

CHALLENGES IN IMPLEMENTING FLOOD STORAGE AREAS IN THE UK

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ABSTRACT: Flood storage can be defined as the temporary detention of floodwater. By capturing and storing the flood water peak flow the extreme volume is not passed downstream to cause flood inundation but gradually released when water levels have fallen. Flood storage has recently received greater interest at the European scale. Where the principle of flooding areas with expected lower losses (farmland) instead of high values areas (urban) is acceptable, obtaining this right on private property remains a challenge. Different forms of economic approach to obtain or incentivise this right may be considered: expropriation, one off- payment, annual single payment, and flood event losses compensation.

This paper presents the results of a qualitative survey conducted in England and Wales in the frame of the FP7 EU EPIWATER project. England and Wales has well established flood storage and continues to be developed as one of a number of flood risk management approaches. The research reviews the current status and mechanisms that have successfully facilitated this approach. The research draws on 14 interviews with a range of key stakeholders involved in implementing and managing flood storage areas. Where flood mitigation is the main issue being addressed in a locality a single payment of partial land purchase with flowage easement was found to be the dominant funding mechanism. Where greater control of land use is required for predominantly environmental and conservation purposes then full land purchase is necessary. Alternative diffuse storage approaches have also been trialled in England revealing their limitations in the predictability of the final storage capacity in the catchment and their long term sustainability in terms of maintenance which is reliant on continued contributions from Agricultural Schemes. The UK context may be unique and not transferable to other countries. The paper further discusses this issue.

Key Words: Flood, Storage, Economic, Stakeholders, Negotiation

1. INTRODUCTION

Flood storage is one of the many options used in flood risk management and has recently received greater interest at the European scale in response to challenges in sustainable flood risk management and associated policy (e.g. Making Space For Water, ecosystem based approach). Where the principle of flooding areas with expected lower losses (farmland or recreational) instead of high values areas (urban) is acceptable, obtaining this right on private property remains a challenge. Different forms of economic approach to obtain or incentivise this right may be considered: expropriation, one off- payment, annual single payment, and flood event losses compensation. With no literature describing actual practices the following research was undertaken to explore the approaches employed in England and Wales to engage with and incentivize landowners to contribute to increasing flood capacity.

2. PHYSICAL BACKGROUND TO FLOOD STORAGE

Flood storage can be defined as the temporary detention of floodwater. By capturing and storing the flood water peak flow the extreme volume is not passed downstream to cause flood inundation but gradually released when water levels have fallen. For the proposal and implementation of storage schemes

hydrological surveying is essential and can be very complex in catchments where there are a number of tributaries. Without careful planning there is the potential of complex interactions which combine stored flood peaks to increase rather than reduce the risk downstream.

Flood storage has been used in England as part of a land management strategy for many centuries. In modern flood risk management it is typically used as one of a number of approaches on a catchment and achieves a reduction rather removal of the risk of flooding altogether. Storage can be combined with approaches that include:

- ☐ Enlarging river channels; and,
- ☐ Raising river banks
- ☐ Constructing flood banks set back from the river
- ☐ Specific building protection
- ☐ Farming practices to reduce surface water runoff via cropping, ploughing direction and water infiltration via soil structure management
- ☐ Community resilience measures (flood warnings and behavioural preparation)
- ☐ Development planning restrictions

A flood storage scheme is composed of an area of land to hold water and structures to regulate the input and output of that water. The regulatory structures can be overspill banks and manual / automatic gates. There are two types of flood storage. On-line storage refers to where the river is not disconnected with the storage area but a damming structure or restriction causes water to back up to be stored upstream. Offline flood storage is disconnected from the river either via flow structures or embankments that overspill purposefully. A detailed description of the physical aspects of flood storage is provided by Hall et al (1993) and an extract reproduced by the Environment Agency e-document called '*Fluvial Design Guide - Chapter 10 Flood storage works*'.

The Environment Agency does not have a legal duty to protect people from flooding but holds permissive powers. However, if deemed a regulator then they do have a responsibility. The UK Floods and Water Management Act sets a safety regime of standards and inspection for any storage capacity over 25,000m³ above natural ground level. This classifies the structure as a reservoir with regulatory responsibilities undertaken by the Environment Agency. Flood storage areas below this capacity do not need to be registered or regulated to mitigate structural failure. At the time of this research the threshold capacity was under Department of Environment, Food and Rural Affairs (Defra) review to be lowered further to 10,000m³.

Flood storage has the advantage of benefiting large areas of vulnerable properties or land downstream of its location which can be a number of kilometers away. However, it is this dislocation between the storage area and the benefiting land or communities that means it is often difficult to justify to the upstream landowners to participate in a storage scheme involving the flooding of their land for beneficiaries they can feel little attachment to. It is the mechanisms that currently persuade these landowners to participate in schemes that this research explores.

3. RESEARCH APPROACH

Following a literature review that revealed no comprehensive descriptions of current practices of incentivising landowner participation in UK flood storage schemes an empirical approach was adopted. Relevant stakeholder organisations were identified that represented the majority of schemes, different approaches to funding and development of flood storage in England and Wales. Scotland was omitted from the research due to research resource restrictions and Scotland having a different flood risk management governance structure to the rest of the UK. England and Wales were at the time of the research similar in management structures. From exploratory investigations with the Environment Agency and from literature key individuals were identified as representing different aspects of the approach.

14 qualitative telephone interviews were undertaken in February 2013 with all the representatives initially identified from the Environment Agency England and Environment Agency Wales, the Royal Society for the Protection of Birds (RSPB), the Staffordshire Wildlife Trust and Doncaster Metropolitan Borough Council. At least two representatives were chosen from each organisation based on both their connection with specific flood storage projects and their differing insights at the policy, management and land negotiation levels of projects. Interviews were undertaken for 30-45 minutes based on a semi-structured discussion approach. Each interview was audio recorded for later analysis and the key themes transcribed and synthesised for this report. Where possible the anonymity of respondents has been maintained. A final meeting was undertaken in May 2013 with the Environment Agency where the key findings were presented to gain further insights, clarifications and as a final test of balance in the research.

4. RESEARCH FINDINGS

A common response from all the interviewees was that the availability of funding is the main driver for landowner adoption of flood storage schemes in England and Wales. While for some private landowners there may be interest in the environmental, ecological and social issues still the key motivation was considered to be financial. Public bodies such as local authorities and interest organisations such as the RSPB viewed their involvement as driven by their organisational agenda and enter into funding partnerships if their concerns are also addressed by a scheme. Within the UK there is a clear legal framework of ownership of land and funding mechanisms which was also considered a key characteristic that enabled the approaches adopted to be successful.

Funding is available from a number of sources. It was found the mechanism for funding is tightly linked to the type of flood storage developed which is in turn informed by the catchment characteristics and interests of the organisations driving the scheme. Three funding mechanisms were revealed in the research; flowage easement, full land purchase and Agricultural Schemes funding diffuse storage.

4.1 The Flowage Easement Mechanism

Flowage easement is the right of government to use the land of another for the purpose of overflow, flood and submerge (Strain, 1981). This is usually in perpetuity and the owner retains rights and privileges provided they do not interfere with that flowage. Flowage easement was reported to be the primary mechanism of the Environment Agency which was reported as the biggest owner of regulated flood storage reservoirs in England and Wales. With 197 regulated Flood Storage Areas (FSAs) split equally between online and offline designs they amount to a total of just over 317million m³ storage capacity above natural ground. 114 of these regulated areas are each between 25,000 m³ and 200,001 m³ and 15 FSAs are over 3 million m³ capacity. The largest is the Ouse Washes at a capacity of 90 million m³. Rather than focused on a few very large storage areas it was reported that the strategy is adopted at differing scales and also in combination with other flood risk management approaches. It was commented that the development of FSA's as a mitigation strategy continues to be used with a number of projects in planning and construction in England and Wales.

4.1.1 The funding approach

Until May 2011 with the introduction of the Flood and Coastal Erosion Resilience Partnership Funding (Environment Agency 2012) the dominant channel for flood defence capital scheme funding was from central government. An economic cost / benefit appraisal would inform if the financial benefits were sufficiently high set against the financial cost of construction and maintenance for the scheme to be funded (Penning-Rowsell et al. 2013). The new policy encourages funding contributions from additional stakeholders with central government only providing sufficient capped funds related to the benefits the scheme will bring in relation to the social and economic characteristics of the communities benefited. In this new funding context a scheme can now still progress provided funds are available from sources other than central government whereas in the old context if the benefit / cost ratio was not met then generally that meant the scheme could not progress. However, even before the introduction of partnership funding it was often reported by the respondents in this research that a form of the partnership approach was

already practiced in some flood storage schemes. Without such an approach these schemes would more than likely not progressed either.

The Environment Agency is the organisation that usually leads the approach and schemes are developed organisationally at a local level. This is because each FSA is unique in terms of stakeholders, frequency of flooding and impact which means national guidance is difficult. However, it is clear in Environment Agency respondents' accounts key principles were followed of a negotiated approach with a single compensation payment.

4.1.2 Negotiated Approach

Once it is found that flood storage is a suitable approach for the catchment and following an initial hydrological assessment to define the land area affected then the landowners can be identified. The amount of water that can be released and the capacity downstream dictate the flooded or impounded area of land. Invariably in the UK flood storage schemes involve a number of landowners who can be farmers, private landowners, local authorities and organisations. Sometimes the owners are not directly affected by the land changes such as tenant farmers and the actual landowners need to be identified and contacted for negotiations. There might be wider stakeholder interest in the scheme other than the landowners. Local authority interest could be in relation to their flood at-risk communities. Environmental interest groups such as the RSPB might see relevant conservation land use change opportunities. There may even be commercial interest of being associated with the scheme. These stakeholders can provide partnership funding contributions for a scheme. For large land purchases where river navigation is affected such as the Leigh Barrier FSA an Act of Parliament was required before work could start (Private Bill River Medway Flood Relief Act).

An option for the Environment Agency to pursue is a Compulsory Purchase Order (CPO) which legally enables enforced purchase and development of the land against the wishes of the landowners. It would need to be proven legally that there would be public betterment as a result of the scheme. However, this would mean owning and having the impounded land as a liability which the Environment Agency respondents explained their organisation wished to avoid. In addition to CPO adopting a conflictual approach the outcome can be uncertain with the possibility of a decision being made against the scheme resulting in wasted time and public money. However, it was reported, the primary mechanism is rather than CPO actually negotiation with the landowners with the use of limited land purchase and flowage easement agreements. This was viewed by respondents as a more constructive approach encouraging long term relationships between stakeholders and sustainable participation in the scheme. But the CPO remains an option if required because with this type of storage every landowner has to participate in order for the scheme to progress. It was also commented that CPO can act to encourage negotiations to come to a conclusion. Negotiations can last many months and sometimes years. In one FSA a CPO option was explored separately and in parallel to negotiations in case it was required.

Negotiations are undertaken by a specialist Environment Agency estates team. At the time of this research there are four regional Estates Leadership Teams made up of estates managers most of whom have operational surveying experience. They are also supported by legal and environmental advisors. This approach was felt to ensure a consistent approach nationally and enable expertise to be built up within the organisation.

A typical process reported was that the local area Environment Agency staff would first make contact with landowners individually. They might already know them and have knowledge of the local context the landowners are operating in. It was advised by respondents that landowners are met individually rather than as a group because the focus and direction of discussions can be changed by a minority which might not be to the advantage of all as individuals. Each landowner will have land with different impounding characteristics so the basis of negotiation will be different for each. It was also advised that the hydrological modelling options are undertaken before meeting the landowners because there will be an immediate need in initial meetings to understand the detail of what is being proposed. Depending on the landowner the modelling consultants used might be taken to the meetings as well because iterations to the models might be required based on new information gained from the landowners.

For the financial negotiations the Environment Agency suggested encouraging the landowners to use a single land agent who acts on their behalf with the Estates Leadership Team. This reduces the transaction costs and misunderstandings for both negotiating parties. The basis of negotiations depends on the characteristics of scheme and stakeholders involved. It was reported that for farmers conversations might start on the basis of irrigation rather than flood management because of their possible lower interest in flood mitigation benefiting communities. The land might already be at flood risk and so the scheme could also be negotiated on the basis of bringing flood predictability but with compensation. However, it was the Environment Agency respondents opinion there is no hiding that storage will blight land and the landowners should get a reflection of that in compensation.

4.1.3 Single payment compensation

Where individual landowners' flood risk is increased a single compensatory payment is made at the time of construction. It was reported that compensation payments in relation to subsequent events is avoided and very rarely agreed. It was argued by respondents that event compensation is too unpredictable to forecast and negotiate, time consuming and expensive to administer, difficult to quality check and the funding of future events could not be guaranteed. Event compensation does not fit well with the costing for the value for money economic analysis and could mean that over time the government paying more than the initial value of the land. It was also suggested that event compensation dripping down to landowners over long periods of time would not provide an opportunity for the landowner to fund a change in their land management practices which a lump sum of money might give.

Two forms of payment are negotiated and are based on the open market land value. This value is driven by local supply and demand based on the agricultural land values informed by the land characteristics eg: at the time of this research arable is more valuable than pastureland and south eastern UK land is generally more valuable than land in the rest of England. As a principle it was stated that the Environment Agency do not pay more than the capital value of the land.

For some landowners, for structural requirements of the scheme, a portion of their land is bought outright. This is the footprint of embankments, sluices, gates, intakes and outfalls. It also includes land that allows legal access and maintenance of these structures. The Environment Agency accept liability for these structures as the regulator inspecting and maintaining them. As guidance to appraise the whole life cost of a scheme the maintenance cost was suggested to be three times the construction cost over 100 years. The construction costs include designed in climate change. Another approach suggested for calculating the maintenance cost was to calculate the cost of a mid-life rebuild and two refurbishments during a 50 year life of the asset.

For the rest of the land which would form the impounded storage area flowage easements are negotiated with relevant landowners. The negotiated price is based on the possible frequency of flooding and proportion of land affected. It was reported that this can be calculated based on return periods of 1 in 2, 5, 10, 25, 50, 75, 100, 200 year flood events. For most catchments an average over the year is calculated because the flooding could occur any time of year. The amount paid for the easement is based on a negotiated diminution in the value of the land normally as a percentage of the market value varying by the frequency of flooding. The less frequent the flooding the lower the diminution in market value. An example is provided in Figure 1.

<u>Flood Return Period</u>	<u>Diminution in capital value</u>
1 in 2 years	100%
1 in 5 years	75%
1 in 10 years	60%
1 in 25 years	35%
1 in 50 years	20%
1 in 75 years	15%
1 in 100 years	10%

Figure 1 Example of the diminution in land value (Lincoln Flood Alleviation Scheme 1998)

This is just one actual example but it was reported that the rates are not set nationally and vary according to the region, type of scheme, topography, predominant land use (arable or pasture), estimated duration of flooding etc. It was observed by one Environment Agency respondent that a large number of return period variations and numbers of days of impounding per year calculations can cause confusion for some landowners during the negotiation. So another approach that was suggested, being trialled in Wales, would model just two scenarios. A 1 in 5 year return period negotiated at 25% of the land value (as above) and any less frequent flood frequencies negotiating at 10% of the land value. For annual inundation the Environment Agency would probably pay the full market value.

Negotiations are based on forecasts which are uncertain. But it was commented by the Environment Agency respondents that forecasts are made conservatively in the landowners favour and the offers are generous. However, in the very few cases where the forecasts are fundamentally wrong they would renegotiate but not paying more than the capital value of the land. It was pointed out that sometimes land agents would like to include a clause for smaller variations in the forecast acting against them but when challenged don't want that agreement to also operate in The Environment Agency's favour. Overall it was stated that there was little option for recourse unless circumstances were exceptionally different and the emphasis would be for the landowner to prove that difference.

4.1.4 Negotiated Agreements

Agreements were reported to be structured around the characteristics of the local stakeholders, their requirements and flood experience. In one FSA the local authority agreed to pay for a community swimming pool to compensate the community for lost historic bathing amenity within the flood storage area. But in that case the cost was not included as part of the project cost. 'Accommodation works' or supplementary work might be offered to the landowner which include the improvement of farm roads, the development of irrigation ponds from borrow pits or undertaking grass cutting and planting maintenance. Where landowners own both up and downstream land it was mentioned that agreements sometimes involved downstream improvements as well. The project cost might be supplemented by other stakeholders such as the RSPB to develop some wetland in the storage area. The Environment Agency also attempt to build in environmental amenity into their schemes. An example was given of a water company that provided funds because it required compensatory flood storage to balance their building of a water pump in the flood plain which was removing storage capacity.

It was suggested by most respondents that a comprehensive record of agreements and meeting minutes is kept because there are often enquiries from landowners regarding the details some time after the FSA is built. The Environment Agency interest in the FSA following completion is with regard to their regulatory responsibilities, agreements to maintenance and the operation of gates if not automated. As part of the flowage easement there might be restrictions on land use change that could interfere with impounding and the Environment Agency would be required to be consulted by the landowner. The organisation undertakes Project Appraisal Reports a period of time following construction to evaluate the initial cost benefit assessment. It was commented that overall where the storage had been tested the outcomes had been very good and as predicted if not better.

It was felt that there is a natural limitation of the number of stakeholders that could be negotiated with at one time. It was reported that the Environment Agency has had to negotiate with large numbers but usually they were sequenced down say a river reach to make it more manageable. It was also thought that where whole livelihoods could be disrupted by storage then outright purchase of the land or land swaps was preferable to a negotiated or event driven compensation approach.

4.2 Purchase of all the land

By this mechanism the whole FSA is purchased included the impounded land. This approach is adopted where far greater control of the land use is required and accepting liability of the land is viewed as an advantage. It was reported by the RSPB respondents that land use change is the key driver in restoring habitat. So this mechanism is one of the main strategies undertaken by their organisation to influence outcomes other than being an influential partner in schemes. The organisation actively looks for opportunities to return wildlife to areas where it has been lost. Washland, wet grassland, water meadows, marshes and fens were reported as key habitats which are in short supply in the UK and so if there is a requirement to create wetland then wet areas of land are important hence the association with flood storage. The respondents commented that organisation views flood risk as an opportunity to develop habitat which also serves the role of flood storage.

It was reported that the RSPB manage some 130,000 hectares of land as the land owner or lease holders where the previous owner or new tenant still has an interest in the land. They are an organisation with an annual turnover of £180 million (€220m or \$300m) with 2000 staff and a large volunteer workforce. The RSPB is structured so that there is a Reserves Team who attempt to identify suitable land. To do this they are in close contact with local organisations as well as scanning catchment flood management plans, shoreline management plans and flood defence asset maintenance to reveal opportunities. Their Regional Teams try to take an overview of activities. Similar to the Environment Agency the RSPB also have a land agency team who undertake negotiations and their services can sometimes be offered as part of negotiated deals. Land purchase is again based on market values.

It was commented that a key driver for land sale is often the landowner is already spending a lot of money on flood defence or the management of flooding of their wet land. Some landowners still wish to manage the land and so maintain an interest as tenants but use the capital from the sale of their land to buy more suitable farmland. The organisation has an annual land acquisition budget but does not undertake formal cost benefit assessments before a scheme. They instead draw on expert opinion of the wildlife contribution set against annual plans. An alternative to land purchase the RSPB can be partners in a scheme driven by say the Environment Agency and look for smaller opportunities within the scheme. Such opportunities can include landscaping to improve habitats but with little impact on storage capacity important to the Environment Agency.

The RSPB respondents reported of their increasing awareness of the conflict between habitat creation and the functionality of flood storage. There has been an increase in the frequency of summer as well as winter flooding which can coincide with the time of nesting for ground nesting birds like the lapwing. The flood water destroying the nests can be disastrous for the next bird generation. However, localised landscaping was suggested as a possible mitigation to help prevent this with little impact to the storage capacity.

4.3 Agricultural schemes and Diffuse Storage

The third mechanism does not involve land purchase or flowage easement agreements but encouraging landowners to undertake their own ideas for flood storage activities. The activities are at a much smaller scale than those already described each falling well below the 25,000 m³ capacity reservoir registration and regulation. The largest of these schemes was reported to be 6,500 m³. However, landowners can undertake a number of approaches spread across their land and across a number of stakeholders resulting in a cumulative effect on storage in the catchment. Compared to the previous approaches the whole storage land is not impounded but patches of the land is affected hence the term diffuse storage.

A comprehensive description of a project by the Staffordshire Wildlife Trust that trialled this approach is given in Farming Floodplains for the Future (Jones, 2010). In this project landowner participation was again found to be driven by payments that ensured there were no financial costs to the landowner other than volunteered time or labour. Payments covered the single capital cost of the asset, its maintenance and additional small compensation payments. The approaches were mostly sluices, scrapes, spillways, flap valves, ponds and woodland operating at low exceedance probabilities requiring very little maintenance. Guidance was provided to the landowners and project team by the RSPB. However, it was commented by a RSPB respondent that the wildlife restoration value was not very great because the patch size was small for each application increasing edge effects and so reduced conservation restoration.

Funding was sourced from securing additional farming subsidy payments (Entry and Higher Level Stewardship schemes). The landowners were already part of subsidy schemes. It was thought that the life of a scheme could be dependent on the life of the subsidy. Without any legal agreements and the loss of funding there were concerns that maintenance would cease reintroducing the previous level of flood risk. For the project it was reported it did progress beyond the three years with funding from the Natural England Meres and Moses which enabled some additional landowners to be recruited including Independent Drainage Boards. It was thought that using flowage easements as a solution to the loss of funding would not be appropriate proving too expensive for the low capacity of storage in each section of land requiring an agreement. The current status of the schemes had not at this stage been further evaluated.

Rather than pushing for a defined capacity of storage linked to particular landowners a catchment of landowners are encouraged or pulled into the scheme through building awareness and trust. It was reported that not all landowners participated in this project. Of 200 holdings invited to local Landowner Day events (supported by the National Farmers Union and the Country Land and Business Association) there was a 10% attendance. Based on past experience of such events this was considered by the Trust respondents as a good level of interest. Over the three project years around eight schemes were delivered the majority of which suggested by the landowners themselves early in the project. The local media was used but word of mouth and landowners who championed the project helped. A guided walk around a scheme already in operation was found to be popular with prospective participants. Time could be taken to discuss the benefits of participating.

Due to resource restrictions the strategy for this project was to work with those landowners who were interested to get involved. The project officer needed the hydrological modelling, negotiation and construction skills to design and help the landowner realise their plans. Also the total flood storage capacity is dependent upon landowner participation and the level of mitigation strategies employed. The 'right catchment' was reported to be required where conventional flood storage costs are too expensive but a range of solutions could be employed to generate sufficient capacity to have an impact. It was also suggested that getting landowners engaged was sometimes more important than their individual storage contribution because their involvement could generate further landowner interest. Although financially less demanding the approach requires time, particular skills and is less predictable in storage capacity outcome or sustainability.

5. DISCUSSION

A characteristic of UK flood risk management is to gain additional benefits from flood mitigation schemes so that they are more economically acceptable. During recent UK droughts of 2012/13 it was reported that the use of large flood storage as possible irrigation for future drought conditions was investigated. However, both institutional arrangements in terms of water charges which are based on the value of water company assets and also landowners not wanting increased disruption to their activities prevented further development of the idea. Conversely fresh water supply reservoirs (as opposed to flood storage reservoirs) were also considered as possible flood storage by drawing water from the reservoir in flooding months increasing capacity for flood water. But it was reported that this introduced uncertainty for the water companies about replenishment for the normal water supply in summer.

Landowners generally attempt to leverage use of the land. Whilst it was evident that land use change was a key ecological concern for the RSPB agenda there was little reported for the flowage easement and diffuse approaches. A key reason given is that farms in England and Wales are now usually arable or grazing and not mixed use so it was thought to change use would require a quite radical change in the landowners practice. The land was usually wet or flooded to start with anyway and so current practices were in tune with the new storage context. However, it was reported during dry spells landowners tended to take risks with their cropping. For example moving to winter wheat and switching to spring rape if they are flooded. Generally it was found that flood storage area land use is for cattle grazing and the farmers move stock when necessary. The Environment Agency inform farmers when they are going to impound their land based on their flood forecasting models. Even so it was commented 'but they are farmers and very well connected with the weather so they move their cattle anyway'.

When asked about Payment for Ecosystem Services, and if familiar with the approach, respondents did not feel it was particularly relevant to flood storage. Improved drinking water quality, lack of pollution and better biodiversity were not really associated with or the primary aim of this approach. Add to this, for rural flood storage, the physical and psychological dislocation of beneficiaries and the storage scheme. It must be noted though that this research has not sampled landowners and this knowledge is based on the observations of the project managers and organisations driving the approach. Additional insights might be gained from interviewing landowners as well. However, with a lack of contested schemes and successful completion of schemes it is felt the research findings presented provide a clear reflection of the management of the processes and associated issues.

In England and Wales flood storage is well established and continues to be used as one of a number of flood risk management approaches. The key driver for landowner involvement is financial. A single payment of partial land purchase with flowage easement is the dominant funding mechanism where flood mitigation is the key concern. Where greater control of land use is required for environmental and conservation purposes then full land purchase is necessary. Alternative diffuse storage approaches have been explored in England revealing their limitation in the predictability of the final storage capacity in the catchment and their long term sustainability in terms of maintenance reliant on continued contributions from Agricultural Schemes was questioned. In an European context the governance context of England and Wales favours the land purchase and flowage easement approaches. In countries where free market land pricing, clear legal ownership is not present and enforced, a culture of land ownership and the necessary hydrological forecasting and construction skills are not present then this approach might be questionable.

6. REFERENCES

Environment Agency 2012: *Principles for implementing flood and coastal resilience funding partnerships*. Environment Agency, Bristol, UK.

Jones, M. 2010: *Farming Floodplains for the Future*. Report by the Staffordshire Wildlife Trust, UK.

Hall, J.M., Hockin, D.L., Ellis, J.B. 1993. *Design of flood storage reservoirs*. CIRIA

Penning-Rowsell, E., Priest, S., Parker, D., Morris, J., Tunstall, S., Viavattene, C., Chatterton, J., and Owen, D. 2013: *Flood and Coastal Risk Management: A Manual for Economic Appraisal*, Routledge, Oxon.

Royal Institute of Chartered Surveyors (RICS) 2012: In DairyCo/Market Information/ Farm expenses/ land prices – RICS 19th February 2013.

Strain, J.A. 1981: "Appraisal of flowage easements – another look." *Appraisal Journal*, 49:4, 580.