

## **Olivia Nelson, Advocacy Officer, Floodplains Meadow Partnership – Written Evidence (LUE0043)**

### **About The Floodplains Meadow Partnership**

The Floodplains Meadow Partnership is unique in bringing together scientists and practitioners, developing understanding based on sound science of how to manage, restore and create floodplain meadows<sup>1</sup> and the multiple benefits they provide. The partnership is led by The Open University and supported by Natural England and the Environment Agency, the Centre for Ecology and Hydrology and NGOs including the RSPB, The Wildlife Trusts, the Field Studies Council, the National Trust and People Need Nature. <https://www.floodplainmeadows.org.uk/>

### **Introduction and key points**

- 1. We welcome the appointment of the new Land Use Committee and this review which sets out to understand how to reconcile competing, and often conflicting, demands on our land in England allowing for a resilient ecologically rich landscape where all might thrive in the face of the joint biodiversity and climate change crisis.**
- 2. We support the notion of multifunctional land use strategies as a mechanism to help drive decisions to make most effective realistic use of land**
- 3. As a society, we need to restore the capacity of our landscapes by using effective interventions that will yield multiple benefits during these times of reduced resources. It is therefore vital that we take a natural capital, ecosystems approach to planning and decision-making at a catchment scale.**
- 4. In the below response to the Committee's call for evidence we will focus in particular on the unique capacity floodplain land retains to deliver the many eco services we require - but only if we allow land use of floodplains to include a substantial level of functional species - rich habitats.**

### ***The importance of functioning floodplains***

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<sup>1</sup> Floodplain meadows are a beautiful agricultural system that has evolved over many hundreds of years through an annual hay cut followed by aftermath grazing. The result of such management has been the development of communities of grasses and herbs that thrive with the flood and drought cycles on floodplains – enabling them to work with nature, rather than against it. Floodplain meadows hold one of the UK's most diverse plant communities, with up to 40 plant species per square metre.

- 5. Floodplains are deeply vulnerable to climate change, and this is already having a devastating impact on the communities, agricultural industry and biodiversity which depend on them.**
- 6. Another key driver of land use change which must be planned will be the impact of competing demands of carbon offsetting/ nutrient neutrality/flood protection versus food production.**
- 7. There are serious challenges facing floodplains from current land use practices which are harming the environment and jeopardising the long-term viability of floodplain land uses in the process**
- 8. Floodplains only cover 5% of the land area in England, yet their contribution to our natural capital value is many times higher than that. They produce more food, store more water, support more biodiversity, store more carbon and have greater aesthetic, social and cultural value than the average piece of land. They are well mapped and should be regarded as a distinct land type with respect to laws pertaining to planning, agriculture, biodiversity and the wider environment, but in too many cases they are treated the same as land in general. As a result, they are widely under-valued and mis-managed.**
- 9. Similarly, the contribution to eco services by species rich grassland, such as floodplain meadows, is also undermined by a gap in the understanding and recognition of this habitat within land use management decision making, policies, strategies and funding.**
- 10. Given the policy changes underway as a result of the UK leaving the EU and the UK Government's commitments to environmental improvements, this is a timely opportunity to restore a diversity of floodplain habitats that are both agriculturally productive and rich in wildlife.**

### ***Our recommendations***

- 11. The Committee has a good opportunity to highlight the importance of floodplains and to ensure they are treated as a distinct entity in all land-related policies, such that their value is sustained and used for the good of all.**
- 12. The Committee to stress the need for floodplains to be futureproofed by a substantial increase of functioning floodplain habitats with a modest investment.**
- 13. The Committee also have an opportunity to champion the role of grasslands as nature-based solutions that are just as important as trees and peat.**

- 14. Working effectively together, and through strategic plans such as Local Nature Recovery Strategies (LNRS), it is vital to ensure the right habitats are restored or created in the best places on floodplains. Achieving the optimum balance will require careful planning to avoid conflicts between, for example, food production, government tree-planting targets and the drive to establish more riparian woodland.**
- 15. Climate change mitigation should not be pursued at the cost of biodiversity, food security or climate resilience. Instead, an integrated approach to these issues needs to be seen as interconnected.**
- 16. Carbon offsetting measures (such as afforestation or bioenergy) need to be balanced with biodiversity targets and consider the carbon potential of well-managed soils, species-diverse grasslands and agroforestry.**
- 17. As part of the recommendations for how England plans for land use change there should be a consideration for an overall Floodplain Strategy allowing for an alignment of different policies and financing, so enabling floodplains to deliver significantly greater public goods. There is currently a gap in this respect, and the Open University / Floodplain Meadow Partnership can offer DEFRA and others assistance in drafting guidance. The Floodplain Strategy should include the following measures:**
  - i. As at least 42% of floodplains are no longer connected to the river system, there is clearly substantial potential for restoring/creating floodplain storage in the middle and lower catchments of rivers. There should be greater investment into Natural Flood Management measures and reconnecting rivers with floodplains through appropriate policies and funding schemes as the River Basin Management Plan, Catchment Management Plans etc;**
  - ii. Floodplains should be included as a specific land-category within the Environmental Land Management Scheme where land-use change (e.g., from arable cultivation to permanent grassland) is often needed to maximise environmental benefits and public goods;**
  - iii. Greater recognition of the role and value of species-rich floodplain meadows and an approach which prioritises their restoration in the appropriate catchment river basin;**

- iv. **Introduction of spatial targets for the restoration of functional floodplain habitats. Defra to be tasked to work with organisations including the Environment Agency and Natural England to ensure that the ELM scheme (alongside other relevant strategic plans such as Local Nature Recovery Scheme, Nature Recovery Network and Biodiversity Net Gain) contains our recommended spatial targets:**
- **25% of floodplain area needs to be low input grassland (which equates to almost 200,000 ha) within 25 years – this is based on our knowledge of restoration potential and the scale we believe is necessary for functionality ;**
  - **70,000 ha of this area to be species-rich habitat in Favourable Conservation Status - to deliver high-nature-value floodplains and to export nutrients from riverine systems in sufficient quantity to allow natural processes to recover.**

## **Questions**

### *Pressures and challenges*

**1. What do you see as the most notable current challenges in relation to land use in England? How might these challenges best be tackled? How do you foresee land use in England changing over the long term? How should competing priorities for land use be managed?**

1. Currently, the majority of UK floodplains do not function as they should. As a result, society faces the impacts of increased flood risk, poor water quality, increased GHG emissions, loss of amenity and biodiversity. **Restoration of our floodplains and the range of habitats they can support would yield significant benefits**, helping with mitigation/adaptation to the climate emergency and addressing the biodiversity crisis. Given the policy changes underway as a result of the UK leaving the EU and the UK Government's commitments to environmental improvements, this is a timely opportunity to restore a diversity of floodplain habitats that are both agriculturally productive and rich in wildlife.
2. Extensively altered by river engineering and land drainage, **at least 42% of all flood-plains in England have been separated from their river** (Maltby et al. 2011<sup>2</sup>) and are no longer able to store,

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<sup>2</sup> Maltby E., Ormerod S., Acreman, M., Blackwell, M., Durance, I., Everard, M., Morris, J. & Spray, C. (2011). Freshwater – Openwaters, Wetlands and Floodplains. In: The UK National Ecosystem Assessment Technical

clean and distribute water across the landscape. The impacts are becoming increasingly apparent as climate change bites - with winter rainfall and flooding predicted to increase, and reduced summer rainfall leading to drought. A step change in the way floodplains are managed is urgently needed to help society adapt and become more resilient to climatic extremes. Just 14% of English rivers currently meet the criteria for good ecological status (Bevan 2020<sup>3</sup>), primarily because of physical alterations and diffuse pollution from agriculture.

3. The links between rivers and floodplains are broken, with widespread misunderstanding about flooding and flood management. **Research has shown 90% of UK floodplains are no longer fit for purpose<sup>4</sup>.** It is a notable and serious challenge for land use in the UK as there are increasing risks going forward with flooding, drought and water quality issues, farmers are struggling to use what is seen as productive agriculture land due to the increase in high impact weather events.
4. The way we manage our land and support farmers has a fundamental and often adverse impact on the water environment. For example, intensive agriculture, particularly cultivation of maize and other arable crops, contributes significantly to both flood risk and diffuse pollution by increasing run-off, soil/sediment and fertiliser/pesticide loads in rivers. 40% of rivers are currently affected by diffuse pollution from agricultural sources <sup>5</sup>. It has been estimated that poor soil management costs the UK £1.4bn/year in soil erosion, "siltation" of rivers and increased water treatment costs<sup>6</sup>. **Supporting and targeting water-friendly farming practices on steep erodible soils and within floodplains** would go a long way to reducing chemical-laden run-off and floods whilst enhancing infiltration to replenish aquifers and helping re-build fertile soils that can hold and filter water. Better control is needed over acceptable land uses within the floodplain, for example there should be a presumption against arable and maize cultivation, and a presumption in favour of the restoration of species rich habitats where land use change is critical to protect water and soils.
5. **Floodplains should be included as a specific land-category within the Environmental Land Management Scheme** where

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Report. UK National Ecosystem Assessment, UNEP-WCMC, Cambridge

<sup>3</sup> Bevan, J. (2020). The state of our waters: the facts. Available at [environmentagency.blog.gov.uk/2020/10/02/the-state-of-our-waters-the-facts/](https://environmentagency.blog.gov.uk/2020/10/02/the-state-of-our-waters-the-facts/). Accessed 30 March 2022.

<sup>4</sup> Christiansen, T., Azlak, M., Ivits-Wasse, E. (2020) Floodplains: a natural system to preserve and restore. European Environment Agency report Available at <https://www.eea.europa.eu/publications/floodplains-a-natural-system-to-preserve-and-restore>

<sup>5</sup> HM Government, 25 Year Environment Plan Annual Progress Report: April 2020 to March 2021, October 2021

<sup>6</sup>[https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/1027599/AUK-2020-evidencepack-21oct21.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1027599/AUK-2020-evidencepack-21oct21.pdf)

land-use change (e.g. from arable cultivation to permanent pasture) is often needed to maximise environmental benefits and public goods. Groups of farmers with flood-plain land should be encouraged to take up appropriate Sustainable Farming Initiative measures, Local Nature Recovery options, and long-term land use change through the Landscape Recovery scheme. We would expect to see this measure successfully introduced as a collaborative activity between the Environment Agency, Natural England, Defra, farming group and NGOs.

6. A "Flood Zone 3" Geographic Information System (GIS) layer is already available on Gov.co.uk; it was used to construct the maps within the Wetland Vision for England, which were endorsed by Defra. Using this layer allows catchment-planning mechanisms to identify local targets to reduce flooding through natural flood-management measures, improve water quality and deliver biodiversity.
7. To reinforce the recognition of floodplains as a distinct land type **the role of the Nature Recovery Network (NNR) and Local Nature Recovery Strategies (LNRS) are critical for floodplain landscape recovery**, where the spatial element is decided at local level by mapping priority areas for restoration. This should also reflect the wider environmental benefits that come from restoring natural processes and biodiverse environments. The Local Nature Recovery Strategies should be key to guiding agreements between local stakeholders regarding the aspirations for floodplain restoration. In addition, CaBA groups work on catchment management are another significant strand of decision making within floodplains see <https://catchmentbasedapproach.org/>.
8. **Floodplains of high nature value that support habitats such as species-rich hay meadows are a vital element of UK natural capital.** There is growing recognition of the contribution habitats such as flood-plain meadows can make to both the climate and biodiversity crises, and increasing evidence for the many benefits they provide. A report "*Natural Capital of Floodplains*"<sup>7</sup> published in 2018 concluded that the overall benefits provided by seasonally inundated flood-plain meadows are greater than those provided by land in intensive agriculture. However there has been a substantial loss of species rich habitats, such as floodplain meadows, through past land-use change. **Nearly 70% of flood-plain land is intensively managed (Heritage and Entwistle**

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<sup>7</sup> Lawson, C., Rothero, E., Gowing, D., Nisbet, T., Barsoum N., Broadmeadow, S., Skinner, A., (2018) The natural capital of floodplains: management, protection and restoration to deliver greater benefits. Valuing Nature Natural Capital Synthesis Report VNP09. Valuing Nature programme (NERC) [https://www.floodplainmeadows.org.uk/sites/www.floodplainmeadows.org.uk/files/VNP09-NatCapSynthesisReport-Floodplains-A4-16pp-144dpi\\_0.pdf](https://www.floodplainmeadows.org.uk/sites/www.floodplainmeadows.org.uk/files/VNP09-NatCapSynthesisReport-Floodplains-A4-16pp-144dpi_0.pdf)

**2017<sup>8</sup>) whereas semi-natural habitats such as flower-rich meadows and wet woodland occupy a mere 11%.** For example once the dominant land-use on floodplains, species-rich meadows are now small and fragmented, so they are no longer able to provide all those benefits they are capable of delivering (see Appendix 1 for outline of the benefits floodplain meadows can deliver). **The loss of these protective flood-plain habitats makes the Government's 25-year Environment Plan target for 75% of waters to be close to their natural state extremely difficult to achieve.**

9. An increasing number of projects show how restoration can have many benefits, often at relatively low cost by kick-starting natural processes. We need to see our floodplains as a resource, enabling dynamic natural processes, and working closely with landowners and local communities. A shift away from arable crops and improved grasslands in floodplains to species-rich meadows (and other linked habitats such as wet woodland and fen) would provide a much more pragmatic and self-sustaining land use that can trap soil running off sloping land, process the nutrients bound to the soil particles, re-build soil fertility and store carbon as well as slowing, storing and filtering the flow of water from the land. These benefits would be realised much more rapidly than if the land were abandoned (e.g. rewilding) or planted up as woodland.
10. At least 42% of rivers are no longer connected to their floodplain, so there is an enormous untapped potential area where increased floodplain storage could be provided. Species-rich floodplain meadows are an extremely cost-effective "no regrets" high nature value farming system that provides multiple benefits, maintaining agricultural productivity whilst helping to meet the ambitions of the 25 Year Environment Plan using Lawton principles (more, bigger, better condition and joined). **The partnership sees the restoration/creation of species-rich grasslands as a stepping stone towards achieving more dynamic natural systems.** All remaining examples are valuable, but need to be bigger, in better condition and more joined to provide all their potential benefits. Natural England are working (with partners) to develop a new Priority Habitat description 'Floodplain Wetland Mosaic'; this encompasses species-rich meadows and is aimed at recognising the value of natural function and high biodiversity in floodplains. Again, plans for floodplains will need to include how this freshwater Priority Habitat will be managed and restored.

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<sup>8</sup> Heritage, G. and Entwistle, N.S. (2017). The impact of floodplain degradation on flooding in the UK. E- Proceedings of the 37th IAHR World Congress, 13–18 August 2017, Kuala Lumpur, Malaysia.

- 11.** The restoration of species-rich floodplain grasslands and implementation of natural flood management measures can and should be funded from several sources, including the water industry (where land management changes bring about water quality improvements, reducing treatment costs and potentially helping aquifer recharge), Environment Agency flood risk management budgets, Environmental Land Management Strategy (to support the long term land use and management changes required) and, where appropriate, developer-funded biodiversity Net Gain. Working effectively together, and through strategic plans such as Local Nature Recovery Strategies (LNRS), is vital to ensure the right habitats are restored or created in the best places. **Achieving the optimum balance will require careful planning to avoid conflicts between, for example, food production, government tree planting targets and the drive to establish more riparian woodland.**
12. A role the Committee could play would **be to advocate the requirement for an overall Floodplain Strategy within the wider Land Use Strategy allowing for an alignment of different policies and financing so enabling floodplains to deliver significantly greater public goods.** There is currently a gap in this respect, and the Open University / Floodplain Meadow Partnership can offer DEFRA and others such as the Environment Agency assistance in drafting guidance. As part of this strategy, **we propose a number of specific spatial targets for the restoration of functional floodplain habitats** and suggest the Committee call on Defra to be tasked to work with organisations including the Environment Agency and Natural England to ensure that the ELM scheme (alongside other relevant strategic plans such as Local Nature Recovery Scheme, Nature Recovery Network and Biodiversity Net Gain) contains spatial targets:
- **25% of floodplain area needs to be low input grassland (which equates to almost 200,000 ha) within 25 years** – this is based on our knowledge of restoration potential and the scale we believe is necessary for functionality
  - **70,000 ha of this area to be species-rich habitat in Favourable Conservation Status** - to deliver high-nature-value floodplains and to export nutrients from riverine systems in sufficient quantity to allow natural processes to recover.
13. Alongside the issues of floodplains we also highlight to the Committee that another key land use which has not been sufficiently recognised is the role of grassland. There is a lack of recognition of the role grasslands can play in enabling floodplains to

be resilient and responsive to climate change – see Appendix A for an outline of the benefits which floodplain meadows can provide.

14. The contribution which species rich grassland can play floodplain meadows have been on the whole unacknowledged compared to that of woodland or peatland but we are now beginning to see a growing recognition of the value of this habitat within the complex and vulnerable floodplains – for example in the report Environmental Audit Committee report “ Biodiversity in the UK: bloom or bust? <https://committees.parliament.uk/committee/62/environmental-audit-committee/news/156218/toothless-government-policy-and-targets-insufficient-to-stem-the-tide-of-uk-biodiversity-loss/> **one of the recommendations from the EAC regarding climate change are “Tree planting should not occur on peat soils and floodplains would be better used for restoring floodplain meadows rather than afforestation projects.”**
15. The natural capital of floodplain meadows in response to climate change adaptation is also acknowledged within a recently published report by the Nature Based Solutions Initiative who were commissioned by the RSPB and WWF on a report looking into NBS and adaptation measures. <sup>9</sup>

## **2. What are the key drivers of land use change which need to be planned for, and how should they be planned for? What is the role of multifunctional land use strategies in implementing these plans?**

16. Another key driver of land use change which must be planned will be the impact of competing demands of carbon offsetting/nutrient neutrality/flood protection versus food production. **We do not believe that Government policy has fully realised the role which regenerative agriculture / agroecological farming methods can play in terms of realising this Country’s targets for net zero.** The land sharing / land sparing debate is ongoing and not necessarily useful as a cornerstone concept for the way land use management decisions and priorities are developed. See: <https://www.open.ac.uk/research/news/ou-experts-ask-why-arent-we-exploiting-sustainable-agricultures-emission-reducing-potential> and <https://sustainablefoodtrust.org/wp-content/uploads/2013/04/Briefing-UK-NDC-Farming-Land-Use.pdf>
17. Floodplain land is increasingly seen as unproductive land due to the increase in high impact weather events leading to **the risk of tree planting schemes for carbon offsetting that may not**

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<sup>9</sup> <https://www.rspb.org.uk/globalassets/downloads/policy-briefings/nature-based-solutions-adaption-report.pdf>

**necessarily be the most efficient use of floodplain land.** This misses the opportunity for a regenerative agriculture approach on floodplain which utilises land in a manner allowing for productive sustainable land.

18. We recommend that:
  - Climate change mitigation should not be pursued at the cost of biodiversity, food security or climate resilience. Instead, an integrated approach to these issues needs to be seen as interconnected.
  - Carbon offsetting measures (such as afforestation or bioenergy) need to be balanced with biodiversity targets and consider the carbon potential of well-managed soils, species-diverse grasslands and agroforestry.
19. **We support the notion of multifunctional land use strategies as a mechanism** to help drive decisions to make most effective realistic use of land. Nature-based solutions provide multiple benefits in both rural and urban landscapes, but their success requires a strategy that targets delivery, captures multi-sectoral involvement (environmental NGOs, water industry, Local Authorities etc), pools resources and expertise and draws upon a diverse range of funding sources. Without this, we will not achieve step change, at scale.
20. As a society, we need to restore the capacity of our landscapes by using effective interventions that will yield multiple benefits during these times of reduced resources. **It is therefore vital that we take a natural capital, ecosystems approach to planning and decision-making at a catchment scale.** Working in this way would enable us to tackle the triple crises of climate change, biodiversity loss and public health simultaneously. Targeted monitoring is also essential to ensure no further deterioration, given the gulf between our aspirations for the freshwater environment and the current situation.
21. The restoration of natural processes and deployment of nature-based interventions are a vital part of making our landscapes more resilient to these extremes in a cost-effective manner. The redeployment of existing resources (for example investments in agricultural support, flood risk management and Water Company plans) would go a long way towards encouraging such an approach. Plans and actions need to be backed up by expert and co-ordinated advice to ensure the right measures are used at the optimum scales in the best locations.
22. For example it is clear that hard flood defences are never going to be sufficient on their own, and that we need more natural flood management measures (NFM) that can slow, store and filter

the flow of water from the land. There is an increasing body of evidence demonstrating the effectiveness of such measures. Currently, the Environment Agency spends a mere 1% of its annual £1bn flood defence budget on NFM. As at least 42% of floodplains are no longer connected to the river system, there is clearly substantial potential for restoring/creating floodplain storage in the middle and lower catchments of rivers, with significant co-benefits including nature recovery, carbon sequestration, water quality enhancements, aquifer recharge and support for summer low flows.

**5. What impact are the forthcoming environmental land management schemes likely to have on agriculture, biodiversity and wellbeing? What do you see as their merits and disadvantages?**

23. **We are looking towards the Environmental Land Management Scheme to help support farmers to restore at least 25 percent of floodplains into species rich habitats and to reduce damaging farming methods on floodplain land.** Whilst we are seeing increasing enthusiasm and interest from farmers for how they change the way they farm on floodplains there are deep concerns that the ELM scheme will not deliver on its original promises.
24. For example we would like to see the Government publish further details on Local Nature Recovery. It is important that **this detail confirms that Local Nature Recovery funding will not only focus on marginal and less productive farmland, as opportunities for nature-restoration exist also on productive farmland.** This land needs not be taken out of production if management techniques are changed. For example, altered management of floodplains could increase their ability to prevent flooding of communities, whilst allowing for productive use, such as hay making and grazing.

*Nature, landscape and biodiversity*

**6. What do you see as the key threats to nature and biodiversity in England in the short and longer term, and what role should land use policy have in tackling these?**

25. Intensive agriculture means the loss of species rich grassland. We highlight our concern that there is no overall strategy for overcoming this loss in a similar vein to peatland and woodland strategy and targets.

## **Appendix 1**

### **Floodplain Meadows - a multifunctional land use for floodplains**

#### **Carbon storage**

Regular replenishment during floods ensures flood-plain soils are constantly accreting and maintain their fertility, in stark contrast to the widespread compaction and erosion found in most lowland agricultural landscapes. Three to five times more carbon is stored in soils than in vegetation such as trees (Anderson 2021<sup>10</sup>). The deep rooting strategies of meadow plants <sup>11</sup>( enhance the ability of flood-plain soils to sequester and securely store significant quantities of carbon throughout the soil profile.

Organic carbon within the top 10 cm of soil at North Meadow in Wiltshire was recorded as 109 tC·ha<sup>-1</sup> (Lawson et al. 2018<sup>12</sup>), a much higher value than reported for neutral grasslands in Gregg et al. (2021<sup>13</sup>). Recently published research (Yang et al. 2019<sup>14</sup>) showed that higher species richness increases the sequestration rate in grasslands. Carbon sequestration in a newly restored flood-plain meadow occurs more rapidly and over a much larger scale than is likely to be achieved through tree planting (Figure 3) and the land can continue to be farmed, which many landowners would prefer. Newly planted trees can actually liberate carbon through soil disturbance and may not begin to sequester net carbon for 10–30 years (Anderson 2021). These facts are at odds with the current widespread focus on tree planting rather than grassland restoration.

#### **Natural flood management and aquifer recharge**

The increased likelihood of extreme events makes it vital that the ability of flood-plains to slow, store and filter floodwater is restored so they can

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<sup>10</sup> Anderson, P. (2021). Carbon and ecosystems: restoration and creation to capture carbon. Available at <https://cieem.net/wp-content/uploads/2021/05/Carbon-and-habitats-paper-v3.pdf>. Accessed 30 March 2022

<sup>11</sup> <https://www.floodplainmeadows.org.uk/about-meadows/wildlife/shoots-roots>

<sup>12</sup>

<https://www.floodplainmeadows.org.uk/sites/www.floodplainmeadows.org.uk/files/Soil%20Carbon%20stocks%20summary%20130619.pdf>

<sup>13</sup> Gregg, R., Elias, J.L., Alonso, I. et al. (2021). Carbon Storage and Sequestration by Habitat: A Review of the Evidence, 2nd edn. Natural England Research Report NERR094. Natural England, York.

<sup>14</sup> Yang, Y., Tilman, D., Furey, G. and Lehman, C. (2019). Soil carbon sequestration accelerated by restoration of grassland biodiversity. *Nature Communications*, 10: 718.

play a critical role in natural flood management. The enormous potential for river and flood-plain meadow restoration as nature-based solutions to both floods and drought is recognised in the Working with Natural Processes documents (Environment Agency 2021<sup>15</sup>), but rarely utilised. Flood-plain soils tend to be highly permeable, often with underlying deposits of sand and gravel, allowing water to replenish the aquifers below and support low summer river flows, buffering rivers against drought.

Conversely, because seasonally inundated flood-plain soils are very vulnerable to compaction when wet, and to erosion when left bare over winter, arable crops such as maize are particularly damaging in flood-plains.

### **Water quality benefits**

Widespread diffuse pollution from intensive agriculture results in many rivers having artificially high levels of suspended sediment and excess nutrients. Restoring flood-plain meadows, for example by replacing arable crops, can directly reduce inputs of both. Up to 40 t of sediment per hectare were deposited after the 2007 summer floods on 10 UK flood-plain meadow sites across five catchments. The deposition of nutrients on flood-plain meadows across England was also significant, varying from 2 to 270 kg·ha<sup>-1</sup> for potassium and 1–32 kg·ha<sup>-1</sup> of phosphorus (Rothero et al. 2016<sup>16</sup>).

The ability of flood-plain meadows to trap sediments and export nutrients such as phosphorus through the annual hay cut is vitally important to the restoration of good ecological status to rivers. A single hectare of meadow can export 5 kg of elemental phosphorus from a river system every year, highlighting their potential as a nature-based solution to eutrophication (Rothero et al. 2016).

### **Sustainable agriculture**

Restoration of species-rich flood-plain meadows at a landscape scale could help in the drive to achieve net zero, support the green economy and provide jobs by extending a naturally regenerative agricultural system that requires no chemical inputs yet recovers well after floods and remains productive during droughts. The animals that graze such meadows and consume the hay require less imported feed, have better nutrition and therefore produce healthier meat for human consumption (Shellswell 2017<sup>17</sup>).

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<sup>15</sup> Environment Agency (2021). Working with Natural Processes to Reduce Flood Risk. Available at [www.gov.uk/flood-and-coastal-erosion-risk-management-research-reports/working-with-natural-processes-to-reduce-flood-risk](http://www.gov.uk/flood-and-coastal-erosion-risk-management-research-reports/working-with-natural-processes-to-reduce-flood-risk).

<sup>16</sup> Rothero, E., Lake, S. and Gowing, D. (eds) (2016). Floodplain Meadows – Beauty and Utility. A Technical Handbook. Floodplain Meadows Partnership, Milton Keynes.

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<sup>17</sup> Shellswell, C.H. (2017). Is the rye-grass always greener? An evidence review of the nutritional, medicinal and production value of species-rich grassland. Plantlife. Available at [www.magnificentmeadows.org.uk/assets/pdfs/Is\\_the\\_rye-grass\\_always\\_greener\\_An\\_evidence\\_review.pdf](http://www.magnificentmeadows.org.uk/assets/pdfs/Is_the_rye-grass_always_greener_An_evidence_review.pdf). Accessed 30 March 2022.