedoms in pursuit of outcomes that serve both the collective and, within this, the private good. There is considerable scope here to apply the theory of collective choice in order to understand and promote the processes whereby individuals and groups are willing to work together to achieve sustainable solutions to flooding problems. This would be a new area of social science research applied to integrated rural land management.

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Annex 1
Literature review on rural land management and flood risk

The extreme flood events in different parts of Europe in the mid 1990s raised concerns about the consequences of flooding (Savenije, 1995; Bronstert, 2003; O'Connell et al., 2004; Pfister et al., 2004) There is a general belief that such flood events will occur more frequently in the future due to changes in land use and climate (Reynard et al., 2001; Brown and Damery, 2002; Fowler and Kilsby, 2003; Borrows and Bruin, 2006). Most climate models suggest higher winter rainfall in Europe due to climate change (Bronstert, 2003; Fowler and Kilsby, 2003; Pfister et al.,2004) causing an increase in the magnitude and frequency of flood events in the future. Not only is the amount of rainfall expected to rise, but also the frequency of extreme events (Reynard et al., 2001). The flood events in the mid 1990s also showed that flood 'defence' was not sufficient to cope with these natural hazards, but that flood risk management involving an integrated catchment approach is needed (Savenije, 1995; Brown and Damery, 2002). This approach, represented in the case of England and Wales by Defra's 'Making Space for Water' (Defra, 2004), recognises the importance of controlling development in flood prone areas as well as controlling runoff from rural catchments where this can be shown to make a difference.

As the debate on the causes and consequences of climate change continues, solutions are being sought to manage the perceived increase in flood risk, including the potential role of rural land management. In the light of these developments, the drivers of changes in rural land use were explored in this literature review, and how these changes might affect the generation of floods.

Drivers affecting land use and management

Although runoff generation and the subsequent flood hazard induced by land use are physical processes defined by technical and bio-physical factors (e.g. tillage practices, topography, soil type), there is consensus that the underlying causes are to be found in the socio-economic, political and cultural context in which land users operate (Blaikie, 1985; Boardman et al., 2003; Enters, 1999; Stocking and Murnaghan, 2001). Decision-making of farmers on the choice of crops and the way to grow them is strongly influenced by agricultural policies and economic incentives such as subsidies, guaranteed prices and protectionist policies (Boardman et al., 2003; Evans, 1990). The South Downs case study in England (Boardman, 2003) for example showed that the probability of flooding was effectively reduced in the 1990s due to a reduction of cereal areas and replacement by grass using Set Aside payments and ESA grants. In this section drivers of land use, such as agricultural policies and prices are discussed.

Agricultural policies

The agricultural policy in the UK originates from the collapse of farm commodity prices and the industrial depression in the 1930s. As the European conflict grew in the

late 1930s, there was a massive effort to intensify agricultural production and convert pasture to arable land to secure sufficient national food supplies. After the Second World War, there were clear priorities for the domestic food production. Agriculture was viewed as playing a central role in the protection of rural environment and the support of the rural economy (Hodge, 2001). The UK government recommitted itself to an intensified and modern agriculture and its policy instruments included price subsidies, ploughing grants and capital grants (Dobbs and Pretty, 2004). As a result, rural land use underwent major changes as agriculture became more intensive. The pre-war landscape with small fields, hedgerows and natural meandering rivers, was transformed into a post-war landscape with larger fields, compacted soils due to machinery, land drains and aligned rivers and channels (O'Connell et al., 2004). Similar policies were put in place in other European countries, and the policies became more uniform with initiation of the CAP by the then Common Market in 1958 (Dobbs and Pretty, 2004). From the 1960s until the 1980s, European agricultural policy promoted increased production of and self-sufficiency in food and fibre, simultaneously supporting farming income through price policies. At the local scale, these policies resulted in removal of hedgerows and woodland, land drainage, pastures converted into arable land (Ogaji, 2005). The drive for increased production led to commodity surpluses, pollution problems associated with agricultural intensification and, of particular concern at the time, a realisation that the EU CAP regime was financially unsustainable (accounting for over 70% of the total EU budget).

In the mid 1980s, a substantive change occurred in British agricultural policy as a modification in the Common Agricultural Policy (CAP) allowed the creation of agri-environment schemes. These schemes are policy instruments which provide financial incentives to farmers to adopt practices that protect and enhance the farmland environment and wildlife. These schemes are designed to implement the policy requirements of the EU's CAP Pillar II, which stresses the importance of building effective mechanisms for the delivery of public benefits through land management policy (O'Connell et al., 2004). The Environmentally Sensitive Areas (ESA) and the Countryside Stewardship scheme (CSS) were the two main agri-environmental interventions, introduced in 1987 and 1991 respectively.

Agri-environmental schemes have become increasingly important as there is an increasing public demand for environmental-friendly farming and WTO negotiations aim to reduce producer support for agriculture (Latacz-Lohman and Hodge, 2003; Herzog, 2005). In 2005, a new CAP-reform came into force, decoupling financial support to farmers from their agricultural production. Direct production subsidies were reduced and income support payments, based on historical entitlements, are linked to compliance with standards (Cross Compliance rules) which protect the environment, animal health and welfare. The environmental burden of farming is expected to reduce by the changes of the CAP-reform, through a mixture of extensification of farming, increased compliance, and wider participation in agri-environment schemes (O'Connell et al., 2004).

Markets, prices and subsidies

The type and amount of agricultural production is strongly influenced by the agricultural markets. In a perfect competitive market, the price expresses the equilibrium between demand and supply of the good. In practice, however, not all markets are perfect (Colman and Young, 1989). The (world) market for agricultural commodities has been distorted by economic interventions such as subsidies and trade tariffs. Agricultural subsidies are considered to artificially increase the supply of agricultural products, depress world prices, disrupt world markets, and reduce economic efficiency. The subsidies provide incentives to farmers to intensify agricultural production through more intensive use of inputs, generating environmental impacts such as water pollution, land degradation and biodiversity loss (Mayrand et al., 2003). Environmental externalities are often excluded from the profit and loss accounts of farmers, meaning that environmental damage caused by farming is not paid for by the producers but society. The subsidies encouraging agricultural production and thus also increased the associated unpriced environmentally harmful by-products (Lingard, 2002).

Figure 1 presents the amount of subsidies provided to UK farmers from 1973 till 2003. In 1994 there was a doubling of the subsidies provided. In 1996, prices for agricultural products declined sharply (Figure 2), resulting in a sharp decline of farm income as well after a short period of income increase (Figure 3). It is not known whether this affected land use or land management though.

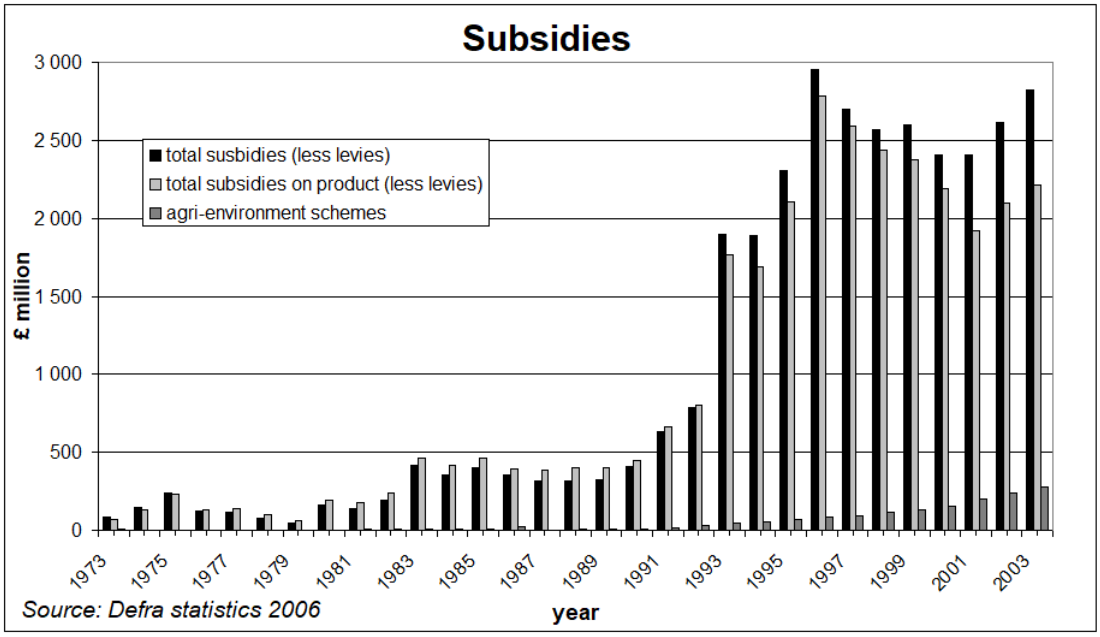

Figure 1 Subsidies for UK farming 1973-2004

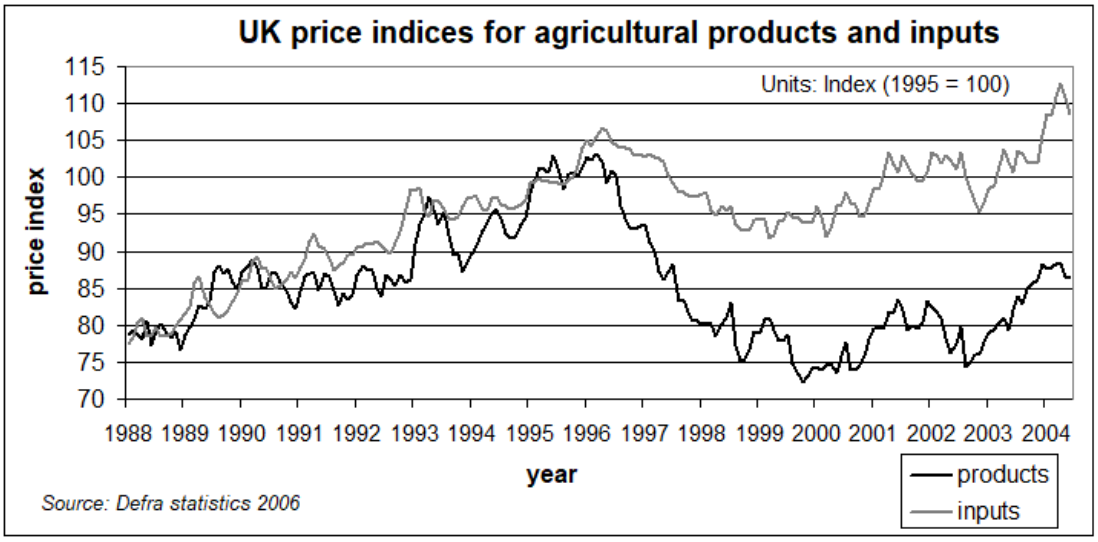

Figure 2 UK price indices for agricultural commodities 1988-2004

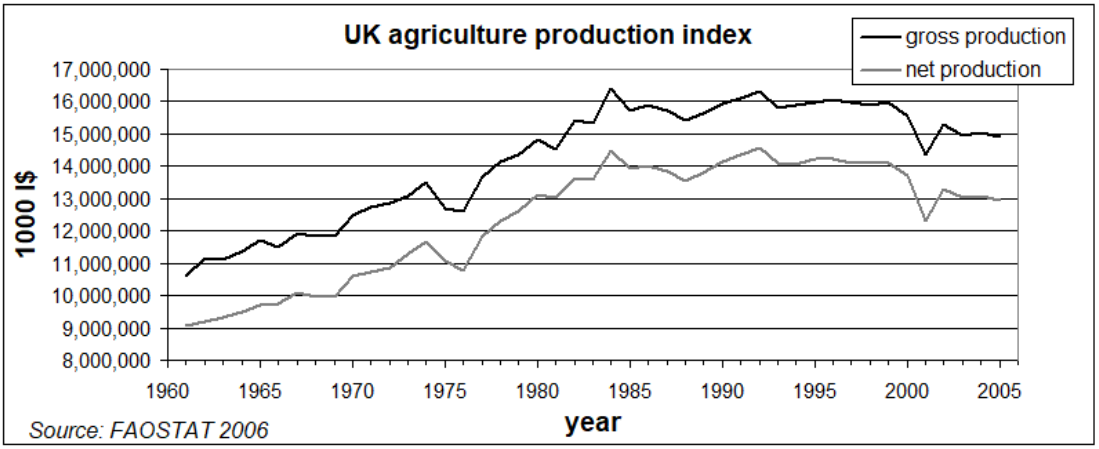

Figure 3 UK agricultural production 1961-2004

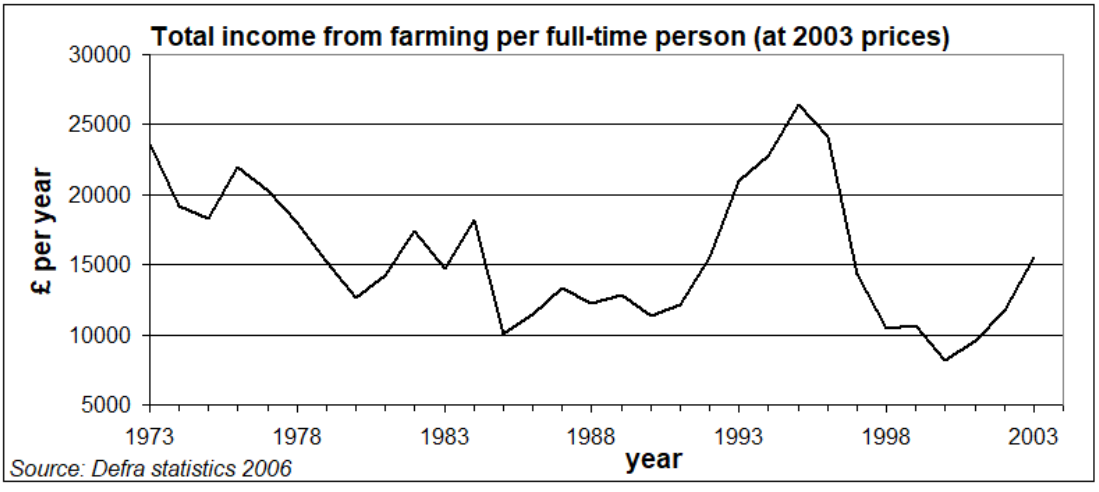

Figure 4 UK farm income trends 1973-2003

It is expected that removal of trade barriers and subsidies results in a rise of aggregate world prices of agricultural commodities. A reform of agricultural policies will increase world trade in agricultural commodities, but leaves the level of total agricultural production unchanged. However, the animal product prices are most likely to increase (Diao et al., 2001). This will result in an increased supply of animal products, and thus increased stocking rates.

In industrialised countries, exchanges of ownership of agricultural produce rarely take place directly between producers and food consumers. The food marketing chain is often simplified by describing five groups of economic agents: producers (i.e. farmers), country dealers, wholesalers/processors, retailers and consumers. These agents are trading with each other through vertically linked markets. In these chains, each stage adds value to the produce of the stage immediately below. Retailers add value to the product delivered by the wholesale sector, wholesalers to the processing sector, and so on down to the farm where farmers add value to the inputs they buy. Farmers are thus very dependent upon the performance of other economic agents above them in the marketing chain in terms of the prices farmers receive and the quality and quantity of products they can sell (Colman and Young, 1989).

Demographic drivers

The agricultural sector in the UK consists mainly of family-run businesses. Demographic changes within farm households and the sector as a whole are likely to influence agricultural land use at farm-scale. Ward et al. (1990) found that changes in agricultural landscapes often occurred when the occupancy changed. Changes in landscape (e.g. loss of field boundaries) conventionally associated with more intensive agriculture are occurring at much faster rates in the lowlands than in the uplands. Resistance to changes in occupancy and the relatively slow-moving agricultural land market are key protective agents for the farmed landscape over this period (Ward et al., 1990). Recent demographic change in the rural population is likely to change rural land use as well. Net incomes from farming declined (Figure 4), as well as the number of farmers (Figure 5).

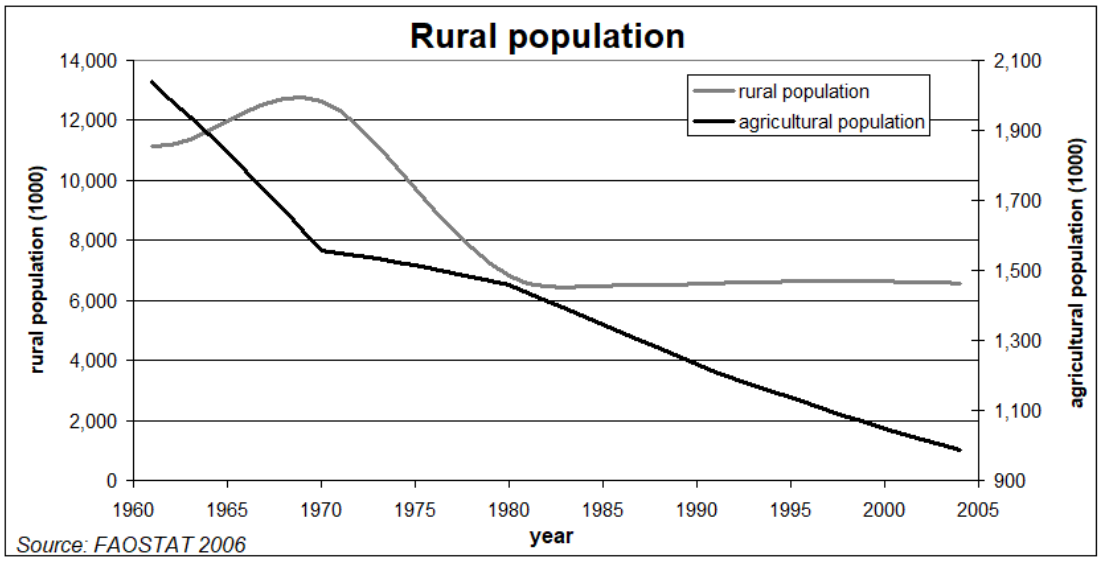

Figure 5 Rural population estimates UK 1961-2004

Many farm households have diversified their income by multiple job-holding by family members. It is expected that the farming community will continue to diversify, ranging from the diversification of income on or off-farm to the replacement of farmers by 'life-stylers' (Lobley and Potter, 2004). Table 1 shows the changes in holdings according to size classes. The number of agricultural holdings has increased, but especially the number of small holdings. Larger holdings which are potentially viable agricultural holdings have decreased in number. This change in the (financial) relationship between the rural inhabitants and the rural land is likely to cause changes in the use and management of the land as well. However, this diversification process is not uniform across UK, but differs per region (Wilson and Hart, 2001).

Table 1 Number of agricultural holdings in UK according to size classes

	1990	1993	1995	1997	2000	2003	2005
Less than 2 ha	12430	13990	11570	15100	21370	34230	34770
2 till 5 ha	19090	20950	18960	19010	21480	33220	33850
5 till 10 ha	30530	30270	29480	28410	25670	27050	28080
10 till 20 ha	37350	37290	36100	34720	30420	29630	30620
20 till 30 ha	25200	24770	23740	23160	19930	18770	19710
30 till 50 ha	35480	34120	32770	32260	27900	26250	27090
50 till 100 ha	42510	41240	40890	39900	36600	35660	35720
More than 100 ha	38470	38700	39250	38550	38880	39750	38570
Total number	243060	243470	234500	233150	233250	280630	286750
Total 1000 hectares	16499	16383	16447	16169	15799	16106	15894

Source: EUROSTAT 2006

Agricultural land management and flood generation

It is thought that the intensification of agricultural land use resulted in increased volume and speed of runoff as less water infiltrates in the compacted soils, and the runoff is discharged faster causing higher peak flows in rivers and channels (van der Ploeg et al., 1999; Bronstert, 2003; O'Connell et al., 2004; Evans, 2005). The Environment Agency (2002; cited by: O'Connell et al., 2004) suggests that 25% of major flood events over the period 1970 to 1990 were associated with runoff from hill slopes, and that 57% of these events have been linked to erosion and deposition. Though there is no firm evidence, the Agency concludes that 14% of flood damage costs in England and Wales are attributable to hillslope floods and to agriculture, equivalent to £115m per year. Two key messages arise: first, the costs of erosion and related runoff from farmland are mainly felt off-farm (for the most part in the immediate vicinity); and second, the incentives for farmers to adopt erosion and runoff control measures are limited.

Several attempts have been made to model the potential impact of changes in land use and climate on flood generation. However, there remains much uncertainty in climate and flood modelling as it is difficult to disentangle the effects of human-induced changes (climate, land use, river regulation measures, settlement expansion) on flood risk, and to correctly predict precipitation and runoff quantities (Bronstert, 2003) especially at the large scale. Climate and water storage determine the probability of a flood event occurring. Changes in climate and reduced water storage capacity due to land use changes (e.g. urban development in floodplains) increase the probability of

flood events. Tu et al. (2005) verified the assumption that rapid land use changes since 1950s had aggravated recent floods in the Meuse catchment. Evaluating historic land use changes and climate patterns, they concluded that most changes in land use occurred before the 1980s, whereas precipitation increased since the 1980s, suggesting that the increased frequency and extent of floods over the last two decades should be ascribed to climate variability. Encroachment, the phenomena of predominantly urban land uses with high damage potential 'invading' the floodplain, is a significant process that increases (potential) flood damage as the properties at risk of flooding have a higher economic value (Pottier et al., 2005).

Flood studies often use the Source-Pathway-Receptor framework, with changes in runoff and drainage being the source, surface water channels being the pathway and the location affected by flooding being the receptor (O'Connell et al., 2004). The source is thus the location where runoff is generated, but the runoff process itself can be considered as a pathway. There is consensus among scientists that at the large scale (e.g. national level) the effects of climate change (that is, increasing winter rainfall) and to a lesser extent urbanisation are the main drivers of increasing flood risk. At the local scale, however, agricultural land use can have an important impact on local flood events, especially during intense storms in summer resulting in flash floods (Niehoff et al., 2002; Hall et al., 2003; O'Connell et al., 2004; Pfister et al., 2004). Though of less importance for the national economy, such events can cause extensive local damage and considerable social problems.

Naef et al. (2002) defined different runoff processes (Hortonian overland flow[6], saturation overland flow and fast subsurface flow) to analyse the effect of land use on flood generation. Land use changes can only result in a reduction in storm runoff causing flash floods if the infiltration capacity of the soil is enhanced. This is especially the case in areas with fast and intensive runoff generation like Hortonian overland flow or rapid saturation overland flow. This occurs when the soil surface is sealed through erosion processes, or the soil has compacted layers. Soil compaction due to intensification of agriculture and erosion-inducing crops are important contributors to local flood events. The high guaranteed prices for cereals under the CAP in the 1980s resulted in a conversion of marginal pasture into arable fields with winter cereals (Evans, 1990). This land use change resulted in local muddy floods, causing damage to properties downstream in the South Downs in England. Flooding incidents were concentrated in the months October to December, which correspond with frequent and long rainfall events, but also with fields under winter cereals being bare (Boardman, 2003). Increased stocking rates in upland areas have reportedly increased runoff and (winter) discharge due to soil compaction and reduction in vegetation cover (Sansom, 1999).

With respect to upland areas, the drainage of moorland (usually above 240m) was promoted during the 1960s and 1970s in order to increase sheep and, in some areas, grouse production. Nowadays, a controversy exists whether this has increased flood generation. As some upland peatlands store large quantities of water, it is assumed that they can act as a source of base flow during dry periods, and attenuate flows as

[6] Hortonian overland flow happens when runoff starts without the soil being saturated, for example when the sealing or crusting of the soil surface occurs.

they soak up rainwater in wet periods. However, peatland catchments tend to have flashy hydrological regimes as there tends to be limited storage capacity: small amounts of rainfall are enough to raise the water table to the surface (Holden, 2005). But other research shows that artificial drainage of moorland can increase peak flows because storm runoff is discharged faster through the drains and additional surface runoff can be intercepted by drains, resulting in higher peak flows (Robinson, 1985; Stewart and Lance, 1991; Sansom, 1999).

Even though there is anecdotal evidence that agricultural land use affects runoff, and it is assumed flood generation as a consequence, much uncertainty still exists about the impact of land management at field-scale on the flood risk at catchment-scale. Runoff from one field may infiltrate downstream before reaching a watercourse. Holman et al. (2003) suggest that in occasional events (high rainfall with bad timing of certain farm operations) the increased runoff does contribute to increased river discharge and thus flood risk. Still, it appears to be difficult to disentangle the precise effects of individual land uses on flood risk at the catchment scale and this underlines the need for a holistic approach to flood risk management (Sullivan et al., 2004).

Agricultural land use can also be the receptor of flooding. Either flood defence can prevent agricultural land being the receptor, or measures can be taken to induce agricultural land being a receptor in order to protect downstream urban areas. It depends on the location and quality of the agricultural land which option is preferable. Flood defence comprises protection against flooding of the surface (inundation) as well as below the surface (waterlogging) of the ground. Therefore, land drainage is important to enhance agriculture. The drainage requirements depend on land use type, with horticulture having the lowest acceptable flood risk and extensive pasture the highest. The damage caused by flooding depends on the severity of the inundation or water logging, land use type, soil type and the season as well (Morris, 2003). When farmland on floodplains is used to store flood waters temporarily in order to reduce the flood risk downstream, there is scope to integrate flood risk management objectives with those of conservation management, extensive farming and rural livelihoods through the creation of riverine washlands (Morris et al, 2005). The new Environmental Stewardship scheme includes a component for inundation grassland for this purpose.

The physical and financial consequences of flooding on farmland are well documented, mostly associated with the estimation of the benefits alleviating flooding and waterlogging to provide agricultural enhancement (Morris et al., 2005). Thus, from a benefit assessment viewpoint, the effects of flooding and re-wetting of farmland are the converse of the enhancement case. The impact of changes in flooding on a given part of a farm can have an effect at farm scale. Pivot et al. (2002) studied the consequences of flood expansion areas on farm management. The losses to the farm differs from the losses on the flooded field, due to ‘knock-on’ effects on farm operations which depend on the internal organisation, availability of production resources, and the farmer’s objectives. The authors defined three possible strategies of farmers related to possible floods on their farm land: no attempt to alleviate the risk, localised (only at the flood-prone fields) reduction of the risk, and overall reduction of the risk. Which strategy is chosen depends on the size of the flood-prone area related to the total farm size (Pivot et al., 2002).

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Annex 2
Description key stakeholders in Laver and Skell catchments

Defra

Defra is the Department for Environment, Food and Rural Affairs, and its overarching aim is sustainable development. Defra's strategic priorities are: sustainable consumption and production, protecting the countryside and natural resource protection, sustainable rural communities, and sustainable farming and food. The England Rural Development Programme (ERDP) is an important tool, besides legislation, to address these priorities. The Rural Development Service (RDS) delivers five out of seven schemes of ERDP, which help rural businesses and communities protect the countryside and adapt to the demands of an increasingly competitive rural economy. The Environmental Stewardship is one of the schemes delivered by RDS.

Defra has overall policy responsibility for flood and coastal erosion risk in England. Defra does not build defences, nor direct the authorities on which specific projects to undertake, but do provide guidance. Defra also provides grants to the flood and coastal defence operating authorities to assist with the cost of capital improvement projects to manage flood and coastal risk. Traditionally, flooding meant from watercourses or the sea rather than from other sources. However, Defra's new strategy (Making Space for Water) is taking a holistic approach to management of risk from all forms of flooding and coastal erosion.

The Ripon Multi-Objective National Pilot Project is one of the initiatives started within this new strategy. The Ripon-MOP aims to demonstrate links between diverse objectives and funding streams to identify solutions for a range of issues within a catchment, including flood management, biodiversity, pollution control, land management and public amenity (www.defra.gov.uk). This project, led by Defra, is carried out in partnership with the EA, EN, RDS, FC, HBC, CLA and RSPB. Each body uses its powers to instigate measures in the catchment and in-channel restoration, which will reduce flood risk to the city of Ripon and provide biodiversity benefits (English Nature, 2005).

Defra is developing the Catchment Sensitive Farming (CSF) scheme in order to reach targets stated in the Water Framework Directive (WFD). This CSF scheme aims to raise awareness of diffuse water pollution from agriculture and the requirements and potential impacts of the forthcoming WFD on the industry, as well as to encourage early voluntary action by farmers to reduce diffuse water pollution in preparation for the WFD. Within the scheme, a number of relatively low-cost but effective capital items will be funded in 40 priority catchment areas.

Forestry commission

The Forestry Commission is the Government Department responsible for forestry policy and aims to protect and expand Britain's forest and woodlands and increase their value to society and the environment (www.forestry.gov.uk). According to the Forestry Commission, forests can help reduce flooding. The sponge effect of the

expansion of woodland onto soils that are prone to compaction could help to reduce the risk of rapid runoff, which might afford some protection against localised flooding. However, the scale of woodland planting would have to be considerable to have an influence on severe flooding events. Also, some trees or types of forests use more water than shorter vegetation. Upland conifer forests seem to reduce the quantity of water reaching the soil. On the other hand though, forest practices like soil drainage and harvesting timber can increase the amount of runoff in the short term. Though the effect of forestry in upland areas on flooding is disputable, forestry has a potential to assist flood control in floodplains. Allowing water to spill across larger areas of land in floodplains slows down floodwater and reduces flood peaks. Wetlands such as wet woodlands can be created in these areas, which would add to the retention of floodwaters because it is hydro-dynamically rougher than other vegetation types (Gregory et al., 2003).

Environment Agency

The Environment Agency provides a 24-hour flood warning service and also maintains, operates and improves flood defences. It is responsible for the larger rivers. Environment Agency is funded by Defra. The EA leads the Catchment Flood Management Plan, which aims to encourage an integrated, sustainable and strategic approach to the management of flood risk in river catchments. The CFMPs are to understand the factors that contribute to flood risk within a catchment and recommend the best ways of managing the resultant risk of flooding within the catchment over the next 50 to 100 years (www.environment-agency.gov.uk). The Environment Agency is responsible for the Ripon Flood Alleviation Scheme, which is still in its planning stage.

NFU

The National Farmers' Union represents farmers and growers of England and Wales. Its central objective is to promote successful and socially responsible agriculture and horticulture, while ensuring the long term viability of rural communities. The Defra funded Catchment Sensitive Farming initiative is a key issue for the NFU. The term refers to the method of farming that reduces agricultural water pollution through land management systems. Although agriculture is not the only contributor to the water quality problem, it is a significant contributor. The NFU strongly endorse a co-ordinated and strategic partnership approach. This relies on early action, local solutions and consists of positive measures that promote and enable farmers to bring about changes in their land management (www.nfu.org.uk).

CLA

The Country Land and Business Association represents the interests of those responsible for land, property and business throughout rural England and Wales. The CLA was founded in 1907 its membership encompasses landowners, businesses and professions. The CLA is worried about the new development of Defra's policy focussing on flood risk rather than flood defence, pleading that current flood defences are maintained and not abandoned (www.cla.org.uk).

Harrogate Borough Council

Local authorities have the responsibility over small drains and dykes in villages and some towns. They improve and maintain flood defences, carry out emergency

response and the aftercare for flooded areas. They raise money locally through council tax for their own flood defences plus grant aid from Defra. More specific, the Harrogate Borough Council has the following responsibilities:

- Deploying men and materials to most at risk areas following advice from Met. Office and Environment Agency, and based on past experience.
- Working with parish council and local communities to develop community based plans or self help schemes which take account of all sections including the vulnerable.
- Raising awareness within local communities of the risk of flooding and to encourage local self help.
- Being pro-active within areas at risk and to identify strategic locations for the storage of sandbags for use by the community.
- Providing sandbags free of charge to residential properties that are in imminent danger of flooding within available resources.
- Working alongside the Emergency Services and other agencies to minimise the effect on the affected communities.
- Providing advice and assistance to those residents of properties that have been flooded, on how to clear up after the event, and to assist the community to return to a state of normality as soon as possible.
- Maintaining essential local services.

(www.harrogate.gov.uk)

Nidderdale AONB

Nidderdale Area of Outstanding Natural Beauty is one of the 41 AONBs in England and Wales. Much of the Laver and Skell catchments are included in Nidderdale AONB. The Nidderdale AONB is a working landscape that evolved over centuries of human activities. This process of change will continue into the future, but the challenge is to ensure that change benefits the landscape and brings renewed prosperity to the AONB's rural communities. There are number of grants available to assist landowners, farmers, individuals, communities, parish councils and organisations. Funding is available for a wide range of activities in the AONB. The Nidderdale AONB has the following four schemes:

- ✓ The Enhancement Scheme supports projects up to £5,000 which enhance the natural beauty of the AONB.
- ✓ The Sustainable Development Fund can support larger projects which benefit the environment, community and economy of the AONB.
- ✓ The Built Environment Initiative provides funding to protect buildings and historic features in the AONB.
- ✓ The Country Shows and Fairs grant scheme provides support for existing events and to help develop new ones.

(www.nidderdaleaonb.org.uk).

Yorkshire Wildlife Trust

The Yorkshire Wildlife Trust works to protect vulnerable wildlife (animals, birds, plants) and their habitats. Under the banner Water for Wildlife, YWT gives advice to farmers, landowners and land managers on how they can manage their river banks and ditches, and enhance and create habitat (especially wetlands) on their land to help water-related wildlife.

(www.yorkshire-wildlife-trust.org.uk)

English Nature

English Nature (EN) is a Government Agency funded by Defra and champions the conservation of wildlife, geology and wild places in England. EN's objective is to conserve a network of special sites, including Sites of Special Scientific Interest (SSSIs) and National Nature Reserves (NNRs) that is well management and in favourable condition, in order to safeguard the diversity of England's habitats, species and geological and physiographic features (English Nature, 2005). EN was involved in the consultation exercise for the Government's new strategy on flood management Making space for waters, published in March 2005. EN supports the conclusions that solutions to flooding problems should be sustainable, base on whole-catchment evaluations and integrated with biodiversity, pollution control and other environmental objectives (English Nature, 2005). English Nature, Rural Development Service and the Countryside Agency Landscape Access Recreation will join in together in 2006 to form a new agency, Natural England, which will ensure that the natural environment is conserved, enhanced and managed for the benefit of present and future generations, thereby contributing to sustainable development. Natural England's functions will include:

- ✓ promoting nature conservation and protecting biodiversity,
- ✓ conserving and enhancing the English landscape,
- ✓ securing the provision and improvement of facilities for the study, understanding and enjoyment of nature,
- ✓ promoting access to the countryside and open spaces and encouraging open-air recreation, and
- ✓ contributing in other ways to social and economic well-being through management of the natural environment

(www.english-nature.org.uk)

Yorkshire Dales River Trust

The River Trusts are independent charities that aim to conserve the rivers and wetlands. The Yorkshire Dales River Trust was registered in 2005 as a charity. The trust has identified several topics of concern, such as flash flooding, river bank erosion, sedimentation, eutrophication, diffuse pollution and obstructions of fish passages.

Yorkshire water

The water company Yorkshire Water abstracts drinking water from rivers in the catchment, Carlsmoor beck, and owns some land in the catchment. Though Yorkshire Water has no direct interest in flood risk management, it is interested in the watercourses in the Laver catchment.

National Trust – Fountains Abbey

The Studley Royal Water Garden is part of Fountains Abbey Estate. The estate covers 333ha. The National Trust has owned the estate since 1983. Over the past twenty years, the water gardens, originally created in the 18th century, have undergone restoration. The lakes were dredged, eroded banks re-profiled and sluices repaired. Water levels in the water gardens are controlled via the sluices and so may impact on

levels in the river Skell downstream as well as upstream the estate (www.fountainsabbey.org.uk).

Land owners and managers
Though the land owners and land managers are officially represented by NFU and CLA, the individual farmers often face different issues and problems than those represented by the official bodies. The group of land owners and managers is diverse, containing large farm enterprises, newcomers with smallholdings, and everything in between.

Inhabitants at risk of flooding
Inhabitants who experience flooding problems are also one of the stakeholders. These are not only the inhabitants of Ripon, but also inhabitants scattered throughout the catchment, including land owners such as farmers. Inhabitants are represented by the local Parish Councils.

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Annex 3
Summary results of case studies

Upper Severn, Wales

In November 2005, nine farmers in the surroundings of Llanfair Caereinion, Wales, were interviewed. Five out of nine farmers were members of the Pontbren consortium. Most farmers had a sheep and beef enterprise; one of the interviewees was a dairy farmer.

Summary farmer characteristics

region	Wales1	Wales2	Wales3	Wales4	Wales5	Wales 6	Wales7	Wales8	Wales9
farm type	sheep/ beef	sheep/ beef	sheep/ beef	sheep/ beef	dairy	sheep	sheep/ beef	sheep/ beef	sheep/ beef/ pigs
LFA	yes	yes	yes	yes	yes	yes	yes	yes	yes
size (ha)	130	130	125	140	120	48	72	124	68
owned	0.85	0.85	0.96	1	0.91	partly rented	?	0.79	1
age	48	43	52	39	45	50	65	67	67
full-time	yes	yes	yes	yes	yes	yes	yes	yes	yes
successor	nephew?	son	nephew?	?	son	no	son	no	son
way of life	4	3	5	3	1	5	5	5	5
conservation	5	5	5	5	2	5	3	5	5
non-farm income	none	wife's salary	none	wife's salary	wife's salary	B&B	contract or	no	pension, salaries son & daughter -in-law
future strategy	reduction production costs; self-sufficiency	expansion, ES	self-sufficiency	self-sufficiency	grazer system	self-sufficiency & ES	ES	extensifi-cation, ES	going out of pigs, changing sheep breed
SFP	indifferent	good	indifferent	indifferent	bad	problems with maps	good	concerned about future	good
Tir Gofal	no	no	no	no	no	no	yes	no	no
Pontbren	yes	yes	yes	no	no	yes	no	yes	no

Distinguishing characteristics of the area:

- High annual rainfall
- Livestock area
- Widespread land improvement during 1970s and 1980s
- Soil compaction due to overstocking
- Hedgerow renovation scheme
- Pontbren consortium

Past and future changes

Talking about the past, all interviewees mentioned the Farm and Horticulture Development Scheme in the 1970s, under which they received grants to improve the

farmland and farm buildings. This was a huge governmental campaign to increase the food production and farmers felt a social pressure to improve and intensify. And they were proud to produce for the nation. The improvements transformed this area, and farmers got involved in a rat race of expanding, chasing subsidies, and further intensification to keep the farms viable. This resulted in widespread land drainage and high stocking rates which probably led to soil compaction. The intensification also meant increasing production costs (fertilizers, feed, straw) and workload as labour became scarcer and unaffordable. As the workload increased and the farms' profits decreased, farmers had to look for other ways of keeping their farm viable. A few farmers came together and we're looking for ways to keep their farm enterprise sustainable by extensifying their farming system. This is how the Pontbren initiative, a consortium of ten neighbouring farmers, started to develop at the end of 1990s. Now the CAP-reform was coming into force, some farmers who are not member of Pontbren, also decided to de-stock to save labour and production inputs. However, they are not sure whether they will increase the stock numbers again in future when the SFP is reduced, to keep the farm viable.

The future of farming in Wales is considered to be uncertain. Many interviewees stated they had lost control over farming. Prices for agricultural products are low and uncertain because of the cheaply imported food, increasing rules and regulations that are not practical, and there are no youngsters interested to go into farming. Some envisioned that only the 'grazers' would stay, turning Wales into an agricultural landscape similar to the one in New Zealand. Diversification was not really considered an option to increase their income because of the costs involved.

Agricultural policies

As already mentioned, the FHDS and the accompanying improvement grants had a huge impact on the area. As mentioned by some, this scheme, combined with declining output prices, resulted in a subsidy chase. For many farmers the impact of the CAP-reform, more specifically the SFP, was still uncertain during the interviews. Some farmers expressed their concerns about the future once the SFP would stop. Also, some felt they were treated unfair, as criminals, as the SFP is used for 'financial discipline'. If a farmer makes a mistake according to the cross-compliance rules, he will be cut on his SFP. Because of the current uncertainties, several farmers decided to sit tight, and wait until the effect would become clearer before they would make any plans again. For the short-term future, most interviewees opt for a reduction of the production costs and relying on environmental stewardship payments. For the long-term future, farmers hope that the economic and political situation will improve in the future. As many said, 'history repeats itself', so for the longer term farmers are cautiously optimistic that there will be a need for more food production again.

In Wales, the agri-environment schemes are slightly different from the schemes in England. Because of the intensification and simultaneously an increased labour shortage, other activities such as hedgerow maintenance were neglected in the 1990s. At that time, a scheme was introduced for hedgerow renovation, in which most interviewees participated. The participants were very pleased with this scheme, but it was stopped when Tir Gofal was started. It appeared to be difficult for many to enter Tir Gofal, because most farmland was improved and therefore not eligible for the scheme. Some farmers were determined to extensify and carry out conservation work

on their farm, even though Tir Gofal appeared not to be an option for them. Being organised within the Pontbren consortium enabled them to find their own funding and draw up their own schemes. These Pontbren schemes are more flexible than the agri-environmental schemes, as members can opt to participate in any activity that suits them. These activities still cost them money, but the farmers are much more motivated as it is under their own control. However, the Pontbren initiative is not only about control and self-regulation, the members considered the social aspects as very important as well. The group gives them a place to discuss ideas and problems, and it performed as a social safety net during the FMD crisis.

Tir Cynnal is a new scheme that is part of the CAP reform. However, the requirements for this scheme were not clear yet at the time of the interviews, so a few farmers did put their name down for the scheme, but they were not sure yet whether they will actually enter the scheme. Several farmers were of the opinion that these agri-environment schemes were too strict and many rules were ridiculous.

Flood risk and overland flow

The widespread land improvement had a considerable impact on the environment. The land improvement enabled improved grass and increased silage production, but it had also some unwanted impacts on the soil (compaction) and wildlife (disappearance of habitats).

Farmers considered (beef) cattle to be important for good land management. First of all, cattle are not as selective in grazing as sheep. So cattle 'clean up the land'. The manure produced by cattle is put back onto the land, improving the humus content and maintaining a good soil structure. It was also argued that cattle cause less poaching, as they are inside during the wet winter months.

Most farmers were aware of flood risk in the surrounding areas, but it was not considered a problem for themselves. Though some farmers did think that the past farming practices and increased stocking rates might have caused soil compaction, poaching and overland flow, they did not feel any responsibility for flood risk downstream. Water is bound to flow downhill, and they cannot stop it raining or water flowing. If there is an increase in flood risk, which on itself is disputed, farmers rather blame it on changing rainfall patterns (increased heavy rainfall) and the expansion of hard surfaces (roads, yards, buildings), being it in the rural or urban areas. And if the land improvement or land drainage would have resulted in increased flood risk, farmers point towards the policy makers who encouraged them to improve the land in the first place. Whoever is 'responsible', studies are currently carried out on farms of Pontbren members to see if the planting of trees and hedgerows reduced overland flow, and as a consequence flood risk. Farmers themselves are very interested in this research, and if any proof is produced, farmers are willing to plant trees and hedgerows to alleviate downstream flood risk, if the right support is given.

Picture gallery Pontbren – Wales

Landscape view

Serious poaching next to the gate

Field runoff

Hedgerow renovation

Hedgerow renovation

Pontbren farmer explaining hedgerow and tree conservation work

Eden Catchment, Cumbria

In December 2005, 6 farmers in Cumbria (around Ravenstonedale, Kirkby Stephen, Appleby and Temple Sowerby) were interviewed. One farmer lived in the top end of the catchment (Ravenstonedale), two farmers lived also in the upper part of the catchment around Kirkby Stephen, one farmer lived downstream near Appleby and two farmers lived further downstream near Temple Sowerby.

Summary farmer characteristics

farmer ID	Cumbria1	Cumbria2	Cumbria3	Cumbria4	Cumbria5	Cumbria6
farm type	dairy/beef	dairy/sheep/ beef	dairy/sheep	sheep/beef	sheep/beef	sheep/beef
LFA	no	yes	partly	yes	yes	no
size (ha)	220	300	151	200	98.4	89
ratio owned	0.33	0.89	0.79	1	1	0
age	55	45	31	54	48	53
full-time	yes	yes	yes	no	yes	yes
successor	?	yes?	no	yes	yes	no
way of life	4	4	3	3	5	5
conservation	5	5	2	4	5	3
non-farm income	none	property, investment	wife's salary	investment, property	sons wages, value farmhouse	B&B, merchant
future strategy	uncertain	depends on successor	maybe specialise into dairy	diversification	extensification ES	extensification diversification
CSS	no	no	no	no	yes	no
ESA	no	yes	no	no	no	no
SFP	bad	good	good	good	good	bad
ELS	maybe	yes	maybe	yes	yes	yes
HLS	no	no	no	no	yes	?

Distinguishing characteristics of the area

- Livestock farming
- Eden River Trust (controversy about river dredging)
- High rainfall coinciding with high tides causes flooding of short duration
- Steep, narrow river valley
- Majority of farmers impacted by Foot and Mouth Disease (FMD)

Past and future changes

About 20 years ago, farming in this area was stagnant in terms of land use and occupancy. However, farmers did compete with each other to be the biggest producer of the area, and agriculture became more intense. Major changes started to happen more recently when the FMD broke out in this region in 2001. Livestock was removed on a large scale, but compensation payments gave a financial boost to some farms, allowing huge investments in farm assets. For many farmers it was a point in time to reflect on the farm management and the future of their farm. Some went out of dairy, whereas others used to money to invest in huge dairy units with modern

milking parlours. Immediately after FMD, there was also a temporarily increase of arable farming.

Interviewees also referred to a decreasing availability of farm labour, which is driven by increasing labour costs, making hired labour unaffordable to many farmers nowadays. The current labour shortage in agriculture results in extensification on some farms. Having no extra labour force puts extra pressure on dairy farmers, as dairy is the most labour intensive farming enterprise. The present economic state of farming makes farmers reluctant to invest or change their farming system. Only farmers with a successor are willing to take a risk to expand or diversify. Looking ahead, farmers foresee the development of factory farms in this region, as the number of farmers is decreasing rapidly and expansion will be the only option to stay in business. There are not many opportunities for diversification, as there is not a widespread market for a service industry.

Agricultural policies

Most farmers were in favour of the recent CAP-reform and the decoupling of Single Farm Payments from production. However, many comments and complaints were made about the implementation of the CAP-reform and agricultural policy in general. Though farmers support the general idea behind the CAP-reform, they do not necessarily agree with the implementation of the policy and the accompanying rules. The CAP-reform also creates a lot of uncertainty for farmers, as they are not sure yet how it will affect farming, and what will happen when this CAP ends. The farmers' opinions about the cross-compliance are often ambivalent as well. They might agree with some rules, and disagree with others. There is a general scepticism about the environmental benefits of the cross-compliance and agri-environment schemes. Though farmers acknowledge the importance of conserving the natural environment, agricultural objectives can conflict with habitat preservation. However, it is also believed that in Cumbria the landscape did not alter much, and thus wildlife has not been affected seriously by the intensification of farming.

Flood risk

The river Eden floods occasionally, and everybody is aware about the flood risk. Especially flood events in Kirkby Stephen, Appleby and Carlisle were referred to. The flooding occurs when there is high tide in Carlisle, backing up the river. Flood events happen very quickly, as the water in the Eden rises and falls quickly. According to the farmers, the main causes of flooding are the increasing torrential rainfall, the lack of river dredging, and the high tides in Carlisle backing up the river. River bank erosion is a common feature along the river Eden, and as a result the river becomes shallower and flows slower. The Eden River Trust opposes against river dredging according to the farmers, but the comments of some farmers suggest that this has caused misunderstanding amongst local residents. They see the river filling up with sand and pebbles, and becoming shallower, resulting in an increased risk of flooding in the upper part of the catchment. Farmers objected the suggestion that intensification of agriculture might have increased flood risk in the Eden catchment.

The impact of land drainage on flood risk probably depends on the scale of analysis. At field-scale land drainage definitely reduces flood risk, and this is the main concern of the farmers. How land drainage affects flood risk at catchment scale, depends on

the difference in travel time of rainwater to watercourses when this is via overland flow or subsurface drainage systems. If overland flow connectivity is high, and soils are often saturated, land drainage might reduce flood risk by delaying the time the water reaches the watercourses. However, if overland flow connectivity is low, and subsurface flow connectivity is high, land drainage will increase flood risk at catchment scale.

Most farmers acknowledge that intensive farming can have negative impacts on the environment, especially through diffuse pollution. But some consider this as a necessary nuisance of food production. Where food crops are grown, fertilisers are used, which may end up in watercourses. Farming is thus perceived to be a leaky system, which cannot be totally prevented. However, some farmers acknowledged that they should be regulated on diffuse pollution.

Photo gallery Eden

River bank erosion upper Eden

Field operations on wet soils

Eden landscape with stonewalls

Lack of river dredging

Laver and Skell Catchments, North Yorkshire

In November 2005, 8 farmers and one estate agent in Ripon were interviewed. Of the farmers, 2 were hobby farmers, 2 dairy farmers, and 4 mixed farmers (combining sheep, suckler cows, dairy, beef, horse liveries and arable). One of the 4 mixed farmers owned a large farm of 578 ha. The farmers were situated throughout the catchment upstream the town Ripon.

Summary farmer characteristics

region	NY2	NY3	NY4	NY5	NY6	NY7	NY8	NY9
farm type	sheep/ beef	dairy/ sheep/ beef	sheep/ horses	sheep	dairy/ horses	dairy	sheep/ arable	dairy/ arable
LFA	no	no	no	yes	no	yes	no	no
size (ha)	62	206	5	22	577	100	371	206
owned	1	0.24	1	1	1	1	0.04	0
age	62	60	40	80	54	50	33	58
full-time	yes	yes	no	no	no	yes	yes	yes
successor	no	yes	no	yes	yes	no	?	yes
way of life	5	5	5	5	2	2	1	2
conservation	3	5	5	4	4	5	3	5
non-farm income	none	none	salaries and pet shop	pension	letting out of property	none	?	wife's salary
future strategy	extensification	destocking	same	none	service industry, ES	extensification (rearing calves), ES	diversification of enterprises. Less arable, more grassland	Diversification (renting of farm buildings)
CSS	no	no	no	no	yes	no	no	no
ESA	no	no	no	no	no	no	no	no
SFP	indifferent	good	good	bad	good	all subsidies are bad	good	good
ELS	yes	wanted to, but Defra lacks info	no	no	yes	yes	yes	yes
HLS	no	no	no	no	no	no	no	no

Distinguishing characteristics of the area:

- Mixed farming
- Ripon MOP project
- Drainage of peat and moors at upper part of catchment
- Quick rising rivers
- Proximity to Leeds and Harrogate
- Increasing service industry and 'import people'
- Flood risk in Laverton and Ripon
- Leeds City Council sold farmhouses and farmland to tenants

Past and future changes

When asking about changes in the past, most interviewees commented that they had expanded since the 1970s. The improvement grants helped farmers in the upper part of the catchment to drain and improve the grassland. The subsidies motivated farmers to increase stock numbers and arable production. These changes were driven by prices and subsidies. With the declining milk prices and huge investment requirements for dairy, especially small dairy farmers have given up or moved into other enterprises. More recently farmers are extensifying and retiring whereas others look for diversification opportunities, especially in the service industry. Others have carried on with the same farm enterprise for years but are now taking their time to evaluate the CAP-reform and possible adjustments needed to keep their enterprise viable. However, in November last year, many did not yet know the consequences of the CAP-reform for their farm. It is likely though that the CAP-reform and the increasing input prices (fertilizers, fuel, etc.) will result in further de-stocking and extensification in the area. This is all defined by profitability of the farm enterprise, but also whether there is a successor. The present low profitability in agriculture discourages young people to take over farming, and many farm houses and farmland come up for sale. Farmland goes to neighbouring farmers, but the farmhouses are bought by people from outside the area, for example Leeds or Harrogate. With the increase of 'non-local' residents, the demands for services increase as well, such as horse liveries, converted barns for rent or workshops, or tourist accommodation. Several farmers try to take part in this service market to gain extra income.

Agricultural policies

Opinions about the single farm payments differ, some think it is an improvement, whereas others do not. Farmers worry though what will happen once the single farm payments come to an end. Many farmers are interested in the Environment Stewardship, and perceive it as an easy way to earn some extra income. Because of the existing landscape features, with many hedgerows, stonewalls and woodlands in the area, many farmers can enter the ELS without making any adjustments on their farm. As most farmers do not anticipate any drastic changes on their farm despite their participation in ELS, they are sceptical about the claimed environmental benefits.

Land drainage and flood risk

In the 1960s and 1970s large areas of the upper part of the catchment were drained, including the moorland and peat soils. The land drainage enabled farmers to improve their land and increase stocking rates. Whether this land drainage increased the flood risk in the area is debated by the farmers. It is difficult to disentangle the effect of different contributing factors to flood risks as rainfall patterns changed and 'urban' developments took place in the catchment as well. When asking whether land drainage might have influenced flood risk, interviewees referred to the drainage of the moorland as a possible contributor. The anecdotal evidence given by the interviewees shows that drainage of peatland and moorland did change the catchment hydrology, but it is difficult to tell whether it changed the flood risk at the catchment scale.

In 2000 Ripon was severely flooded. Some houses in Laverton are also at risk of flooding. In 2003 Kirkby Malzeard was struck by flash floods and a bridge was destroyed. Many farmers refer to it as extreme events, caused by exceptional long and

heavy rainfall. Some think that flood risk in general might have increased as well, due to changing rainfall patterns (longer and heavier rainfall), property development along rivers, lack of river dredging and lack of road drainage.

Picture gallery Ripon

Rivers Laver and Skell joining at Ripon

Common field boundary features

Drainage of moorland

Ripon landscape

Field operations on wet soils

Stakeholder workshop Ripon

Hampshire Avon Catchment, Wiltshire

In May 2006, 6 farmers in Wiltshire were interviewed. The sample consisted of two small beef producers, two mixed farmers, one arable and one dairy farmer. Two farmers lived in the middle part of the catchment around Amesbury, two farmers in the upper part near Devizes, one farmer in the upper part near Pewsey, and one in the lower part near Shaftesbury.

Summary farmer characteristics

farmer ID	Wiltshire1	Wiltshire2	Wiltshire3	Wiltshire4	Wiltshire5	Wiltshire6
farm type	beef	dairy	beef	beef / dairy/arable	arable	dairy
LFA	no	no	no	no	no	no
size (ha)	20	56	50	340	400	160
owned	1	0.00	1	0.59	0.4	1
age	78	60+/-	52	60+/-	35	65 / 40
full-time	no	yes	no	yes	yes	yes
successor	no	yes	no	yes	?	?
way of life	5	1	5	3	5	5
conservation	5	5	5	5	5	5
non-farm income	pension	none	consultancy	none	B&B, renting out cottages	renting out buildings, farm shop
future strategy	extensification	finding niche market (quality)	finding niche market (quality)	expansion	diversification	diversification
CSS	no	no	yes	no	yes	yes
ESA	no	no	no	yes	yes	no
SFP	bad	good	good	bad	good	good
ELS	yes	yes	yes	yes	yes	yes
HLS	no	no	no	SSSI	no	no

Distinguishing characteristics of the area:
- Arable farming
- Organic farming (arable, beef)
- Landcare initiative
- Army training land (government is landlord)
- Proximity to London
- Large-scale ‘factory farms’
- Diffuse pollution River Avon
- Limited low-intensity rainfall
- Water meadows in past
- Recent conversion to arable

Past and future changes

When asking about changes in the past, all interviewees referred to the disappearance of small dairy farms during the last 15 years. Main reason to go out of dairy is the huge investments needed to keep the milking parlour up to date. With the decreasing milk prices, this becomes more and more a problem. In some cases the buyer refuses to pick up the milk in case the milk production is too little. Another reason why

farmers end their dairy enterprise is because of animal diseases. Those who bought a dairy farm often do not buy the accompanying milk quota as this is too expensive. It is also thought that the CAP-reform will result in more farmers leaving the dairy enterprise, as it now pays to reduce production costs and farm more extensive. A few dairy farmers manage to expand their dairy unit and can profit from economies of scale to remain competitive. Others convert to arable or beef production, as these farming systems are less labour intensive and require less investment. With the disappearance of many dairy farms, less calves are produced as well, which is an impulse for beef farms, as basic grazing animals will always be needed for the grazing of grassland and also nature conservation areas.

Farm income has decreased drastically since the 1980s, as output prices decreased, subsidies were cut down and input prices increased. As a consequence, farm labour becomes scarce, as skilled labour is not available because of the relatively low wages, but also because farmers cannot afford to hire labour. Paperwork has increased considerably over the years and has gotten beyond farmers' control. Several farmers have agents and farm secretaries to deal with the paperwork. The current CAP-reform has not made it easier.

The decline in income is threatening the existence of many farm enterprises. Farmers have developed several survival strategies:
- Find a niche in the market like high quality products or organic products.
- Expansion and developing towards factory farms to remain competitive (making use of economies of scale).
- Extensification or reduction of production costs (arable, beef).
- Diversification into non-farm activities (service industry).
- Financial support through Single Payment Scheme and agri-environment schemes.

Farmers are also keen on signing up for the Single Farm Payment and Environmental Stewardship, as the extra money they can earn is more than welcome in their battle for survival. It is thus more for financial reasons than environmental considerations.

To keep the farm enterprise viable, farmers have to reduce the production costs, either by developing towards 'factory farms' or by extensifying. For the long future a decline in food production is expected. It is thought that this will result in a price increase, but it also implies a risk of future food shortages. Some think that British farming might develop towards New Zealand farming in future, involving abolishment of subsidies and low-input farming.

Agricultural policies

Opinions about the recent CAP-reform differ. Some consider it as an improvement as the pressure is released and farmers can be more flexible in adjusting their farming system. Others consider it as a bad development, since they will receive less financial support, and it seems unnatural for them to receive money for doing nothing, as not farming will be more profitable than farming. Obviously, everyone complained about the extraordinary delays of the payments. Most farmers acknowledge that the SFP should be accompanied with some regulations as they agree they should not receive

money for nothing. Most of the cross-compliance rules were considered as common good agricultural practices, and most farmers thought it would not turn out to be difficult to comply with these rules. Also the requirements for ELS are considered as common good farming practice. For some farmers, the policy changes are quite abrupt though, and they find it difficult to change their attitude from production-oriented to environmental management. However, others acknowledge that the former production-oriented subsidies were not appropriate.

Flood risk and diffuse pollution

There are no serious flood problems in the area, except for Salisbury with five rivers surrounding this town. However, all interviewees reported that water levels of the river Avon had decreased over time, due to drinkwater abstraction by Thames Water. Furthermore, rainfall is normally not heavy in this area. Some farmland along the river is flooded occasionally, but these were originally water meadows during the last century. However, their use is disappearing, partly because the river floods less often.

Though soil erosion is not a big problem either according to interviewees, it was acknowledged that especially on maize fields there is a risk of soil erosion. However, it was stated that at present this risk is very low, as rainfall has been low for the last two years, and maize is not grown anymore on sloping fields or near the watercourses. Also, several farmers have to make a soil management plan. One farmer was sowing grass immediately after the maize since a few years to get two crops a year. According to the interviewees any issues with soil erosion on maize fields are now resolved. One farmer admitted that there were sometimes erosion problems in one of his maize fields, but he was thinking of putting this field under grass.

There were contradicting comments on diffuse pollution. According to some there were no problems at all, and if there had been in the past, they had been resolved now. Two farmers confirmed that there were problems with diffuse pollution in the area, but not on their own farms. Most problems are experienced on farms situated on greensand. However, others mentioned that there have been problems with diffuse pollution related to slurry application and manure storage in past years. Since a few years, farmers have to be more careful because of new regulations, and the threat of prosecution.

The Landcare project aims to raise awareness about diffuse pollution in the area. However, the project was unknown with most farmers, even though they were on the list of the Landcare project manager. The two farmers near Amesbury had heard about the project, but were not actively involved. A farmer near Devizes who was offered an agreement according to the EA, said he had not heard about the project. Though it was anticipated to talk with farmers about the Landcare project, this did not happen, as these six interviewees said they were not informed.

Photo gallery Wiltshire

Arable fields in Wiltshire

Ploughed arable field in Wiltshire

Field margin (6m)

Watercourse protection

Hampshire Avon

Rough seedbed

Fine seedbed

Parrett Catchment, Somerset

In November 2005, 7 farmers in Somerset were interviewed. The sample of farmers interviewed consisted of one arable farmer, one large vegetable grower, one mixed farmer (dairy, beef and arable for fodder), three dairy farmers, and one beef farmer. The seven farmers were located throughout the catchment. One farmer was situated at the top of the catchment near Fitzhead (120 masl, river Tone), three farmers were located in the upper part of the catchment near Wellington (80-125 masl, river Tone), one farmer was further downstream of the river Tone, on the West Sedge Moor near Stoke St. Gregory (15 masl, river Tone), one farmer was located near Ilminster (65 masl, river Isle), and one farmer was located near Martock (50masl, river Parret). The soils in Somerset are light soils, varying form silt to loam to sand. Most soils are very susceptible to soil erosion.

Summary farmer characteristics

region	Somerset1	Somerset2	Somerset3	Somerset4	Somerset5	Somerset6	Somerset7
farm type	beef	arable	dairy	arable	dairy	dairy	dairy/beef/ arable
LFA	no	no	no	no	no	no	no
size (ha)	100	960	65.6	100	140	48.4	160
owned		0.30	0.00	0.8	0.86	0.93	0.625
age	47	60/35	50	38/70	50	45	60
full-time	yes	yes	yes	yes	yes	yes	yes
successor	?	yes	no	yes	yes	no	yes
way of life	4	4	1	4	3	3	5
conservation	5	5	5	5	5	4	5
non-farm income	wife's salary	no	letting property	contracting	no	wife's salary	pension
future strategy	doesn't know, HLS	expansion	wearing out capital till retirement	contracting, market niche (vegetables), energy crops	expansion	going out of dairy, energy crops, ES	going out of dairy, simplificati on farm, reduction production costs
CSS	yes	no	no	no	no	no	no
ESA	no	no	no	no	yes	no	no
SFP	bad	bad	bad	good, but has difficulty with policy change	good, beef price will go up	undecided	policy changes from one extreme to the other
ELS	will do	yes	yes	yes	yes	will do	yes
HLS	will do	no	no	no	yes	no	no

Distinguishing characteristics of the area:
- Mixed farming
- Soil erosion major problem
- FWAG assistance to prevent soil erosion

– ‘New’ soil management practices such as minimum tillage and undersowing maize

Past and future changes

In the past, most farms in the region have specialised into one enterprise and expanded, but there are many different farm enterprises to be found. Whereas some farms disposed of their dairy unit, others specialised into dairy and invested in the unit. Same happened with arable units and beef units. However, hardly any sheep are to be found in Somerset. In which way a particular farm specialised mainly depended on the farmer’s preferences and skills, as well as the suitability of the farmland for a particular enterprise. Specialisation and expansion was needed to keep a viable enterprise as margins decreased. The improvement grants provided by the government in the 1970s facilitated this process. Those who specialised into arable, have removed some hedges to straighten fields and make them a reasonable size. Livestock farms kept the hedges intact as these also function as shelterbelts.

More recent changes have been caused by the involvement of FWAG in order to improve soil management and reduce soil erosion and local muddy flooding. Because of the light soils in the area, there were many problems with sediments on the roads, and EA started to threaten some farmers to sue them if they would not change their farming practices. Farmers involved in the FWAG-project underwent a major shift in attitude and awareness about soil management, which they recognise themselves. This change was further facilitated by agri-environmental schemes, which made it financially also attractive to change farming practices. And many now see more benefits in the changes than they had anticipated.

The interviewees found it difficult to picture where agriculture will be in five years time. Main causes of this uncertainty are the low prices and profitability of agriculture nowadays. For future, farmers involved in arable activities think that industrial crops or bio-fuel might be an option. Farmers with a future successor aim for further expansion to keep the enterprise viable (economies of scale). Farmers without a successor are reluctant to invest in their farm capital for the moment and will gradually go out of production. Agri-environment schemes are seen as an important source of income for the nearby future, as well as energy crops for bio-fuel.

Agricultural policies

Within one generation, many farmers have seen huge changes in agricultural policy, going from one extreme (intensification and maximisation of food production) to the other (environmental stewardship) according to most farmers. Many would be in favour of a more balanced policy and, more important, fair prices. Opinions differ about the CAP-reform, especially the Single Farm Payments (SFP). Some farmers said they would survive financially without SFP, but took it anyhow as the money was available. One big farmer did not want to take the SFP though, but was forced to as he rents the majority of the land. However, when the interviews were carried out (November 2005) farmers were not sure what the impact of the SFP would be on their farm in particular, or on agriculture in general. Most farmers expected that beef and sheep production would decrease, which might result in better prices. But other input and output prices might adjust as well because of the introduction of SFP.

Most farmers considered the cross-compliance rules to be common good practices, and many did not have problems with this rules. Surprisingly, every interviewee was participating in, or planning to, ELS. For many this was for financial reasons rather than environmental ones, anticipating on the future decline in SFP payments. Farmers thus entered the scheme based on features and practices they were already doing anyhow.

As it was a bit too early to know the effects of the CAP-reform, farmers were not speaking out too much. Most seemed to be fairly resigned to the CAP-reform, even though not every one agreed with all CC-rules, especially the waste regulations and hedgerow maintenance. However, many farmers were more concerned about the increasing regulations and inspections, mainly associated with farm assurance schemes. Another area of concern is the lack of money to afford (skilled) farm labour.

Flood risk and soil erosion

Throughout Somerset there were severe problems with soil erosion which resulted in sedimentation on local roads and siltation of ditches and watercourses. The Environment Agency and the highways started to trace farmers and told them to change their land management practices or otherwise they would be sued for bad farming practices. FWAG got funded to advise farmers on soil management practices, and this resulted in huge changes on farms involved in the project. Main 'new' practices are early sowing, undersowing maize with grass, leaving rough seedbeds, minimum tillage, installing buffer strips, and contour ploughing. The practice of leaving maize stubbles over-winter has been abandoned by most, as this was the worst practice, causing the most runoff and soil erosion. Most farmers also became aware that it is their responsibility and in their own interest to retain soil on their land. The stick of the Environment Agency (threat of prosecution) and the carrot of FWAG (free advice) resulted in a raised awareness about soil erosion. However, in case of extreme rainfall soil is still lost, and farmers cannot control it then.

Most interviewees had land that gets flooded during winter, but it was not considered as being a huge problem. For most, the land would just be flooded during several hours and then disappear again. Only if land was flooded during spring, it might damage some crops. Opinions differed whether flood risk has changed, or increasing overland flow has contributed to the problem.

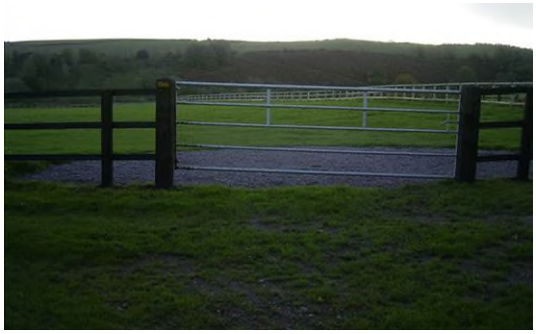
Though farmers acknowledged their responsibility for soil erosion, flood risk is not in their control or their concern. However, farmers do consider retaining or slowing down runoff, for the reason of reducing soil erosion and diffuse pollution, not in order to reduce flood risk. As one farmer reasoned, when soil or nutrients are lost from farmland, it is actually a cost for the farm enterprise.

Photo gallery Parrett

Waterlogged soil

Watercourse protection

Poaching near the gate



Avoidance of poaching

Local road flooding

Landscape in Somerset

Landscape in Somerset

River bank erosion

Annex 4

Good practices / Sustainable land management

Good practices	Promoting schemes	Runoff generation	Soil protection	Diffuse pollution	Habitat for wildlife	Easy to fit in farming system	Low costs (incl. maintenance)	Observable effect	Economic effect
Stonewalls (maintenance)	ELS	If along contour, slow down / retain runoff	Protects against erosion if along contour	Slow down runoff: sedimentation	Good (insects and small birds)	Yes	Yes, but labour required	yes	Maintenance costs (compensation available through ELS)
Hedgerow maintenance	ELS	If along contour, interception of runoff (buffer function). Might increase infiltration	Protection against (wind) erosion, increase organic matter	Traps sediments	Good	Yes	Yes, but labour required (often done by contractors)	Yes	Maintenance costs (compensation available through ELS)
Buffer strips (along contour, field borders, sufficient width)	ELS / HLS	Slow down runoff, increase infiltration	Protection against erosion	Traps sediments	Good	Somewhat	Yes, but might hamper field operations if installed within field	Yes	Maintenance costs, disturbance field operations, compensation available
Within-field grass strip	ELS / HLS	Slow down runoff, increase infiltration	Protection against erosion	Traps sediments	Neutral	Somewhat	Yes, but might hamper field operations	Yes	More weeding costs if invasive species, disturbance field operations
Margins around hedgerows / watercourses	SFP	Slow down runoff, increase infiltration	Protection against erosion	Traps sediemtns	Good	Yes	Yes	Yes, but depends how margins are treated	Less yield, less damage to machinery
Woodlands	FWP / ELS	Interception of runoff, increase of infiltration	Protection against wind and water erosion	Traps sediments	Good	No (farmland to be converted into woodland)	Planting trees can be costly	Yes	Change of land use

Good practices	Promoting schemes	Runoff generation	Soil protection	Diffuse pollution	Habitat for wildlife	Easy to fit in farming system	Low costs (incl. maintenance)	Observable effect	Economic effect
Field drainage maintenance		Reduced runoff, if save disposal of drainage water.	Avoid waterlogging problems	None	Bad?	Yes	Maintenance can be costly	Yes?	Decreases risk of crop failure due to waterlogging
No field operations on waterlogged soils	SFP	Avoid soil compaction, that is decreased infiltration capacity	Avoid soil compaction	None?	None	Yes	Yes, but may cause delay of other field operations	Yes	Depends on ‘ knock-on’ effects (delay farm operations)
Tillage along contour		Slow down runoff, increase infiltration	Protection against erosion, but if not well done increased risk of erosion	Potentially less runoff = less sediments	None	Is difficult to practice, especially for combine crops	Yes	Yes, if carried out properly	Field operations take more time. Not suitable for combinable crops
Avoid tramlines		Less accumulation of water along tramlines	Avoid soil compaction	None	None	No	Requires extra field operations	questionable	Inconvenient for field operations
Post-harvest: cover crop	SFP	Slow down runoff	Protection against erosion	Less sediments	Good?	Yes, but depends on crop rotation	Yes	Yes	Can hamper crop rotation or field operations
Post-harvest: rough surface seedbed	SFP	Increased infiltration, slow down runoff	Less sealing of soil surface, less erosion	None	None	Yes	Yes, reduction in tillage costs	?	
Conversion arable land into pasture	SFP	Possible increased infiltration	Permanent soil cover, protection against erosion	Less sediments	Good	No	No	Yes	Conversion costs depends on farming system

Good practices	Promoting schemes	Runoff generation	Soil protection	Diffuse pollution	Habitat for wildlife	Easy to fit in farming system	Low costs (incl. maintenance)	Observable effect	Economic effect
Spring cereals instead of winter cereals		Less runoff during winter (depends on land management during winter)	Less erosion (but depends on land management during winter)	None	None	Depends on crop rotation	Yes	Depends on land management during winter	May have ‘ knock-on’ effects on farm, depends on crop rotation
Early sowing of winter cereals (September)		?	Improved soil cover: less erosion	?	None	Depends on crop rotation	Yes	Yes	Suitability depends on timing of other field operations
Organic farming	OFS, OELS	Increased infiltration due to better soil structure	Increased soil organic matter (reduced risk of soil degradation)	Less pollutants (no chemicals)	Good	No	Conversion of farming system is costly	?	Conversion of farming system, but compensation is available
Ditch management (keep livestock out, grass on banks)	ELS	Better drainage, slow down runoff	None	Less sediments in water	Good	Yes, but livestock access to drinking water might be problem	Fencing can be costly	Limited	Fencing and maintenance costs
River bank protection (fence off watercourses)		Slow down runoff	Avoid river bank erosion	Less sediments	Good	Yes, but livestock access to drinking water might be problem	Fencing can be costly	Limited	Fencing and maintenance costs, provision of new access to drinking water for livestock
Watercourse protection (no cultivation or application of inputs within 2m)	SFP	Buffer function: slow down runoff, increase infiltration	Avoid river bank erosion	Traps sediments	Good	Yes	Yes	Yes	Set-aside entitlements can be used for these strips

Good practices	Promoting schemes	Runoff generation	Soil protection	Diffuse pollution	Habitat for wildlife	Easy to fit in farming system	Low costs (incl. maintenance)	Observable effect	Economic effect
Light breed of sheep / cattle		Better infiltration capacity soil	Less soil compaction	None	None	No, farmer needs to change breed	Initial conversion costs	Changes in runoff is difficult to observe	Generally lower output, but breed less susceptible to diseases
Lower stocking rate / avoid overgrazing	SFP	Better infiltration capacity soil	Less soil compaction	None?	None	Need for extra land or fodder		Changes in runoff is difficult to observe	More land or fodder required
Seasonal removal of livestock	ELS (HLS)	Better infiltration capacity soil	Less soil compaction and poaching	None?	None	No, extra housing and fodder needed	No, housing of livestock is expensive	Changes in runoff is difficult to observe	Extra feeding and housing needed, which is costly if not readily available
Suitable supplementary feeding, avoid poaching by mobile feeders	SFP, HFA	Better local infiltration capacity soil	Locally less poaching and soil compaction	Reduced sediments because less poaching	None	Yes	Yes, but mobile feeders need to be purchased	Yes locally	

Based on DEFRA documents:

- ✓ Single Payment Scheme; cross compliance guidance for the management of habitats and landscape features. 2005
- ✓ Single Payment Scheme; cross compliance guidance for soil management. 2005
- ✓ Single Payment Scheme; cross compliance handbook for England, 2005 Edition
- ✓ Farm Woodland Premium Scheme; rules and procedures
- ✓ Hill Farm Allowance; explanatory booklet 2005
- ✓ Best practices, Environment Agency

Annex 5
Report stakeholder workshop in North Yorkshire

Land management and flood risk in the Laver and Skell catchments

Report of stakeholder workshop

Held on: 17 March 2006
At: Kirkby Malzeard

Dr. Helena Posthumus
Prof. Joe Morris
Cranfield Univeristy Silsoe

Dr. Caspar Hewett
Dr. Paul Quinn
University of Newcastle upon Tyne

Deirdre Murphy
Defra

1. Introduction

Joe Morris welcomed everybody and explained the aim of the workshop, namely to work towards a common understanding of the relationship, actual or potential, between rural land use management and flood risk management. He noted the wide range of stakeholder groups represented in the workshop (see chapter 9 for list of participants).

2. Causes of flood risk in Laver and Skell catchments

Each participant was asked to write down three factors which in their view contributed to flooding problems. Figure 1 classifies the results of this opening question.

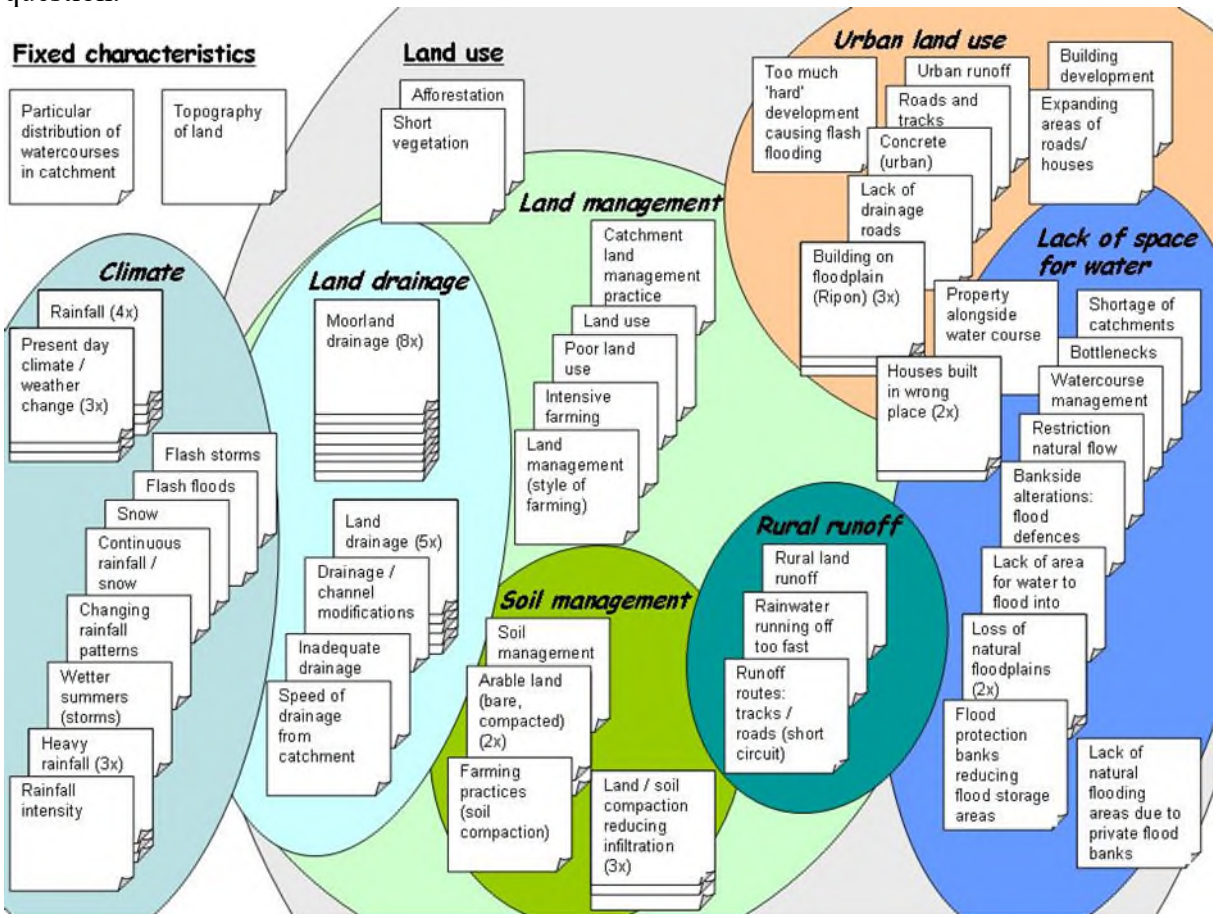


Figure 1 Factors contributing to flooding problems in Laver and Skell catchments

Obviously, rainfall and changing rainfall patterns (climate change) were recognised as important factors causing flood risk. Two characteristics of the catchment were mentioned as well: the particular distribution of the watercourses and the topography. These define the flood risk, but can not be changed or controlled. Practices relating to land management (31x) were most often mentioned as a contributor to flood risk, of which land drainage (16x), both of the moors and farmland, was the most often mentioned. Other land management practices were mentioned, ranging from land

management in general to more specific soil management practices leading to compaction and runoff from rural areas.

Another important factor causing flood risk is the urban land use (11x). Urban development (including roads) was perceived to cause large amounts of runoff, also due to a lack of appropriate drainage, especially along the roads. But it was considered that urban development in the floodplains and along watercourses also aggravated the problem. Natural floodplains thought to have decreased and the natural watercourses have been altered and restricted, decreasing the space for water (10x). The natural space and buffer zones for water have thus been reduced, increasing flood risk.

This short opening session showed that most participants did think that land management contributes to flood risk, but also suggested that changing land management only is not enough to tackle the problem. Problems in the urban areas (restoring floodplains, improve strategic drainage) have to be solved as well in order to make an effective integrated approach to flood risk management.

3. Presentation Deirdre Murphy

The Ripon Multi-Objective Pilot project is a catchment scale project carried out in the Laver and Skell catchments. It is focusing on the impacts of land use and management on Flood Risk Management (FRM). It is also trying to pursue multi-objective opportunities across FRM, resource protection, biodiversity and public access. The project tries to link into, and integrate, several policies concerning rural areas, namely the Rural Strategy, the Water Framework Directive, Catchment Sensitive Farming Schemes and 'Making Space for Water'. The project is led by Defra, but many other governmental bodies and non-governmental organisations are involved as well.

The project looks for opportunities to implement several practices and activities, ranging from field to catchment level, like:

- *Reduce the rate of runoff*, for example by opening culverted watercourses, blocking of strategic moorland grips, blocking key field drains.
- *Retain runoff*, for example by creating and extending floodplain woodland, encouraging wet pasture and encouraging wooded gills in the moors.
- *Reconnect the floodplain*, for example by reconnecting cut off channels, retaining wet pasture and seasonal scrapes, encourage woody debris dams
- *Changing land use and management*, for example promoting arable conversion, establishing and maintaining boundary hedges, reducing fertiliser input, fencing rivers to avoid unlimited access by stock, improving stock water points, avoiding poaching by vehicles and stock, reducing grazing intensity, managing rush pasture sensitively, establishing riparian buffer zones.

The Ripon project involves:

- Influencing local Environmental Stewardship targets
- Working closely with RDS to engage farmers
- Working with National Trust on sustainable maintenance issues

ming catchment flood management plans

encing decision makers including planners (local) and policy makers (national)

- Demonstrating a range of flood risk management options.
- Identifying barriers to change
- Challenging current funding streams and identify current barriers to use specific funding for land management and FRM.

4. Presentation Helena Posthumus

Helena reported on the preliminary findings of her survey of land managers in the study area. She began by thanking those who had kindly given up time to speak to her.

In total 25 farmers in the area were visited and interviewed, of which 7 dairy farmers, 12 sheep/beef farmers, 5 hobby farmers and the owner of the moors. During the interviews issues such as the Single Payment Scheme, agri-environment schemes and flood risk were discussed.

As flood risk management is a secondary objective of the Entry Level Scheme (ELS), farmers were asked their opinion about the scheme during the survey. 58% of the interviewees had signed, or were planning to, sign the agreement. The main reason to apply was mainly because it was perceived as relatively 'easy money'. For a few farmers ELS enabled them to extensify their farm. Only one mentioned he went into ELS in order to enhance the environment. Most farmers enter the ELS with existing features on their farm: especially hedgerows and stonewalls, and trees and ponds to a lesser extent. 21% of those involved in ELS introduced a 'new' practice on their farm, mostly low input grassland. But in general, it appeared that ELS hardly results in new practices or landscape features (like hedgerows, woodlands, ponds) in the catchment. Field margins are new practices that are adopted on a larger scale but these are introduced through the cross compliance rules.

Practically all farmers are aware of flood problems in the catchment. Flood events in Laverton were often referred to, as well the bigger flood in Ripon in 2000. The Creets bridge near Kirkby Malzeard was badly damaged in 2000 and reopened in 2003 (see Figure 2).

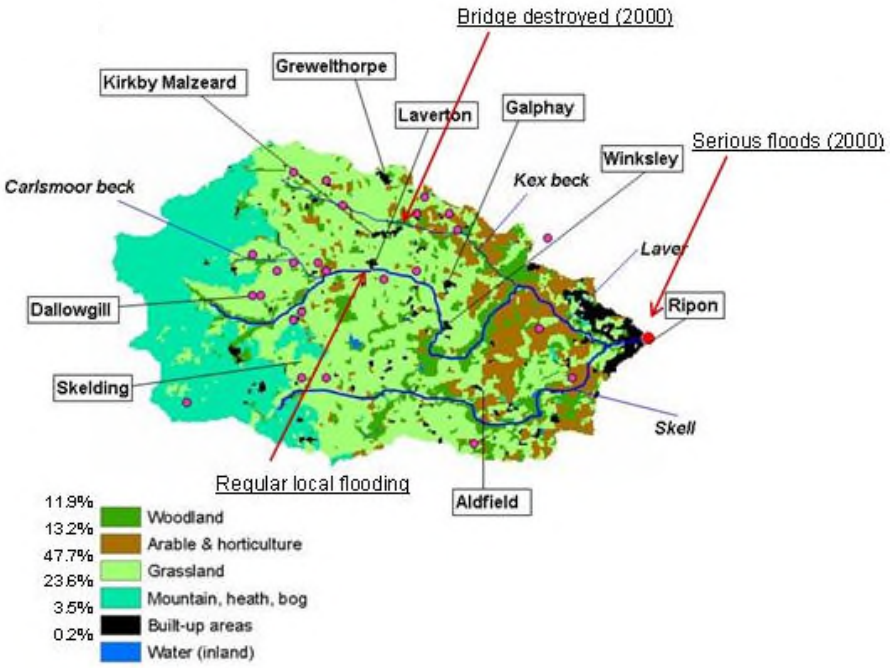


Figure 2 Land use and flood risk in Laver and Skell catchments

Some farmers also experience flooding occasionally in their farm yards or on farmland along watercourses. A large number of farmers had observed overland flow on their land, but often water also accumulates on the land itself before it infiltrates into the soil (see also Table 1). However, flooding is not considered as a large problem. If land is flooded, livestock are moved to drier land, and the water usually disappears within a few days.

However, considering they manage a large proportion of the land in the catchment, farmers do acknowledge that they can play a role in flood risk management. But they think this will only work if their contribution is part of a bigger plan, involving more stakeholders, especially the county council. They said that they would need financial support for making a contribution to alleviating flood risk.

Table 1 Percentages of farmers experiencing water-related problems on farmland

	Never	In extreme rare events	Once in 2-3 years	Every year
Overland flow	17%	25%	12%	46%
Accumulation of water on field	50%	4%	13%	33%
Flooding along watercourse	46%	13%	12%	29%
Riverbank erosion	88%	4%	4%	4%
Flooding on roads	50%	21%	25%	4%

5. Session 1: Land management and flood risk in the Laver and Skell catchments

All participants were split up in four groups in order to discuss questions on land management and flood risk. The groups each comprised a broad representation of stakeholder interests. The feedback of each group is given below each question.

What part does land use and the way land is managed play in flood problems?

Feedback Blue group:
- Climate change is causing an increase in flood risk.
- Geology & geography define soil type, which defines land use. Key factor in this is also economics, dictating getting best value of the land, which has led to more intensive farming, compaction and runoff, possibly contributing to flooding. Flood alleviation therefore depends on economics (that is, of farming and of the incentives offered to farmers for controlling runoff).
- Land users in upper part of catchment with help from others have a joint responsibility as water runs down.

Feedback Green group:
- Need to confirm if there is a problem? Has flooding increased? Need evidence.
- Farming has impact, but lot of changes are going on now (extensification) due to CAP-reform. The impact of recent changes is unclear.
- Need to start at top of catchment.
- Different part of the catchment have different impacts so different roles to play.

Feedback Yellow group:
- What is the problem? Mainly that urban areas get flooded.
- What makes the problem: speed to peak, timing of flow: all water comes together
- Development (roads and houses), and lack of road drainage

Feedback Red group:
- Does land management play a role? Need evidence.
- Soil management: infiltration, compaction, soil type, arable (siltation) could be important
- Land drainage: grips + field drains, forest plantation
- Routing of water down roads and tracks
- Loss of peat on moorland resulting in loss of potential water retention on the moors
- Lack of wet habitats

Overall comments
A common theme of the discussions in the smaller groups was the need for evidence on the matter. Questions were asked such as is there a change in rainfall causing an increase in flood risk, what exactly is the problem and what is the (quantitative) contribution of land management? Despite these questions that still need to be answered, there was consensus that intensive agricultural practices resulting in soil compaction might contribute to flooding problems. However, it was noted that

intensive agriculture is driven by other forces (economics) and is changing now due to the CAP-reform.

Another important common theme is the impact of urban development and especially roads routing down water, which results in a shorter time to peak of water causing flooding problems in downstream urban areas.

How can the management of land help reduce flood problems? What can be done and by whom?

Feedback Blue group:
- Creation of on farm bunds, ponds, drainage pattern, which has to be done by land owner, with assistance of agencies.

Feedback Green group:
- Efforts have to be made further up in catchment as well rather than only in the bottom.
- Solutions: blocking grips, store floodwater. But the land that is best to store water is often also the best agricultural land.

Feedback Yellow group:
- At the top (moors): blocking grips (funding), but has economic impacts
- Middle (Kirkby Malzeard): reduction of stocking rates
- Bottom: ……??

Feedback Red group:
- Strategic blocking of grips and drains, improve forest design, improving soil structure, housing livestock during winter (less compaction), avoid peak flows coinciding
- Whom: farmers and agencies together.

Overall comments
Participants agreed than an integrated approach for flood risk management is desirable. Different solutions are needed for different parts of the catchment. In the upper part of the catchment, drains on the moors and farmland have to be blocked strategically. Farmers can help to reduce peak flows by slowing down water on farmland (through bunds and ponds) and reduce stocking rates (to increase infiltration). Farmland at the bottom of the catchment can also be used to store water. Participants agreed that farmers should be supported by the agencies when implementing these practices.

6. Session 2: Discussing good land management practices with the FARM-tool

In his short presentation, Paul Quinn gives some examples of good and bad land management practices concerning runoff and flood risk. Key message is: Can

practices reduce runoff? Suggested answer – Yes. Can practices reduce flooding? Suggested answer – Maybe.

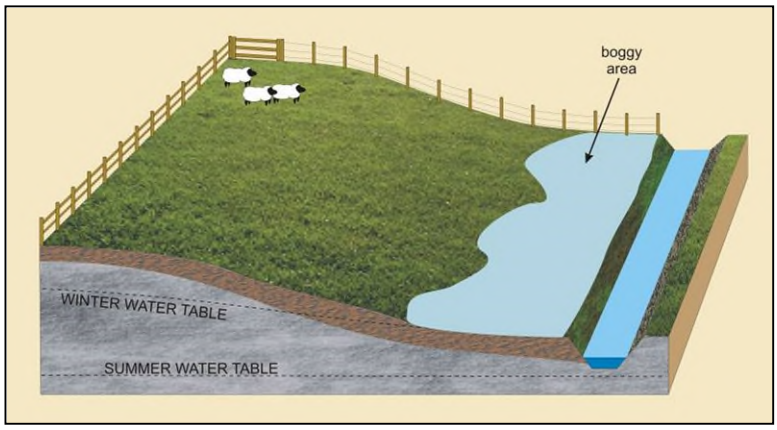
Casper Hewett introduced the Flood and Agriculture Risk Matrix (FARM), a decision support matrix designed to allow farmers and land use planners to assess the risk of increased runoff from their land, and to explore options to reduce that risk whilst maintaining farmer income. Its purpose is to allow farmers to compare their current land use practice within the wider context of alternative land management options.

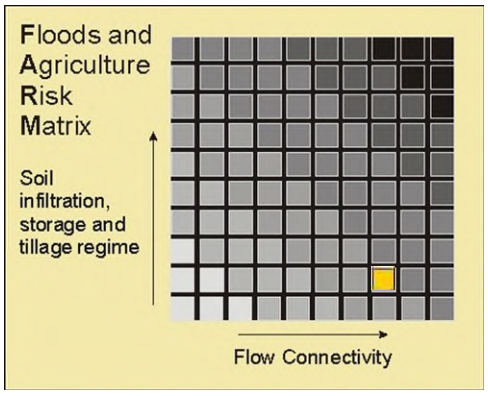
The tool makes an assessment of potential contribution to flood generation by assessing the degree of run-off potential associated with land management, and the degree of connectivity of overland flows to the network of drains, watercourses and rivers. Hence a highly compacted soil on a steep hillslope with potential for runoff to make its way quickly without impedance to a river creates a high flood risk assessment.

The tool also contains farm scale measures for reducing runoff. However, multiple benefits can be achieved, as diffuse pollution will be reduced as well. Though the field-scale is applied in the FARM-tool, solutions can also be implemented at farm-scale by targeting specific areas on the farm rather than on each field.

Working in the aforementioned groups, selected land management scenarios for grassland were evaluated. Each group was asked to assess the associated level of flood risk by denoting a position in the matrix as shown below. Solutions to reduce the risk were also discussed.

First example:

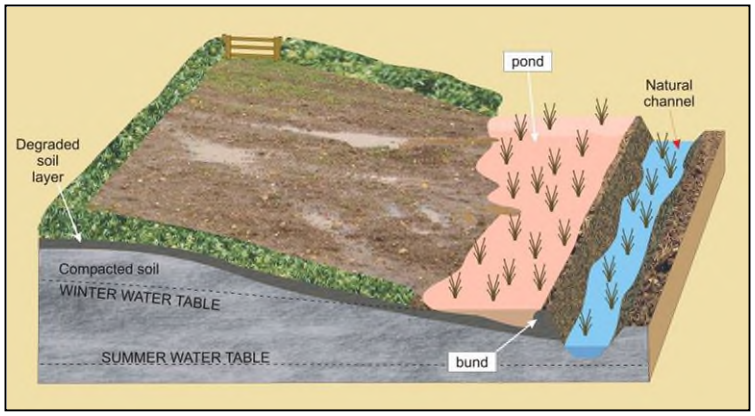


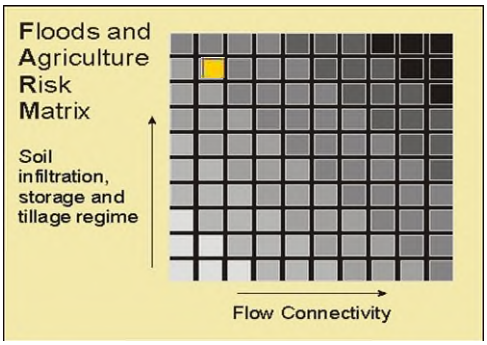


Possible practices to reduce flood risk:

- Reduce stocking late summer / autumn,
- create pond,
- dig soil/sediment out of pond along the river
- and plant willows there
- create some marginal vegetation around pond,
- plant it with trees,
- more variety of vegetation in channel.

Second example:



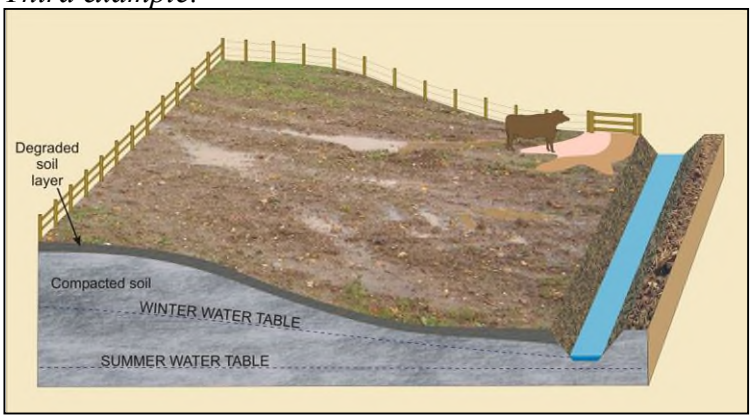


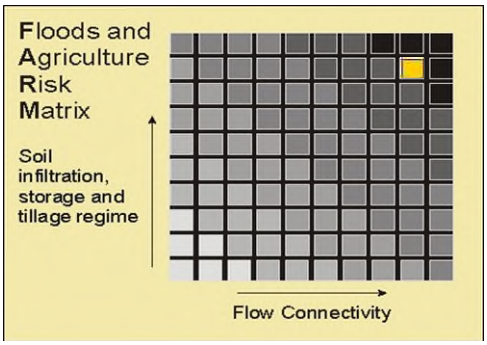
The risk rating above assumed a pond at less than full capacity. The group identified that flow connectivity would be high if it rained heavily when the pond was already at full capacity.

Possible practices to reduce flood risk:

- Drain in bund wall to manage pond level
- No winter grazing
- Sub-soiling cross-over soil
- Strip linches
- Plough across the slope to form roughness to slow flow
- Summer and winter pond

Third example:





Possible practices to reduce flood risk:

- Reduce stocking density (remove stock?)
- Vegetative buffer zones, especially close to the ditch
- Fencing
- Cross-field mould ploughing
- Catchment pond: willows + reeds
- Relocating gate
- Engineering in ditch to reduce water flow
- Reseed + farm manure: increase organic matter
- Water borehole (to reduce water level)
- Planting trees at watercourse

The risk tool generated much discussion and showed itself to be a very useful participatory learning tool. It was commented that many of the above practices could be implemented in short term, but money (funding) is needed. It was thought that it might be better to use the money for flood 'defence' structures for these land management solutions.

These solutions require many people to participate to have an effect and of course incentives are needed for that.

7. Session 3: promoting uptake of good land management practices

At the start of the third session, the comment was made that we should not discount ELS and HLS as a mean of introducing good practices. The disadvantages now are that conditions are written, and it is a 10 year agreement. "The farmers are behind the train". They are either locked into their agreements or the criteria are set and therefore farmers feel they can change little. However, if additional grants are given for additional work for flood risk management, it could be a good instrument to promote these practices.

The aforementioned groups discussed questions on how to promote the uptake of good land management practices. The feedback of each group is given below each question.

From your viewpoint, what are advantages and disadvantages of practices farmers / land managers can implement to control runoff from farm land?

Feedback Blue group:
- Buffer zones + ponds (bunds) useful, also reduce pollution
- Water for hydro-electric schemes: make sure that all farmers get free electricity by using water
- Stonewalls slow runoff but maintenance stonewalls is quite expensive

Feedback Green group:
Disadvantages
- Change of land use / farming practice can have negative impact on income
- On-going commitment by farmers and funding body

Advantages
- Soil protection and improvement of assets
- Better than high-engineering solutions
- Good PR for farmers

Feedback Yellow group:
- 100% needs to be engaged to be effective: should it be compulsory?
- Targeting use of public money
- Capital value land: needs to be long term to be appealing, as farmers are then able to plan better

– Trade-off environment / society versus family income.

Feedback Red group:
– A lot is multi-objective: spin-offs for wetland habitat, resource protection
– Farmers should recognise they are stewards of countryside
– Marketing spin-off, for example Yorkshire lambs. If farming is more sustainable and consumers are willing to pay a bit more for this.
– Advantages for water authorities (as less coloration)
– Peat acts as carbon sink
– Planting woodlands are good for wildlife and game shooting.

Overall comments
It was appreciated that multiple objectives (e.g. favourable for wildlife, reduction in diffuse pollution) can be achieved with the mentioned practices. However, there was a general concern about the economic consequences for farmers. If these practices are to be implemented, an appropriate funding scheme needs to be agreed on. This is important, as 100% of the farmers need to be engaged for these practices to be effective.

What needs to be done to make these practices appealing to farmers?

Feedback Blue group:
– Money. HLS costs farmers money as the scheme pays only 50%[7]. A flood management scheme is for benefit of urban people, and thus needs 100% compensation for services provided by land managers

Feedback Green group:
– Right level of grant aid
– Soil management plans should get more points for ELS/HLS to include water management
– Facilitator for farmers (to help identify areas and apply for grants)
– Catchment Sensitive Farming (CSF) grants should be higher than 40%
– Potential HFA for issues upper catchment
– Blocking grips with grant-aid of Defra
– Audit through ELS, cross-compliance

Feedback Red group:
– Earlier comments on HLS are not entirely correct: capital grants are 50-80%, grants for creating wetlands are 100-120%
– Business has to be economically viable
– Not keen on building dams
– Low-cost simple measures on critical mass basis, needs 80-90% farmers involved
– Farm walks, social events (like FWAG organises)
– Face-to-face contact with farmer

[7] The HLS handbook states that fixed payments are given for capital grants, with only a few items at 80% and some at 60%

Overall comments
To make these practices appealing to farmers, it was generally agreed that money is needed. Grants that cover 40% (like CSF) are considered to be insufficient.

What is the best way of promoting these practices amongst farmers?

Feedback Blue group:
- Demonstration site, farm walks (for farmers and public, so farmers get back respect from public back)
- Free flood risk analysis and modelling: landowner will understand risk on own land
- Also economic impact assessment (bottom-up instead of top-down)
- Promoting best practices
- Stakeholder involvement like this workshop
- Local responsibility of community
- Give success-stories as examples

Feedback Green group:
- Defra grant for grip blocking
- Audit through existing Environmental Stewardship or cross-compliance systems
- Farmer meetings
- Needs to 'educate' farmers: computer games, leaflets
- But if the money is right (enough funding) farmers will join up.

Feedback Yellow group:
- HLS is not the way forward, but ELS might be as it is easier to get an agreement

Feedback Red group:
- Keep things simple, limited paperwork
- Accept criticism HLS, it will be revised this year
- Make schemes financially appealing, maybe compulsory

Overall comments
The ELS and HLS in their existing forms were considered as inappropriate instruments to promote these practices. However, if revised, these schemes will provide opportunities. Engaging farmers and bringing them and other stakeholders together was also considered to facilitate the promotion of these practices. Giving examples through success stories, demonstration sites and farm walks will increase the willingness of farmers to cooperate and also improve the relationship between the public and the farming community.

At the end it was still commented that it might also be a good idea to use the money reserved for the flood alleviation scheme to pay for the effort of farmers to retain and slow down water in the catchment.

8. Conclusions of the workshop

The workshop rounded off with a number of conclusions drawn from discussion and group reporting.

There was agreement that relying solely on 'hard' engineering to manage flood risk is not the way forward. There are opportunities to use good land management practices to slow down overland flow and as such alleviate flood risk in the catchment. Linking these practices with other objectives, like reduction in diffuse pollution and enhancement of biodiversity, creates opportunities to improve the reputation of farmers amongst the public. However, farming is currently facing lots of changes, especially changes in agricultural policy, but the effects of these changes are not clear yet.

There was general agreement that money is a key issue when it comes to the implementation of these practices. Low-cost solutions are needed and they should be simple but effective. Advice is needed on effective solutions and identification of strategic areas to implement these. Sources of funding need to be identified to allocate appropriate grants to farmers who can contribute to flood risk management.

It was concluded that bringing land managers and other stakeholders together facilitates implementation of these practices. Demonstration farms are vital, as these can show the effect of these practices. They will also help inform the public on good practices that farmers implement, and in which way farmers deal with environmental issues such as biodiversity, diffuse pollution and flood risk. This will increase the understanding of the public and improve the relationship between the public and farming community. Demonstrations farms have to be done properly though to be effective, and before any practices are installed, runoff assessments, designing a runoff management plan and GIS-mapping should be carried out. Newcastle Univeristy can assist in this.

The Ripon-MOP project was seen to be a good opportunity to start demonstration sites in Ripon if there are farmer volunteers. Defra-funding could be channelled through this project to enhance flood risk management in the catchment and provide the necessary demonstration effect.

The participants recognised that changing land management is not sufficient in itself to reduce the risk of flooding in the catchment. Urban runoff needs to be managed in an appropriate way and watercourses need more space so they can overflow without causing damage. Control on urban development is therefore an important issue which must be considered along side rural land management.

Annex 6
Policy interventions and flood risk management under different future scenarios

In this annex, an overview is given of likely policy interventions that might be implemented under the four different future scenarios World Markets, National Enterprise, Global Sustainability and Local Stewardship. This overview is based on the findings of O'Connell et al. (2004) and Foresight Programme (2004).

World Market:

Agricultural policy:

- Abandonment of CAP, WTO-led free trade in agricultural commodities.
- Limited interventions for social or environmental purposes.
- Increased global trade agricultural commodities.
- Rural diversification opportunities based on market potential.

Environmental policy:

- Limited restrictions on chemical use.
- Limited interest in soil and water conservation unless affecting production.
- Environmental risk managed through economic instruments.

Food markets and prices:

- Market led, consumer driven, but increased domination of food retailers.
- Producer and consumer food prices fall for global products, with premia for niche products

Agricultural production and farming systems:

- Relatively low farmgate prices for 'bulk commodities', partially offset by low input prices resulting in moderately high input levels and yields.
- Commercially driven high technology systems, 'industrialised' agri-businesses, reaping economies of scale.
- Marginal arable land and uplands abandoned or occupied by lifestyle hobby farmers.

Flood risk and management:

- Strong prospect of climate change and high economic growth (resulting in increased value of assets), resulting in increased flood risk in urban areas.
- Reduced profitability, release of marginal farmland and lower land prices reduce agricultural damage costs due to flooding.
- Increased runoff generation in intensively farmed areas, but potentially reduced runoff generation in 'abandoned' areas.
- Flood defence driven by economic imperatives, farmers in lowland areas paying directly for flood defence services (land drainage), or selling flood water storage services.
- Possible market in wetlands and runoff retention based on 'willingness to pay' for environmental goods in 'abandoned' upland areas.

National Enterprise

Agricultural policy:

- Protectionist agricultural policies, involving input and commodity subsidies, deficiency payments and marketing / intervention regimes.
- Rural economy is primarily based on agriculture and food production. Farming is the main agent of development.

Environmental policy:

- Input intensive farming, limited controls on agro-chemicals and farming practices on environmental grounds.
- Relatively high probability of runoff generation, soil erosion and diffuse pollution, with regulation where these prejudice commercial interests.

Food markets and prices:

- Supply-driven food chain. Food industry, especially producers and processors define product offering and criteria for food quality.
- Government support to agriculture maintains high producer prices, but cheap consumer food prices. Little pressure for farmers to be market oriented.

Agricultural production and farming systems:

- Commercially driven production focus, emphasis on output and production.
- High guaranteed farm-gate prices and moderate input prices encourage intensive farming systems with high yields.
- Mixed arable and livestock farming systems, intensive lowland dairy and cattle, with beef and sheep maintained in disadvantaged areas.
- Moderate trends towards large farms, but family farms remain viable.
- Environmental motivations mainly commercially based and remedial.

Flood risk and management:

- Moderate economic growth and climate change result in increased flood risk in urban areas.
- Intensive agriculture in lowland as well as in upland areas results in high runoff generation. Little importance given to social and environmental issues unless this affects agricultural production.
- Flood defence for agriculture justified in terms of a 'food from our own resource' strategy, funded through public purse (similar to flood defence policy in 1960s to 1980s). When flooding occurs, agricultural damage costs are high. Floodplains will not be used for flood water storage.

Global Sustainability:

Agricultural policy:

- Reformed CAP: decoupled agricultural support, retention of area payments
- WTO promoted liberalisation.
- Promotion of sustainable agriculture, including agri-environment and animal welfare regimes.
- Global rules seek ethical rural development.
- Multifunctional agriculture produces public goods.

Environmental policy:

- Comprehensive, integrated approach to prevent or minimise diffuse pollution from agriculture.

- Policy mix includes regulation, voluntary measures and economic instruments reflecting a commitment of stewardship and biodiversity.
- Promotion of 'best available practices'.
- Controls on water abstraction and use, with some trading.

Food markets and prices:

- Food supply chain accepts responsibility for promoting and responding to consumer concerns about safe, healthy and ethical foods.
- Consumer food prices rise due to quality assurance and compliance costs, providing incentives to producers.

Agricultural production and farming systems:

- Production-oriented farmers tempered by increasing interest in conservation, expressed in agri-environment schemes.
- Moderate farm-gate prices for bulk commodities. High input prices and moderate regulation on inputs leads to moderate increases in agricultural productivity.
- Large-scale farms, but with policy to retain family farms through targeted support. Diversification and multifunctional agriculture important.

Flood risk and management:

- Integrated approach towards flood risk management and biodiversity in the form of managed washlands and wetlands in both upland and lowland areas with low agricultural productivity. The application of a catchment-wide approach helps to reduce cost of flood damage in receptor areas.
- Intensification of agriculture on productive land, but commitment to sustainable land management practices to protect soils and reduce runoff generation.
- Emphasis on wise use of land and water resources including floodplains, seeking a compromise between protection of valuable agricultural production, protection of wetland habitats and flood storage attenuation.

Local Stewardship

Agricultural policy:

- Protectionist and regional support policies justified in terms of social and environmental priorities, and a commitment to self-reliance and independence.
- Rural development emphasise conservation and community: a living / working countryside, balanced communities, sustainable livelihoods. Policy support for low-input and extensive farming including remote areas.
- Multifunctional agriculture produces public goods.

Environmental policy:

- Generally lower environmental risk, but fragmented and selective regulation and control.
- Sustainable soil and water management embedded in farming culture, backstopped by strong regulatory and protective policies, e.g. to control soil erosion or water quality.

Food markets and prices:

- Distaste for global, processed foods.
- Greater connectivity between consumer and producer. Developed local area produce and markets.

- Highly differentiated foods are traded between regions. Local 'brands' emphasise environmental and social attributes.
- Farmer cooperative production, processing and marketing schemes to add value and raise prices.

Agricultural production and farming systems:

- Farmers are stewards of countryside, embracing commitment to sustainable livelihoods. Strong conservation and community ethics.
- High farm-gate commodity prices, moderate to high input prices, and strong ethical (and regulatory) framework encouraging relatively low intensive farming, integrated with environmental management as a basis for sustainable agriculture and multifunctionality.
- Input levels and yields are low, but high usage of land for farming.
- Retention of small-scale, family-based farming units, including support to remote upland and hill areas.

Flood risk and management:

- Strong cultural commitment to sustainable agriculture to protect soils and reduce runoff, resulting in multifunctional agriculture.
- Emphasis on sustainable flood management solutions which integrate multi-functions at catchment level flood plains, including agriculture, biodiversity, soil and water resources, tourism and recreation. Return of flood plains to natural condition and functions, encourages culture of flood management rather than defence, and reduces overall cost of flooding.
- However, tensions may arise between environmental and agricultural management as pressure on land increases due to domestic demand for agricultural commodities.

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