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INTEGRATING FLOOD MANAGEMENT AND AGRI-ENVIRONMENT THROUGH WASHLAND CREATION IN THE UK

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ABSTRACT

In many river floodplains in the UK there has been a long history of flood defence, land reclamation and water regime management for farming. In recent years, changing policies with respect to farming, environment and flood management is encouraging a re-appraisal of land use in rural areas. In particular, there is scope to develop, through the use of appropriate promotional mechanisms, washland areas which will simultaneously accommodate winter inundation, support extensive farming methods, deliver environmental benefits, and do this in a way which can underpin the rural economy.

This paper explores the feasibility of flood storage and washland creation, the likely economic impacts of this type of development, and the financial and institutional mechanisms required to achieve implementation.

The outcome is the identification and assessment of a washland package within the UK agri-environment framework. However, given the diversity of circumstance and practice, it is suggested that a range of options, and not just those associated with management agreements and annual payments, is used for the management and administration of washland areas.

INTRODUCTION

In many river floodplains in the UK there has been a long history of flood defence, land reclamation and water regime management for farming. In recent years, however, the limits of these floodplains has been demonstrated by fluvial floods during the winter months (English Nature, 2001). This has encouraged a re-appraisal of land use in rural areas encompassing farming, environment and flood management. The aim is to find sustainable solutions for the management of water, both in flood events and throughout the year.

Washlands are one mechanism for flood defence and management (Environment Agency, 2002). These are flood storage areas used during times of high flow to reduce flooding in other parts of the catchment (English Nature, 2001). . For the purpose here, a washland is defined as an area of the floodplain that is allowed to flood or is deliberately flooded by a river or stream for flood management purposes, simultaneously providing potential for a wetland habitat.

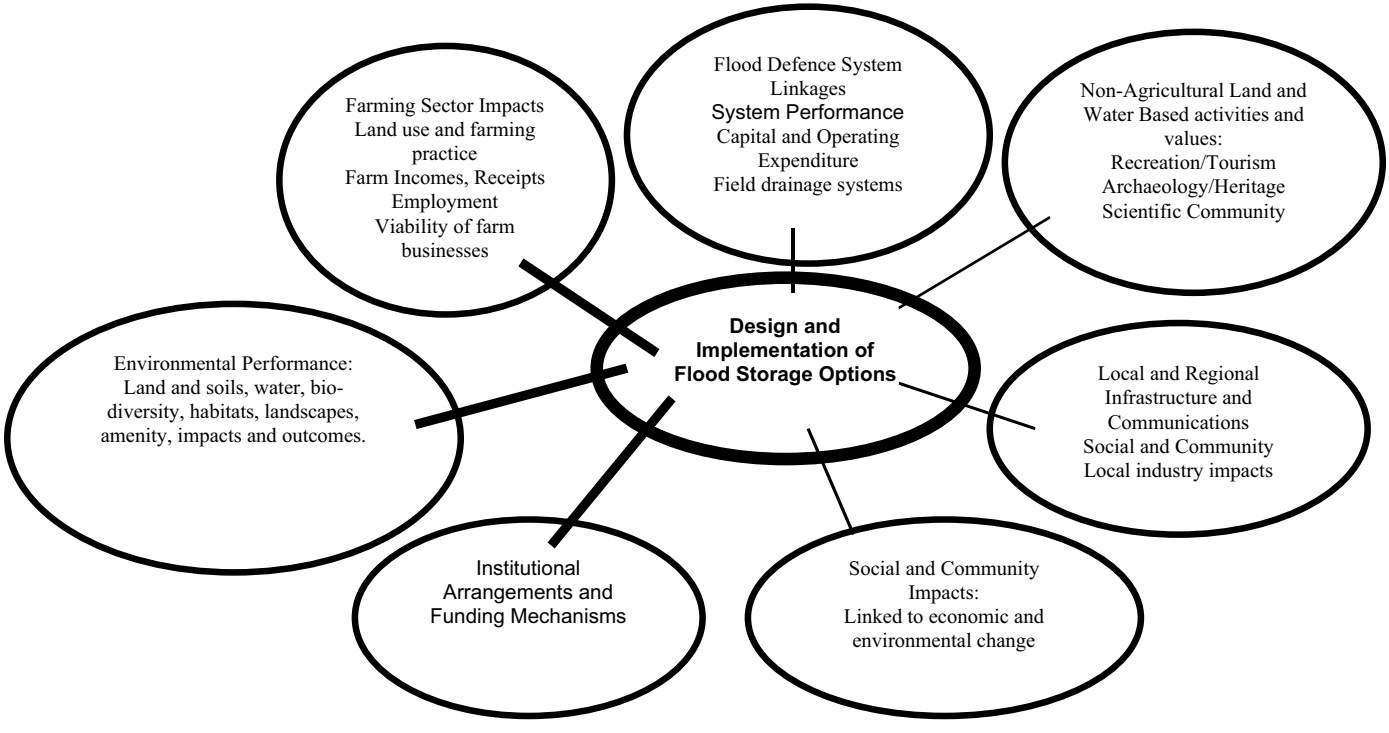
This paper explores how public funds might be used most effectively to achieve better flood moderation through appropriate use of agricultural land within a catchment in a way which will reduce the adverse effects of unwanted flooding and simultaneously exploit the beneficial opportunities that the managed storage of floodwaters would bring. These opportunities are explored below. In particular, there is scope to develop, through the use of appropriate promotional mechanisms, washland areas which will simultaneously accommodate winter inundation, support extensive farming methods, deliver environmental benefits, and do this in a way which can underpin the rural economy.

Washland Adoption

The adoption of flood storage options will inevitably lead to a change in flooding and water management regimes. The extent of change will vary according to particular site characteristics and the design and operation of the flood facility. Nevertheless, the change in regime is likely to include a change in flooding frequency, duration and depth of winter flooding. In most cases, washland adoption will involve increased incidence of flooding in the flood storage areas, but in other areas existing high levels of flood risk could be alleviated. Changes in winter groundwater levels associated with increased winter flooding, and in some cases the retention of high field water levels at other times may also occur. In other areas, there would be opportunity to relieve excessive waterlogging.

Consequently, a managed and controlled approach to flood storage on designated washlands would help alleviate undesirable flood risks, and at the same time exploit the opportunities that such managed washlands might offer to various stakeholders. The latter include land managers, environmental bodies and those organisations charged with providing flood defence and land drainage services (Figure 1). Of particular interest are the agricultural and environmental impacts and the consequences of the adoption of flood storage options on water regimes, land use, farming practices and incomes, and environmental quality (Morris et al., 2002). These are briefly reviewed below.

Figure 1 Framework for Economic Appraisal of Flood Storage Options on Washlands



First, and given that washlands offer a managed facility, they would alleviate flood damage and disruption borne by those areas currently at risk, as well as incidental flood damage in other areas in all but the most extreme events. They could take pressure off flood defences which protect urban property and infrastructure. They could also reduce the impact of uncontrolled flooding of communications infrastructure and the disruption this causes to economic and social activity, both locally and regionally.

Second, agricultural land use, farming practice and performance are critically dependent on flood defence and land drainage (Dunderdale and Morris, 1997; Morris and Hess, 1987; Morris et al., 2002). This is particularly where flood risk and field water management largely define what is possible. Flooding above and waterlogging below the surface of the land has major implications for land use, farming practices, productivity, value-added, and farm incomes. Generally, the lower the standards of flood defence and drainage, the lower is the intensity and commercial viability of farming. Further, in recent years, flooding has been excessive, to the point where farming futures are threatened. There is scope, through a managed approach to flood storage, to provide relief to those farmed areas worst affected by long duration flooding at the present time, and simultaneously provide new opportunities for washland creation in other areas.

Third, changes in flood regimes will have impacts on environmental quality. The extent of the impacts will vary according to the degree of change in the water regime, existing or potential environmental features and their sensitivity to changes. Plant communities and wetland birds are deemed to be the main environmental qualities to be protected and enhanced. Species rich plant communities associated with valued and protected habitats are sensitive to prolonged winter flooding and have relatively low tolerance to spring flooding. Conversely, migrant wildfowl enjoy deep winter water and breeding waders require shallow surface flooding during the spring. As a result, there are potential conflicts of interests between environmental components which will require careful management of flooding regimes, especially in the spring period. Nevertheless, the adoption of flood storage options, replacing uncontrolled flooding with managed washlands, provides an opportunity for enhancing existing environmental quality. At the same time however, increased flooding in some areas could, unless purposely controlled, cause damage to existing valued habitats, and frustrate the potential creation of new ones.

The various dimensions of the environment include field and ditch plant communities, birds especially migrant wildfowl and breeding waders, invertebrates, fish and small mammals.

Fourth, tourism and recreational activities may also benefit from a flood regime that served to enhance the wetland characteristics of an area, provided that access and mobility were maintained. The same could be said for the

preservation of archaeological remains. However, traditional rural activities, such as peat abstraction and withy (willow) production, may suffer from long duration flooding or permanently high water levels, although these could be relocated beyond the washland areas.

Finally, the flood storage options through washland creation could re-orient capital and revenue expenditure more towards flood 'management' than flood 'defence' per se. This would serve to reduce the uncertainty of the impacts of flood events and provide responsible agencies with greater flexibility for flood management. The flood storage options would contribute to sustainable flood management in so much as they could provide a cost-effective basis for reconciling social, economic and environmental objectives within a flood plain.

The remainder of this paper examines the feasibility of flood storage and washland creation, the likely economic impacts of this type of development, and the financial and institutional mechanisms required to achieve implementation.

Feasibility of Washland Creation

Catchments can be classified into a number of zones which vary in terms of topography, hydraulic characteristics and potential contribution to flood storage management. Within this there may be a number of options, for example, creating temporary flood storage areas on farm land in designated storage areas in upper and mid catchment until the peak flow has passed in the floodplain watercourses, or creating new wetland habitats throughout the catchment to intercept and store floodwater during flood events.

The suitability of potential sites for washland creation depends on a large number of factors: technical, economic, environmental and social. However, in the first instance, it is required that a site must work from a hydraulic point of view. Basically storage sites must not only offer the potential of containing worthwhile quantities of flood water, but both the filling and the evacuation must be controllable for sufficient benefit to be achieved. Thus hydraulic potential should be the initial selection criterion followed by other criteria which reflect opportunity for environmental enhancement, and likely social and economic impacts. These are further explained below.

First, in terms of ease of filling, it must be possible to fill the storage zone at the right time and quickly in order to optimise the flood protection benefits. Accordingly the storage site should be close to an arterial river, have internal ground levels well below normal flood level in the river so that it could be filled quickly by gravity, and should require the minimum of engineering works to convey and control the floodwater into the storage zone.

Second, with regard to ease of evacuation, it must be possible to time the evacuation of the storage zone and to do so expeditiously in order to optimise flood protection benefits. Accordingly the site should be close to a suitable outlet path with spare capacity even under flood conditions, have internal ground levels well above normal flood level in the receiving watercourse so that water can be evacuated quickly by gravity, and require the minimum of engineering works to convey and control the floodwater out of the storage zone.

Third, regarding ease of containment, flood water in the storage zone must be effectively contained in order to retain control and also to ensure the safety of adjacent areas. To facilitate this the area should have convenient natural or man-made features already present to delineate the zone (if necessary with improvements). Suitable features could include rising ground, raised floodbanks, highway causeways, or railway embankments. If new embankments are needed, the site will need to have suitable geology and soil types to facilitate this.

Fourth, a site's current susceptibility to flooding needs to be considered. Areas which are currently flooded infrequently offer the greatest potential for providing flood relief benefits, although areas which currently suffer frequent and prolonged flooding, might offer scope for managed flood storage if the evacuation arrangements could be significantly improved.

Fifth, the potential for habitat improvement could be an important factor where environmental enhancement is a key objective. Flood storage and washland creation could involve improvement of existing wetland sites and the creation of new ones. The availability of funding for the development of new flood storage areas is certain to be linked to the achievement of environmental enhancements. Accordingly the following features would assist: the area falls within a designated conservation area; it is physically easy to enhance the habitat; there is scope for reconciling flood storage objectives with environmental objectives, through managed flood and water level regimes; and offers the possibility of up-rating the sites official status for instance by re-designation. However, it is also recognised that adoption of flood storage options on some species rich sites could potentially damage valued habitats due to untimely or prolonged flooding.

Sixth, current land use needs to be appropriate, in that it could tolerate the regular inundation associated with the storage of flood water. Thus, extensively managed grassland which is lightly stocked would be considered suitable. However, areas of intensive grass or arable production might have to be abandoned. This may give rise to the need for compensation.

Finally, the area should be free from existing infrastructure. Where this is present, the cost of providing protection or relocation should be acceptable. Roads, railways, buildings, buried pipelines, underground and overhead electricity

lines, the landward face of raised floodbanks and any land drainage pumping stations would be susceptible to increases in flood frequency and duration. The effect of the stored water on routine access is also important. Inundation of these assets, services and utilities could involve substantial damage costs. The presence of these infrastructural assets reduces the attractiveness of a potential storage site, although it might be feasible to abandon a limited amount of infrastructure, or in other cases protection might be provided at reasonable cost. In many cases, however, the protection or relocation of assets would significantly add to the cost of developing a given flood storage site.

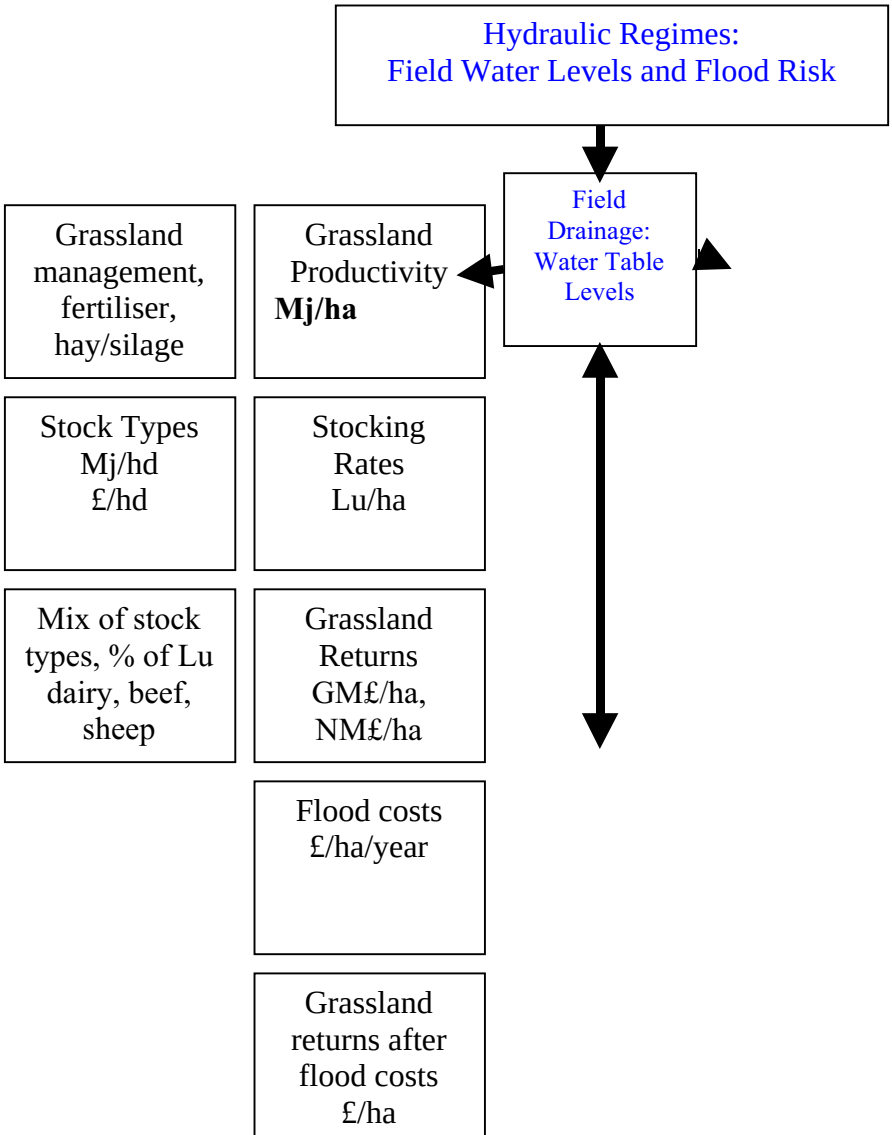
Impacts on the Agricultural Sector

Flood defence for agriculture, as for most land-engaging activities, refers to acceptable levels of flooding above and below the surface of the ground. Acceptable levels of flooding depend on the types of farming activities and practices. Generally, the more intensive the system of production the greater the need for flood defence. Arable systems involving root crops and cereals are considered more sensitive to waterlogging and flooding than grassland systems, whether grazed or cut for winter feed. As a result, floodplain areas within the UK are predominantly down to grass, although where flood risk is low, cereals and maize for fodder are sometimes grown, in some cases assisted by private pump schemes. The agricultural economy resulting from this is primarily based on dairy, cattle and sheep production. Further, regional farm business data suggests that farms within these areas tend to be smaller and less intensive, and therefore generally have lower average farm incomes than their regional average. Although very good performance is possible, many farms operate at lower levels of intensity than either their potential or the regional average. Most of the areas are used for grass conservation and/or stock grazing. The latter mainly involves dry milk cows, beef cattle and sheep. In the drier areas, over-wintering of sheep provides a useful income source. In this context, the relatively extensive system of grassland management provides opportunities to qualify for extensification (under EU Beef and Sheep Premia).

The alleviation of flooding in those areas worst affected will reduce damage costs and increase output and profitability, other things being equal. Conversely, an increase in winter flooding in the newly created washlands would impose restrictions on farming, which, in the absence of incentive payments, would reduce the income and profitability for farmers. The extent to which this occurs depends on the degree of change in flooding and waterlogging, and the extent to which existing land use is sensitive to this. For example, increasing the extent of flooding, particularly in the spring, on agriculturally productive grassland would result in the development of flood tolerant vegetation such as rush-pasture, inundation grassland or swamps depending on the degree of flooding. Although these communities can provide summer grazing, changes in agricultural practices will be necessary as a result of the change in flood water distribution. Further, flooding depth and duration has obvious impacts for the timing of critical field operations and access. These apply to arable operations such as crop establishment and the grassland management operations such as forage harvesting and turnout dates of grazing animals. Disruption and delay will have an impact on revenues and costs.

The method needed to assess the financial and economic impacts of changes in drainage conditions and flood risk associated with the adoption of flood storage options is summarised in Figure 2 (Morris and Hess, 1987; Penning-Rowsell et al., 2003). First, field drainage conditions should be identified as these determine the physical productivity of farming activity, whether for grassland (energy Mj/ha) or arable crops (t/ha). Energy from grass converts into a potential livestock carrying capacity (livestock units per ha) and, depending on the type and mix of livestock in the floodplain, into financial returns £/ha. Financial returns from arable production (£/ha) reflect the type and mix of crops in the flood plain. Second, therefore, estimates of the financial returns from each enterprise are needed. These are net of relevant production expenses (such as seeds, fertilisers, veterinary expenses and machinery operating costs). They may also include any receipts from government schemes such as Beef and Sheep Premia, IACS area payments, and ESA membership. Third, flood damage costs (£/ha/year), which vary according to flood risk and land use, will need to be identified and deducted from financial returns to give an overall estimate of financial performance (£/ha/year) for each major land use type.

Figure 2 Approach to Financial and Economic Appraisal of Washland Options



Field drainage conditions determine land use options and the physical productivity of farming activity. Commercial crops are sensitive to waterlogged soils and anaerobic soil conditions during critical growth periods, with consequences for crop yield, quality and value. Wet soils have reduced strength and this reduces their bearing capacity which, in turn, restricts field access by machinery or grazing livestock. This leads to delays in critical field operations such as cultivations and fertiliser application, and to restrictions on grazing seasons. In the case of grassland, wet soils will not provide suitable growing conditions for commercially 'improved' grass species, restrict field access for the early application of fertiliser, and are liable to damage by grazing animals. For these reasons, and other requirements of more intensive livestock husbandry systems such as quality silage-making, persistently wet field conditions tend to be associated with extensive grassland, whether grazing or hay cutting.

In terms of the flood damage costs, these will vary according to the quality of grass, and the duration and depth of flooding. Relatively short duration, even multiple winter flooding on extensive grassland has limited impact. Grassland is very tolerant to winter flooding. However, long duration flooding will destroy grass or result in an overall loss of grassland productivity. The same is true for repeated relatively short duration floods which can be additive. There may also be problems of soil compaction and erosion.

From a farmer perspective, increased flood risk could reduce farm revenues, increase some operating costs and therefore reduce profitability. In some cases, there may be savings in some farm level costs such as regular labour and machinery if a farm moves to a less intensive system. Much depends on farm circumstances, especially whether farms have scope to reduce not only direct costs such as fertilisers but also overhead costs such as labour and machinery and other general expenses in the process of adjustment. Estimates would need to be made regarding the financial revenues and costs for the main livestock and arable enterprises (Morris et al., 2000). A key factor influencing the impact on a farm business of a change in flood risk on any parcel of land is the proportion of the total area of the farm that is accounted for by this parcel. Generally, the larger is the proportion of the whole farm subject to change in flood defence standards, the bigger is the impact on the whole farm business.

In reality, therefore, arable farming would not be considered feasible on washland areas. There may be a role for dairy systems, although conversion to a beef cow system is more likely to offer a better prospect. For beef and sheep systems, there may be some advantage in switching to less intensive systems, providing savings in overall fixed costs at farm level can be achieved.

Table 1 contains indicative estimates of the reductions in financial indicators associated with the adoption of a wet grassland options on washlands in South West England (Morris et al., 2002). These vary by land use type and by the particular financial measure which is used to assess income loss, whether gross margin or net margin. For the assumption made, compensatory payments of between £200 and £300 may be needed, conditional upon positive environmental enhancement. These are consistent with the range of payments currently paid under the UK's existing agri-environment framework incorporating ESA and Stewardship arrangements (see subsequent section). At present land managers in ESA wetland areas are paid between £80 and £430 according to the level of compliance required.

Of course, farm subsidies need to be stripped out of the financial analysis to determine the value added from an overall economy perspective. Defra provide guidance on the use of economic adjustment factors (MAFF, 1999). The switch to heavily subsidised livestock systems may reduce the economic attractiveness of switching to extensive livestock systems. However, Defra are willing to accept environmental payments to farmers as an indicator of society willingness to pay for, and hence the value of, environmental enhancement (MAFF, 1999; Penning-Rowsell, 2003).

Table 1 *Indicative reduction in financial indicators associated with a switch from typical grassland or arable land use to extensive grazing under a washland regime**

£/ha/yr reductions 2001 values**	Dairy	Beef	Beef and Sheep	'Average' Catchment Dairy and Livestock	Arable
Gross Margin (before forage costs)	410	280	260	350	300
Gross Margin (after forage costs)	330	190	170	260	300
Net Margin after semi fixed costs***	215	140	100	170	150

Net Margins after full fixed costs****	150	80	0	90	90

* based on estimates in on the Somerset Morris and Levels, S W England
**excluding any environmental payments on grassland , but including CAP area payments on arable
*** direct labour and machinery operating costs only
**** including labour costs, machinery operating and depreciation, and housing/building costs for stock.

Administrative Options for Flood Storage

There are a number of alternative forms of management and administration for washland creation and operation. These include land purchase, easements on flooding, management agreements supported by annual payments and leaseback partnership arrangements (Morris et al, 2002).

Under the land purchase arrangement the land asset is voluntarily sold by owners at prevailing market prices to a responsible organisation which manages it in accordance with programme objectives. The organisation involved may operate the site directly or may manage it indirectly on short term or seasonal tenancy agreements with farmers, with preference to previous owners/tenants. There is a growing experience of this type of purchase, and of subsequent operation and maintenance by voluntary and statutory conservation organisations, often working in partnership.

The land purchase option, in that it involves up-front financing and asset and management transfer for the purpose intended, has a relatively low risk of failure. Further, the transfer of responsibility for ownership and operation to a responsible authority, has the potential to deliver effectively against the programme objectives, especially floodwater management and environmental objectives. Land purchase also lends itself to capital funding, including eligibility for capital grants (as in the case of flood defence capital projects). Finally, the challenge of negotiating annual agreements, and variations in these that reflect design or actual water regimes, is removed.

However, there is a risk that local and community ties with the land are reduced once ownership becomes institutionalised, and there may be associated problems of attracting and negotiation tenants. There will also be administrative challenges lining up volunteers for land sales, especially in areas characterised by fragmentation of holdings. It is easier if large blocks of land or whole farms can be purchased from a few individual owners. This may be feasible in some locations and farmers may be inclined to sell if land can be acquired elsewhere in the vicinity. Some farmers will see land sale as an opportunity to exit the industry, relocate or refocus. A land bank could be used for this

purpose, whereby the sponsoring organisation buys up land locally to achieve land or whole farm swaps. This approach has been used in Denmark and the Netherlands and to a limited extent in Britain. Compulsory purchase in the public interest could also be considered to ensure the integrity of flood storage schemes. However this is unlikely to prove popular even though it may be the only option to deliver a large scale, comprehensive scheme. Land purchase, whether voluntary or compulsory, is also potentially unfair on those who would otherwise wish to continue farming as before.

The purchase of flood storage easement takes the form of an up front payment, expressed as a % of prevailing market prices. This easement reflects the loss of asset value, and related income loss into perpetuity, associated with specified increased flood risk. The arrangement is subject to an easement agreement, which specifies conditions applying in each case. Owners retain rights which are not the subject of the easement and its effects. This model has been used over the last 20 years by the Environment Agency in flood alleviation schemes. Payments have ranged between 40% and 80% of market land values reflecting easement against a design flood event.

Easements are designed to accommodate changes in the risk of flooding borne by existing owners and occupier. For the most part they apply to infrequent, major flood events which potentially cause occasional damage rather than significant changes in land use. Owners, and occupiers through reduced rents, receive compensation for absorbing the risk of increased flooding. Occupiers can insure themselves against known risks if they wish.

Easements are attractive to flood defence organisations because they involve a one-off negotiated settlement, the cost of which can be charged to a capital scheme and which, in the case of flood defence, is potentially grant-aided from Government. In some cases, easements which serve the public interest can be compulsorily acquired by Government bodies.

Easements could potentially deliver the flood defence objectives of washland creation, but are less effective for delivering environmental enhancement or livelihood objectives. They will produce a one-off injection into the farming community, but will substantially reduce remaining asset values. Although, initially they could be administratively easy to establish, there are risks that the terms of the easement may restrict operational flexibility and be a source of contention if water regimes differ from those covered in the agreement. Finally, given the proposed frequency of flooding, it is likely that easements would approach the full market value of land, in which case outright purchase might be preferred.

Arrangements involving annual payments allow existing tenure arrangements to continue. Farmers sign a management agreement for a specified minimum period with a responsible organisation which specifies land management in accordance with programme objectives. The contract may be for a given flood storage facility, possibly specified by timing, duration and depth. Although these will include environmental protection measures, they may or may not require

actions to enhance the environmental quality of the site itself. Farmers receive annual payments in return for services rendered.

Management agreements are commonly practised under the European Unions Rural Development Regulation agri-environment scheme package. Within the UK this includes Environmentally Sensitive Areas (ESAs) (Defra, 2002a) and Countryside Stewardship (Defra, 2000b), amongst others. ESAs are areas designated primarily for nature conservation interest. Farmers within these areas are free to opt in in return for annual payments based on restricted management practices such as limiting agro-chemical use, stocking rates and periods. The Countryside Stewardship scheme on the other hand is discretionary, is available across the country (different schemes operate within the different UK regions), and focuses on targeted landscapes. Each scheme has a number of options from which the farmer can choose to incorporate within a management plan. Farmers are required to draw up the management plan themselves to apply for the funding. Applications are undertaken annually, and not all applicants will necessarily receive funding for their plan. Stewardship as a result of option identification places more emphasis on environmental outputs than ESA agreements which tend to focus on compliance.

Annual payments in return for management agreements are common place and well understood. They have been widely adopted directly by farmers, and by institutional land owners who use them as a basis for delivering their own environmental objectives, often through tenanted farmers. They are also a key component of farm incomes and underpin much subletting of land, providing income to owners, and to a degree, low rents to tenants.

Given the experience to date, a Washland ESA or Stewardship scheme would be relatively easy to set up and administer, and could be an extension of existing arrangements. ESA terms could be drawn up for specific hydraulic units, or sub units to reflect existing and future typical land use, proposed water regimes (flood risk characteristics), environmental enhancements and related compliance costs. Alternatively, Washland Stewardship agreements could be drawn up with land managers to reflect specific site and farm circumstances. Payments would reflect a defined flood facility, environmental enhancement and compliance prescription.

Consequently, annual payments have the potential to meet the multiple objectives of flood plain management. They offer some flexibility to the responsible management organisation to direct change in accordance with changing circumstances and priorities. They are compatible with the principles of the new Rural Development Regulation which seeks to strengthen the social and economic viability of rural communities through support to agri-environmental and diversification initiatives.

However, there is debate regarding the efficiency of annual payments from a public purse viewpoint. They are expensive, may pay farmers for doing what they would do anyway, and can create a dependency and, from this, a future vulnerability. Further, annual payments may need to exceed 'compensation' levels in order to persuade farmers into adoption. Simultaneously, their magnitude (like land prices) may reflect the extent of subsidy to the farming sector, rather than any economic opportunity cost or added value. At a practical level, annual payments are at risk of policy change and funding availability, especially as they rely on revenue rather than capital funding. This concern applies to farmers and responsible organisations alike. Farmers, perceiving a return to a previous and possibly irreversible wetland condition, will seek security of payments over the medium to long term, probably 20 years. Implementing organisations may also feel vulnerable in their dependency on Government funding.

Their greatest drawback is that they place a high ongoing burden and dependency on continued revenue funding. To be attractive to farmers, they need to be secure for the longer term.

Finally, the lease–back/partnership initiative transfers land entitlement in the form of a lease from farmers to a newly created project organisation for a specified period (20 to 30 years). As partners, farmers operate the land in accordance with programme objectives for which they receive annual payments. At the end of the lease term, the arrangement can be extended or terminated. In the latter case, land returns to partnership farmers. A joint management committee with representation by the major partners would be formed to manage the initiative.

The transfer of the management of land assets to a responsible partnership organisation of which the asset owners are part has the advantage of focusing on the programme objectives, vesting management responsibility in a programme management unit, and directly engaging farmers in the process of delivery. The 'partnership' approach is consistent with the idea of sustainable and wise use, and is likely to meet with approval from potential sponsors. It is likely to be more administratively and legally complex to establish, and there may be resistance from land owners to engage until the benefits are clear, especially as they, as contributors of the land assets, carry the greatest risk. They would, however, enjoy management participation and security of agreement. It is possible that a partnership approach would lend itself to a private-public partnership/private finance initiative. This leaseback option could suit situations where there is a clear community of interest.

In summary, the suitability of these options varies according to the purposes to be achieved, the need to provide long term robust solutions, and, linked to these, the preferred link between the farming community and the management of the land.

All of the aforementioned approaches are potentially feasible. Land purchase, annual payments and leaseback have their particular advantages, disadvantages and risks, and suit the interest of different groups. Easements may be appropriate to accommodate modest increases in flood risk, but probably not for regular deep flooding and where there is a wish to achieve environment enhancement.

The diversity of circumstance and practice within floodplain areas suggests that a diversity of approaches to washland administrative arrangements will be needed. A mosaic of land tenure arrangements may be acceptable provided this can deliver the scale, integration and reliability of service required.

Further, institutional and administrative arrangements for flood storage and washland creation should reflect the land management and funding mechanisms. Given the multiple objectives to be served, a Washland Programme organisation with membership drawn from key stakeholders, would provide strategic direction and management, delegating responsibility for administration of the programme and its constituent projects to member organisations as appropriate. In the UK, the flood storage facility could be managed by the Environment Agency in collaboration with Defra and the Internal Drainage Boards. Statutory and voluntary conservation organisations could variously manage operations at project area level. If it was decided to progress washland creation through an annual payment regime, it would make sense to administer this through existing mechanisms such as those operated by Defra or English Nature.

Finally, in addition to the possibility of land purchase, easement costs and/or annual payment, a meaningful estimate of costs needs to include design, supervision, engineering works, and operation and maintenance costs. These costs, reflecting the capital and operating costs of 'engineering' washland projects, are very site specific and will vary according to flood characteristics and impacts. However, it is likely they will replace some costs currently committed to conventional flood defence.

Conclusion

It is considered feasible to create facilities in the flood plain of a river catchment which will store flood water and create washland, and which will potentially meet all or some of the multiple objectives of flood and water resources management, environmental enhancement, and farming livelihoods. However, there is both synergy and conflict of interest in washlands amongst flood storage, environment and farming objectives. Different sites are likely to have different priorities and management systems. Accordingly, prescriptions for flood facilities, environmental and farming management will require local definition.

Further, the storage of winter floodwater and washland creation on farmland will result in income losses to farmers, and would mean a switch from arable to grass, and from improved grassland to extensive systems. The extent of loss of net income (revenues less costs) associated with a switch in cropping and extensification will depend on whether farmers can achieve savings in costs to offset reductions in revenues.

Set against this, is the scope to design a washland flood storage package, involving land purchase, easement, annual payments, or partnership/leaseback. Given the diversity of circumstance and practice across the UK, a range of approaches to washland tenure arrangements is suggested, provided this can deliver the scale, integration and reliability of service required. Payments should reflect the different levels of risk. Where the owner maintains occupation, payments should also reflect the timing, duration and depth of flooding during the season.

However, there are potentially a number of barriers to the adoption of flood storage options by farmers:

- Inadequacy of financial incentives for flood storage and washland creation;
- The perceived adequacy and predictability of existing agri-environment payments;
- A large proportion of the farm lying in the area of a proposed scheme which will fundamentally affect the whole farm business in a way which is unacceptable;
- A wish to continue farming commercially, and a perception that the washland option is not compatible with this;
- A reluctance to return the farm to wetland after a lifetime of drainage for agricultural improvement;
- Lack of evidence that washland agriculture is feasible and practical, especially regarding information on the viability of 'new' washland farming practices;
- Lack of confidence and trust in promoting and implementing organisations, based on previous experience or hearsay;
- High degree of uncertainty concerning farming futures and related policy framework.

Nevertheless, at current levels of government support, there appears to be an economic advantage in moving to extensive washland farming systems. Given the potential to achieve further social economic and environmental benefit, it would appear in the public interest to redirect funding into flood storage and washland creation as part of an integrated and sustainable approach to flood management.

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Author Biographical Details

Professor Joe Morris (j.morris@cranfield.ac.uk) has over 30 years experience in farming systems research, development and consultancy. He has particularly been involved in the design and appraisal of farming systems, which reconcile environmental and economic objectives. This has been carried out in both lowland and upland contexts in England and Wales, and with respect to particular landscape or ecological features.

Dr Alison Bailey (a.p.bailey@reading.ac.uk) is an agricultural economist with particular expertise in the analysis of agri-environment interactions. This includes financial and economic analyses of the impact on farm productivity, the valuation of environmental benefits, and the trade-off between the benefits and costs of alternative farming systems and policy strategies.

Dr Clare Lawson (c.s.Lawson@reading.ac.uk) is a plant ecologist whose research interests focus on community ecology and habitat restoration. Her work has included experimental studies on the effect of hydrology on grassland community composition.

Professor Peter Leeds-Harrison (p.leed-harrison@cranfield.ac.uk) has over 30 years experience in the science, engineering and management of natural systems and, in particular, in the sustainable use of soil and water. He work includes physically based modelling of hydrological processes in managed soil systems.

Dan Alsop (d.alsop@virgin.net) is a self-employed river engineering consultant and on the Board of Directors for the UK's River Restoration Centre. He has 35 years varied civil engineering and management experience and has previously worked with the UK Environment Agency / Drainage Boards. Recent work has included the preparation of water level management plans, development control work, and planning design and supervision of flood protection and raised water level schemes.

Richard Vivash (rmvivash@yahoo.co.uk) is a Chartered Civil Engineer who has spent most of his career in river engineering and management with the National Rivers Authority (now Environment Agency) and its predecessors. He is also on the Board of Directors for the UK's River Restoration Centre. The concept of integrated river management has been a driving motivation throughout Richard's career. He is currently looking at river catchments resulting from catchment management practices. This will highlight links to farming and landscapes as well as to sustainable urban drainage.