NR0149: Ecosystem Interactions on the Somerset Levels

Final report
Prepared by LUC
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Executive Summary

This study can be summarised as 'Research to examine and facilitate debate on the interactions between competing land use priorities on the Somerset Levels, developing analytical tools that identify synergies and trade-offs between the natural services that the area provides, contributing to more effective policy interventions and lessons that can be applied to other areas of lowland farmland in the UK'.

The project has sought to gain a better understanding of the interactions between the ecosystem services provided by the Somerset Levels at three different levels:

- **Spatial interactions** – understanding the patterns of land use priorities, focussing particularly on where there are competing priorities between different ecosystem services.

- **Social interactions** – understanding how different groups of people (e.g. landowners and managers, local communities, statutory bodies and non-governmental organisations) are involved in providing and using different services, and the competing and supporting relationships between them.

- **Policy interactions** – understanding how public policy at both national and local levels regulates and supports the delivery of different services, and how, collectively, policy instruments are effective at balancing and optimising the public benefits provided by the services.

During the period of the study, the project area was subjected to two major flood events, the latter (in the winter of 2013/14) unprecedented in recent times. These events presented a major issue for the study methodology. The severity of the short term issues of recovery from flooding made theoretical questions about long term land and water management seem irrelevant. As a result, the nature of this project changed from one that sought to inform decisions and take a direct role in influencing outcomes to one of observation and passive assessment.

**The project area** is defined by the Somerset Levels and Moors National Character Area (NCA), focussing on the southern two thirds of the NCA below Weston-super-Mare, encompassing the lower floodplains of the Rivers Brue, Parrett and Tone. This is a flat landscape of rivers and wetlands, artificially drained, irrigated and modified to allow productive farming. Livestock farming is the economic mainstay, and the primary land use pattern is one of summer grazing with hay or silage production. Settlements tend to be concentrated on the higher ground around the fringes of the area or within the area. The area is subject to a number of statutory designations that seek to protect its natural and heritage assets. These include the Somerset Levels and Moors Special Protection Area (SPA) which recognises the international importance of the flood plain and coastal grazing marsh habitat for overwintering and breeding wading birds.

**Principal benefits and services provided by ecosystems in the area**: Implicit in the concept of ecosystem services (defined as is the "the benefits people obtain from ecosystems"1) is the understanding that single areas of land or natural resource can deliver many different ecosystem services and that management activities that favour some services may constrain or damage the delivery of others. Natural England’s recently prepared National Character Area profiles provide useful evidence of the extent of 19 different ecosystem services in the project area. Five of these services stand out as being particularly significant because of their international importance (biodiversity; and sense of history), their national importance (climate regulation through the storage of organic carbon in soils), their very high local socio-economic importance (flood risk management) and because they provide the dominant land use (food provision).

**Understanding the interactions between ecosystem services**: A range of methodologies have been developed in the UK for mapping ecosystem services to inform decision making. This study has used publically available spatial data which either directly or indirectly represents ecosystem service delivery to map each of the selected services. These maps, and analysis of optimal land and water management requirements, show that there are strong synergies between the three services of

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1 MEA (2005)
biodiversity, a sense of history and soil carbon storage. Broadly speaking, the same forms of management (usually raised water levels and extensive livestock grazing) are compatible with the delivery of all these services.

The interactions between flood risk management and the other services are complex. The maintenance and operation of flood defence structures tends to operate independently of the other services but it is when these are overwhelmed by flooding that interactions become evident. Shallow and short term flooding is broadly compatible with other services but long term and deep storage of flood water causes conflicts, particularly with food production and biodiversity. However, the generally unavoidable nature of severe flood events means that the opportunities to plan for win-win trade-offs where such conflict is minimised, are limited.

**Economic valuation techniques** can play a valuable role in helping stakeholders prioritise the benefits provided by different ecosystem services. Despite the well-recognised methodology for valuing ecosystem services, generating a set of values for the selected services that would give a sound basis for dialogue or decision making in the project area would be very difficult, particularly for the two cultural services of biodiversity and sense of history. However, thinking about how services are valued does produce useful analysis of who gains and losses from their provision and how financial measures could be designed to transfer value from the beneficiaries to the providers.

**Drivers of change**: Looking to the future, each of the selected services has a number of drivers of change acting on them that will, individually or in combination, result in increases and declines in their delivery. The most significant driver of change that will affect land and water management and the condition of all the selected ecosystem services is flooding, which the changing climate is likely to make more frequent and severe. Public policy is likely to maintain high levels of flood protection to economic assets (such as housing, industry and transport routes) and to sites of high biodiversity value.

**Policy responses and local initiatives**: The need to balance trade-offs between different ecosystem services, and seek win-win outcomes, is acknowledged in principle in public policy but there are fewer practical policy mechanisms in the project area available to achieve this. This is particularly the case in undesignated areas of countryside where the reduced budget of the Countryside Stewardship agri-environment scheme means that it is likely to be more tightly focussed (spatially and in its outcomes) on the primary objectives of biodiversity and water quality, compared to its predecessor.

A result of the recent severe flood events has been better local dialogue between stakeholders and the search for consensus and a common vision for future land and water management. The ecosystems approach has played a part in this process since it provides an objective way of establishing and debating the values that the area provides.

Although the focus of most of the work, particularly that using public funding from central and local government, has been on flood defence and flood risk management, the way in which this has been done has meant that the value of the ecosystem services provided by the area is better understood and taken into account. It is significant that much of the additional funding recently acquired by the Somerset Levels Development Fund is being used to enhance these values. Initiatives such as the exploration of an Ecological Enterprise Zone, a pilot Payment for Ecosystem Services scheme and conducting research into the creation of a Community Land Trust represent novel and innovative approaches that take a more integrated and ecosystem service-centred approach than has been taken previously.

**Lessons to and from other areas**: Increasing flood risk is a significant threat to many other low-lying coastal areas of England. There are strong similarities to the Somerset Levels where these areas contain wetland habitats of high environmental value. Expertise gained on the Somerset Levels in water level management to balance flood risk with environmental objectives can be shared with other areas. In the other direction, techniques for mapping ecosystem services and assisting public dialogue that have been developed in other areas might prove useful in the Somerset Levels.

An important overall conclusion from this project is that extreme events such as flooding can provide the catalyst that encourages stakeholders to look objectively at the full range of benefits that natural systems provide, and to develop policies that incentivise these. If the same sense of urgency can be created to bring parties together, the concepts of values, benefits and services provided by the ecosystems approach can provided a common language for productive dialogue and the development of more integrated policies.
1 Introduction

Chapter summary: This introductory chapter describes the objectives and research topics addressed by this project. It briefly reviews the policy context to the study and the concept of ecosystem services before describing the project area, its designations and recent environment projects and its social characteristics. The chapter concludes by describing the methodology of the study and the impacts on the methodology caused by the severe flood events experienced early in the project.

Project objectives

1.1 In 2011 Defra identified a need for projects to examine, in real-world situations, how discrete areas provide the wide range of ecosystem services that are valued by society; how the different natural benefits can be delivered in ways that complement and add value to one another; and how systems of governance and policy delivery can best support these multiple benefits.

1.2 This project was one of those that received funding from Defra to address these issues. In a nutshell, this project can be summarised as:

Research to examine and facilitate debate on the interactions between competing land use priorities on the Somerset Levels, developing analytical tools that identify synergies and trade-offs between the natural services that the area provides, contributing to more effective policy interventions and lessons that can be applied to other areas of lowland farmland in the UK.

1.3 Lowland landscapes in England such as the Somerset Levels are subject to many pressures and demands on the use of land and the benefits, or ecosystem services, that it provides. These include maintaining the livelihoods of the agricultural businesses who own and manage the majority of the land; providing essential services and amenities to the people who live and work in the area’s towns and villages; and recognising the wider public interest that the land and its ‘natural capital’ provide to society as a whole.

1.4 Understanding the interactions between these various demands and benefits is essential if public policy is to balance the rights and responsibilities of different groups involved in managing and using the land. This project seeks to gain a better understanding of these interactions at three different levels:

- **Spatial interactions** – understanding the patterns of land use priorities, focussing particularly on where there are competing priorities between different ecosystem services.

- **Social interactions** – understanding how different groups of people (e.g. landowners and managers, local communities, statutory bodies and non-governmental organisations) are involved in providing and using different services, and the competing and supporting relationships between them.

- **Policy interactions** – understanding how public policy at both national and local levels regulates and supports the delivery of different services, and how, collectively, policy instruments are effective at balancing and optimising the public benefits provided by the services.

1.5 The project has been guided by a number of research questions, summarised below in Box 1.1, which aim to define the current ecosystem interactions; anticipate future changes and plan for positive outcomes; and identify the transferability of results to other areas of England.

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2 Defra Competition details and project specification ERG1109: Ecosystem Interactions, October 2011.
### Box 1.1. Key research questions addressed by this project

<table>
<thead>
<tr>
<th>Defining current interactions</th>
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<tbody>
<tr>
<td>1. Which ecosystem services are currently delivered, to a significant degree, by Somerset Levels?</td>
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<td>2. What are the pathways (natural assets, functions, benefits, values) for each of these services?</td>
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<td>3. What are the trends in delivery for each of the services?</td>
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<td>4. Who are the actors (suppliers, regulators, users, beneficiaries) in each of these pathways?</td>
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<td>5. At what spatial scales do these actors operate (local, regional, national, global)?</td>
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<td>6. How are the benefits provided by these services currently valued?</td>
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<td>7. What are the spatial synergies and trade-offs between services?</td>
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<th>Anticipating future changes and planning positive outcomes</th>
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<td>8. What drivers are responsible for significant ongoing increases and declines in service delivery?</td>
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<td>9. What public policy instruments might be deployed to address these increases and declines? What gaps are there, where key needs to protect or enhance service provision are not being met?</td>
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<td>10. How can public policy take account of synergies and trade-offs between services?</td>
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<td>11. What lessons can be learned about techniques for engaging with and involving key actors and audiences in policy development?</td>
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<th>Identifying the transferability of results</th>
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<td>12. Which other areas of England are likely to be facing similar challenges for ecosystem service delivery, particularly the co-location of compatible and conflicting services, to those found in the Somerset Levels?</td>
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<td>13. What are the data requirements for modeling the spatial extent of ecosystem services followed in this project and how readily is such data likely to be available to other areas?</td>
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<tr>
<td>14. What other examples are there of similar governance and stakeholder representation to those in the Somerset Levels, where the lessons learned about participatory and deliberative techniques for prioritizing ecosystem services in policy in this study could be applied?</td>
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1.6 Unforeseen events in the form of severe and sustained flooding of large parts of the project area during 2012, 2013 and 2014 had a significant impact on the research. As noted further below, the attention of all stakeholders in the area was focussed on the pressing issues of recovery, flood defence and future risk management following the flooding. This lead to a number of changes in the methodology and timescale of this project.
Research context

1.7 The concept of ecosystem services needs no lengthy introduction here. The concept is embedded in Government’s policy towards the natural environment and research at both an international and national scale is demonstrating its relevance to a wide range of topics such as natural resource management, land use planning and public engagement in relation to the environment. Defra has produced guidance on the use of the concept in policy-making and implementation and the a web-based resource, the Ecosystems Knowledge Network, provides information and links to protects and research papers.

1.8 Suffice it to say that ecosystem services are most succinctly defined as “the benefits people obtain from ecosystems”. Collectively, these benefits are fundamental to the health and well-being of all humans and the maintenance and development of society on earth. The way that society values these benefits, whether this is through public policy interventions (decided by government), through the operation of the market (decided by economic entities), or through the stated preferences of individuals, is critical in determining the practical application of the ecosystem services concept. Furthermore, services such as the regulation of the climate have benefits which are broadly spread amongst millions of people whereas other services such as the regulation of flood risk have benefits which are more tightly concentrated in certain communities.

1.9 Implicit in the concept is the understanding that single areas of land or natural resource can deliver many different ecosystem services and that management activities that favour some services may constrain or damage the delivery of others. In an intensely managed and populated country like the UK, it is rare for decisions about land use and management to be predicated on producing a single service. Instead there will inevitably be conflicts and synergies between different services. Land use and management decisions therefore almost always involve weighing up the impacts on several different services which have different values for different groups of people. For public policy to have a role in producing the optimal mix of benefits (for instance balancing small benefits to many with great benefits to few), it is important we understand how the interactions between services play out spatially and socially. This is the challenge addressed by this project, which uses the Somerset Levels and Moors in South West England as its case study area.

The project area

1.10 This project area is defined by the Somerset Levels and Moors National Character Area (NCA), focussing on the southern two thirds of the NCA below Weston-super-Mare, encompassing the lower floodplains of the Rivers Brue, Parrett and Tone (Figure 1.1). This is a flat landscape extending across parts of the north and centre of the county of Somerset, reaching from Weston-super-Mare in the north to Glastonbury in the east and Ilchester and Langport in the south. The western boundary is formed by Bridgwater Bay and the Bristol Channel beyond. The landscape blends almost seamlessly into the Vale of Taunton in the south-west and into the Yeovil scarplands to the south.

1.11 It is a landscape of rivers and wetlands, artificially drained, irrigated and modified to allow productive farming. The coastal Levels were once mostly salt marsh and the meandering rhynes and irregular field patterns follow the former courses of creeks and rivers. They contrast with the open, often treeless, landscape of the inland Moors and their chequer-board-like pattern of rectilinear fields, rhynes (the local name for field ditches), drains and engineered rivers, and roads. Today, the Levels and Moors have many similarities but their histories are quite distinct. The Levels landscape, on the coast, was probably established by the time of the Norman

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1 See for instance the Natural Environment White Paper The Natural Choice: Securing the value of nature, June 2011, which advocates the ecosystems approach and the concept of ‘natural capital’ as a means of focussing on the range of benefits that society gains from nature.
2 For instance The Economics of Ecosystems and Biodiversity (TEEB).
3 http://ec.europa.eu/environment/nature/biodiversity/economics/index_en.htm
4 Pre-eminently the UK National Ecosystems Assessment (2011) and its current Follow-on Phase http://uknea.unep-wcmc.org
5 https://www.gov.uk/ecosystems-services
6 http://ecosystemsknowledge.net
7 MEA (2005)
Conquest while the Moors, further inland, remained an open waste until enclosure and drainage between 1750 and 1850. Water is an ever-present element in the area; water from a catchment area four times the size of the Levels and Moors flows through the area, often above the level of the surrounding land. Much of the area lies below the level of high spring tides in the Bristol Channel.\footnote{Natural England summary of Somerset Levels Natural Area profile \url{http://publications.naturalengland.org.uk/publication/12320274?category=587130}}

1.12 Livestock farming is the economic mainstay, and the primary land use pattern is one of summer grazing with hay or silage production. During the twentieth century, pump drainage of the low lying fields (in which water in the rhynes is pumped into the river channels which are often higher than the water table in the rhynes) allowed cultivation and agricultural improvement leading to cropping for cereals or animal forage crops such as maize.

1.13 Settlements tend to be concentrated on the higher ground around the fringes of the area (such as along the central ridge of the Polden Hills which extends into the NCA) or within the area. The towns of Bridgwater and Burnham on Sea lie on the western coastal edge of the area. Larger villages further inland include Westonzoyland and Meare. Between the villages are a significant number of farmsteads, many below sea level, built since 1750 as the wetlands were drained and converted to farmland.

1.14 The Levels and Moors have been recognised in public policy as a distinctive area with special environmental and cultural characteristics for many decades. It has often attracted national attention because of the significance of its natural assets (for instance the archaeological value of the bronze age artefacts buried in peat soils in the Brue Valley\footnote{Coles J and Orme BJ (1980). Prehistory of the Somerset Levels. The Somerset Levels Project. ISBN-10: 0950712205.} and the nature conservation importance of the flood plain and coastal grazing marsh habitat and the wading birds that overwinter on there). Its communities, renowned for their independent spirit, have sometimes courted controversy such as when farmers publicly burned an effigy of the chair of the Nature Conservancy in 1983 in protest to the designation of Sites of Special Scientific. It has received unwanted national attention (but also Government support) when prolonged flooding has caused severe disruption to local residents and businesses such as in 2013 and 2014.
Designations and recent projects in the study area

1.16 The area is subject to a number of statutory designations that seek to protect its natural and heritage assets. The international importance of the flood plain and coastal grazing marsh habitat for its populations of overwintering and breeding wading birds was formally recognised in 1997 with the designation of the Somerset Levels and Moors Special Protection Area (SPA) under the EU Birds Directive. The SPA covers around 35,000 ha in the floodplains of the Rivers Axe, Brue, Parrett, Tone and their tributaries. These and other areas of the same habitats are also recognised for their wider national nature conservation importance and are designated as Sites of Special Scientific Interest (SSSI). Archaeological and other heritage assets, including the remains of bronze age landscapes preserved in peat soils, are recognised as Scheduled Monuments, of which there are 58 in the project area.

1.17 The Somerset Levels and Moors were amongst the first tranche of areas to be designated as an Environmentally Sensitive Area (ESA) in 1987 (subsequently extended in 1992). The ESA was
established to “protect and, where possible, enhance the wet permanent grassland character of the area, and its special landscape, wildlife and historic interests, by encouraging the maintenance and adoption of extensive pastoral farming systems”. This was delivered through ten year management agreements with farmers involving three tiers of permanent grassland management covering successively higher degrees of conservation activity\textsuperscript{11}. The ESA scheme finished in 2004 and was replaced by the nationally available agri-environment schemes of Environmental Stewardship and now Countryside Stewardship.

1.18 **The Parrett Catchment Project** (PCP) was set up in 2000 following extensive flooding in 1997 and 1999/2000 which attracted Ministerial interest and a determination by local organisations to work together to implement long term solutions to flooding problems. The PCP’s aim was to tackle conflicts between land and water management activities throughout the river’s catchment to resolve these problems. It developed a 50 year vision and Strategy and a 10 year Action Plans to achieve integrated, sustainable land use planning and resource management\textsuperscript{12}. The PCP came to an end in 2005.

The PCP became well-known nationally for its integrated approach to land management across the whole catchment and for its broad partnership structure that sought to engage with all stakeholders (particularly communities affected by flooding, farmers and regulatory bodies such as the internal drainage boards). This attention led to the Parrett Catchment being chosen as the case study area in a Defra funded **Catchment Futures Project** in 2006. This project investigated the value that an ecosystems approach can offers for sustainable natural resource management \textsuperscript{13}. The report found that, despite high levels of community involvement in the PCP, a considerable investment in resources would be needed to transform public understanding and interest in the ecosystems approach. It found that the administrative boundaries that tend to determine the area of public interventions are poorly matched to the natural boundaries of ecosystem services. Neither were the methods used to assess public policy particularly well-suited to producing integrated and ecosystems focussed outcomes. The research produced a number of recommendations for overcoming these boundaries which included better information and mapping of service delivery and more public discourse including in policy appraisal.

1.19 **The Brue Valley Living Landscapes Project** has been led by the Somerset Wildlife Trust to restore, recreate and reconnect wildlife habitats across this valuable area of wetland. It followed on from an earlier **Avalon Marshes Project**. The project was initially funded through the EU Wave project (see below) and is continuing as part of the EU INTERREG ‘value of WOrking Wetlands’ (WOW) project\textsuperscript{14}. The project has a number of strands, one of which has examined the opportunities for landscape scale conservation\textsuperscript{15}. This has mapped potential benefits that could be delivered at a landscape scale from eight themes which are loosely based around ecosystem services. These themes are floral biodiversity; invertebrate biodiversity; avian biodiversity; local economy; heritage features; landscape features; water management; and carbon storage. One of the specific opportunities examined was ‘accessing and enabling payment for ecosystem services’.

1.20 **WAVE – “Water Adaptation is Valuable for Everybody”** was a partnership project supported by EU Interreg IVB NEW funding to prepare for changes to water systems caused by climate change and help make these systems more ‘climate-resilient’. The project sought to identify the local effects of climate change in Somerset, and identified how this can be communicated and how risks could be managed through the sustainable management of excess water\textsuperscript{16}.

1.21 **The Mid Parrett Wet Farmland Project** is part of the RSPB’s Futurescapes project on the Somerset Levels and Moors, working with a range of partners and part funded by the EU Interreg WAVE project (to June 2013) and Interreg WOW project (to March 2015). The project area covers the grazing marsh between Langport downstream to Dunball. The main focus for the


\textsuperscript{14} http://www.valueofworkingwetlands.com

\textsuperscript{15} http://www.somersetwildlife.org/hres/11_04_15_opppdoc_lowres.pdf

\textsuperscript{16} http://www.somersetwave.co.uk
project is to work with the farmers, in particular encouraging them to make best use of Environmental Stewardship agreements.

Social governance and representation

1.22 The project area has a population of some 102,800 residents in 44,000 households, located in 84 parishes. Sixty percent of this population lives in the larger towns of Bridgwater, Burnham-on-Sea and Highbridge, Langport, Street, Glastonbury, Axbridge and Ilchester but the remainder is rurally based in villages such as Burrowbridge, Mark, Meare, Othry and Westonzoyland. The low-lying nature of the land between the towns and villages (which were established on higher ground) means that relatively few people live directly in the flood plain, apart from isolated farms which are often located near the causewayed roads and raised river banks.

1.23 The project area is split between six local Government Districts. The majority (about 60%) lies in Sedgemoor District with the easternmost 30% lying between Mendip and South Somerset Districts. Smaller areas lie in Taunton Deane, North Somerset and West Somerset Districts.

1.24 Concern about the antipathy of local residents and landowners in the area towards the objectives of public bodies, and the failure of these public bodies to engage with local people, led the County Council to produce the Somerset Levels and Moors Strategy and Framework in 1984. This established the Levels and Moors Project, staffed by a project officer and funded by the County Council and Countryside Commission, to administer a Countryside Forum and deliver a programme of work. By 1993 the effectiveness and legitimacy of the Countryside Forum was being questioned and the County Council replaced the Forum with the Levels and Moors Partnership (LAMP) which gave formal representation to 86 parishes and Bridgwater town covering a population of around 160,000 people. LAMP sought “to promote the wise management of the Levels and Moors, and the understanding, enjoyment and celebration of this unique working landscape by local people and visitors”. It aimed to promote the recognition of the Levels and Moors as a distinct ‘Cultural Landscape’ and had a primarily socio-economic focus. Following a funding review in 2005, LAMP was dissolved.

1.25 Despite being the dominant form of land use, agriculture accounts for a small proportion of employment and most people who live in the area work in urban centres such as Bridgwater, Weston-super-Mare, Taunton and Bristol. Analysis of Defra’s agricultural survey suggests that around 2,400 are directly employed in farming (about 700 as full-time farmers, 1,000 as part-time farmers and the remainder as salaried workers). Purchases of land by environmental charities to conserve its nature conservation value have meant that organisations such as the RSPB and Somerset Wildlife Trust have become significant landowners in some areas.

1.26 Responsibility for maintaining the flood defence structures and controlling water levels is split between the Environment Agency (for the main rivers and waterways) and Internal Drainage Boards (IDBs). As a result of their statutory funding structure (with landowners required to pay an annual levy to the IDB) and their role in regulating water levels, the Drainage Boards are important social institutions in the rural parts of the project area. The Boards have rationalised their structures in the last 15 years and now operate as the Somerset Drainage Boards Consortium, incorporating the Axe Brue IDB and the Parrett IDB.

1.27 In the last year, largely as a response to the flood events at the start of 2014, the organisations responsible for maintaining flood defence structures in the area have agreed to form a new advisory body, the Somerset Rivers Authority. This was launched at the start of 2015 and will seek to unifying the efforts of the drainage boards, the Environment Agency, councils and communities so that they are better prepared to deal with flood events.

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17 Source: The 2011 population census based on parish data with parishes crossing the project boundary split on an area pro-rate basis.
19 These figures are based on analysis of the 2004 agricultural survey which is the most recent to provide sufficiently fine-grained spatial data (at Middle Level Super Output Areas) to fit with the project area. The figures have been reduced in line with national trends to produce current estimates.
As noted above (para. 1.18), the Parrett Catchment Project, which operated between 2000 and 2005 had a broad-based partnership structure, involving 27 organisations and a steering group of ten key organisations.

Although, as noted above, farming accounts for a relatively small proportion of employment, its importance in land use and the landscape is recognised in the high profile of farming and landowning organisations such as the National Farmers’ Union (NFU) and the Country Land and Business Association (CLA). Both organisations were influential, supported by the local authorities, IDB, RSPB and Wildlife Trust, in the establishment in the establishment of the Somerset Levels and Moors Task Force in 2013 following the flooding in that year. As will be described in Chapter 3 of this report, this group has led debate amongst a wide range of stakeholders in a long term vision for the future of land and water management in the area.

A large number of charitable organisations have been active in the area. These include the Royal Society for the Protection of Birds (RSPB) with its reserves at West Sedgemoor, Ham Wall and Greylake (all flood plains grassland sites), and the Somerset Wildlife Trust, with its reserves at Catcott, Westhay Heath and Moor and Sharpham Moor (wetland sites previously worked for peat extraction). As well as managing their own land, and being involved in the IDB’s covering this, both organisations have campaigned for land and water management policies that benefit wildlife.

Another charitable organisation that has taken a significant role in campaigning on behalf of rural communities and businesses in the area is the Royal Bath and West of England Society (the body that organises the annual Bath and West Show). This has raised money to assist people affected by flooding and has commissioned studies on the causes and effects of the flooding on local people.

Methodology

The project was split into four phases, as follows.

A. Project scoping and planning

To prepare a scoping report and project plan, including a set of detailed research questions, taking account of existing knowledge and the range of stakeholders and audiences to be involved in the study, and establishing a core group of stakeholders who will act as a local steering group and sounding board.

B. Data gathering and modelling of spatial interactions

To gather existing evidence describing current and potential ecosystem service delivery (based on an understanding of the functional pathways from environmental assets to benefits realisation), covering the spatial extent of service pathways and interactions, and comparative valuation of benefits, and also the recent trends and expected trajectories of service delivery to 2030. To analyse these data and to prepare modelling outputs showing current spatial patterns, synergies and trade-offs between the selected ecosystem services.

C. Testing and refinement of modelling outputs through stakeholder involvement

To work with key stakeholders (as producers, regulators and users of services), to test and refine the functional pathways and spatial models, identifying thematic and spatial priorities for policy interventions to maintain and enhance service delivery that take account of synergies and trade-offs between services and anticipated drivers of change. To match these priorities to current and planned policy measures, identifying gaps in interventions.

D. Reporting

To report on project outputs as the project progresses and to prepare draft and then final project reports describing the process followed, the lessons learned and assessing the transferability of these to other landscapes in England and further afield.
The impact of flood events on the project

1.37 Since the start of the project in February 2012, the Levels and Moors have been subject to a series of exceptional flood events. Between April 2012 and March 2014 the Somerset Levels and Moors were flooded three times. The summer 2012 flooding affected property and infrastructure and was particularly damaging for agriculture (summer flooding causing more damage to growing crops).

1.38 However, it was the December 2013 to March 2014 flood which was particularly devastating, with around 175 homes flooded. Records of flooding in the area go back as far as the 1600s and this event was the most extensive yet recorded with more than 65 million cubic metres of floodwater covering an area of 12,200 ha (See Figure 1.2). The villages of Moorland, Chadmead and Fordgate (in the Northmoor area) were evacuated, while Muchelney and Thorney were variously flooded and isolated for months, accessible only by boat.20

1.39 With the water taking up to 12 weeks to recede, there was significant impact on transport (road and rail closures), business and tourism. The A361 was closed for almost three months and the mainline railway from Taunton to Bristol was closed at Fordgate for three weeks. Farming was also severely affected, with thousands of hectares of land underwater for many months. Around six farms and a number of small holdings, including animals, were evacuated from the Moorland and Fordgate area.21

1.40 A study of the economic impacts caused by the 2013/14 flooding, commissioned by Somerset County Council, put the total cost of the impacts at £118.4m (central estimate), with £74.6m of this being incurred in direct impacts, £8.8m in indirect impacts and £35.0m in qualitatively assessed impacts. Direct impacts included a £16.8m costs to local government and the emergency services, £16m to residential property owners or their insurance companies, £12m to businesses and individuals as a result of highway and other travel disruption (plus £17m for rail repairs) and £5.5m losses to farmers.22

1.41 These events presented a major issue for the study methodology. The aim had been to undertake a process of dialogue with farmers and landowners, local communities and agencies over alternative outcomes from the land. It quickly became clear in April 2012, and again in the winter of 2013/14 that no progress could be made with discussions about different land use priorities when the focus of all local stakeholders was, for understandable reasons, on addressing the immediate impact of flooding on livelihoods and properties. The severity of the short term issues made the kind of theoretical long term issues raised by the project seem irrelevant.

1.42 As a result, it was agreed that there would be a change of focus in the project from direct engagement with stakeholders to one of desk-review and data analysis. The nature of this project has therefore changed from one that sought to inform decisions and take a direct role in influencing outcomes to one of observation and passive assessment.

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22 Parsons Brinckoff (2015)
The structure of this report

1.43 This report closely follows the sequence of research questions addressed by this project (Box 1.1) and is split into four further Chapters, as follows:

- **Chapter 2** identifies the ecosystem services, and the pathways delivering them, that are active in the project area and defines the interactions between them, including the spatial trade-offs and synergies.

- **Chapter 3** examines the tools and evidence that is available for more co-ordinated and effective planning of ecosystem service delivery. It assesses the use of economic valuation to better understand the relationship between services and it examines the social and human dimension of who is involved in delivering, regulating and consuming the selected services in the project area.

- **Chapter 4** looks to the future, examining the drivers of change acting on land use and the services provided by the area and it reviews the role of policy mechanisms and partnership working on the interactions between services and the achievement of positive outcomes.

- **Chapter 5** draws lessons from the findings of the study including opportunities for achieving co-ordinated planning of ecosystem services in areas of England facing similar issues.

1.44 At regular points in the report, conclusions are drawn on the key findings of analysis. These conclusions are shaded in grey to draw the reader’s attention to them.
2 Defining current ecosystem interactions

**Chapter summary**: This chapter reviews the evidence for the key ecosystem services that are covered in detail in this report and it examines the natural assets and pathways involved in the delivery of these services and their benefits. It draws on existing spatial data to map the parts of the project area where each of the services are most significant and it reviews the synergies and conflicts between the services, based on the forms of land use and management needed to deliver them. The last section of the chapter describes the vision, put forward by local stakeholders, for future management objectives of the area and reflects on the relationships between future ecosystem service delivery.

The ecosystem services delivered by the Somerset Levels

2.1 Natural England’s National Character Area (NCA) profile for the Somerset Levels and Moors (NCA 142) includes an analysis of the ecosystem services provided by the area. This covers 19 services (See Figure 2.1) and provides a summary of the assets that are contributing to the service, the current state of service delivery, and opportunities for securing or enhancing service provision.

Table 2.1. The framework of ecosystem services from the Natural Character Area profiles, used as the basis for analysis in this study

<table>
<thead>
<tr>
<th>Provisioning services</th>
<th>Regulating services</th>
<th>Cultural services</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Food provision</td>
<td>• Climate regulation</td>
<td>• Sense of place / inspiration</td>
</tr>
<tr>
<td>• Timber provision</td>
<td>• Water quality regulation</td>
<td>• Sense of history</td>
</tr>
<tr>
<td>• Water availability</td>
<td>• Water flow regulation</td>
<td>• Tranquility</td>
</tr>
<tr>
<td>• Genetic diversity</td>
<td>• Soil quality regulation</td>
<td>• Recreation</td>
</tr>
<tr>
<td>• Biomass energy provision</td>
<td>• Pollination</td>
<td>• Biodiversity</td>
</tr>
<tr>
<td></td>
<td>• Pest regulation</td>
<td>• Geodiversity</td>
</tr>
<tr>
<td></td>
<td>• Coastal erosion regulation</td>
<td></td>
</tr>
</tbody>
</table>

2.2 The NCA profile for the Somerset Levels and Moors also identifies the scale at which each of the services provides benefits (ranging from international to local). The area is judged to provide benefits at the international scale for two services, both cultural services (Biodiversity and Sense of History) and at the national scale for a further eight services, most of them regulating services, (Climate regulation, regulating water flow, regulating water quality, regulating soil quality, regulating coastal erosion, sense of place/inspiration, recreation and geodiversity). Table 2.2 shows the scale of benefits attributed to all of the services as recorded in the NCA profile.

Table 2.2. The scale of benefits derived from ecosystem services in the project area

<table>
<thead>
<tr>
<th>The scale of delivery</th>
<th>The selected services delivered at this scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Services providing benefits at an international scale</td>
<td>• Biodiversity</td>
</tr>
<tr>
<td>Services providing benefits at an national scale</td>
<td>• Climate regulation</td>
</tr>
<tr>
<td></td>
<td>• Water flow regulation</td>
</tr>
<tr>
<td></td>
<td>• Water quality regulation</td>
</tr>
</tbody>
</table>
Selecting the key services for analysis in this study

2.3 Decisions over land use and management, which this study is primarily concerned about, are influenced to varying degrees by most, if not all, of the ecosystem services listed above. A more focussed approach is required, however, in order to examine the interactions between the services that are considered most influential in determining land use decision or to provide most value to society. On this basis, the following services were selected for analysis in the project area:

• **Biodiversity** – on the basis of the international importance of the designated Special Protection Area sites.

• **Climate regulation** – on the basis of the national importance of store of organic carbon locked up in the peat soils. In the remainder of this report, this service is referred to as ‘Storage of soil carbon’.

• **Regulating water flows** – on the basis of the national/regional importance of the flood plain and the very high local socio-economic impact of flood events. In the remainder of this report, this service is referred to as ‘Flood risk management’.

• **Sense of history** – on the basis of the international importance of the prehistoric archaeology preserved in the soils

• **Food provision** – on the basis that livestock farming (for beef, lamb and dairy products) is the dominant land use

**Biodiversity**

2.4 The Somerset Levels and Moors NCA contains 8,385 ha of Sites of Special Scientific Interest (SSSI) over 36 sites, 6,777 ha of Special Protection Area (SPA) and Ramsar, and 651 ha Special Area for Conservation (SAC). Six National Nature Reserves (NNRs) cover 1,437 ha of the area. Thirteen per cent of the area is designated as SSSI over 36 sites. In 2011, 92 per cent of SSSI land was in favourable or unfavourable but recovering condition.

2.5 Over 43,000 ha, two-thirds of the NCA, is classified as flood plain and coastal grazing marsh priority habitat and there are 1,790 ha of fen. The large areas of widely undisturbed wetland habitat support large numbers of over-wintering and breeding waders, wetland and farmland birds. This is complimented by the close proximity to the fertile waters and mud flats of Bridgwater Bay and the Bristol Channel.

2.6 Common species of bird, invertebrate and mammals can be found in large numbers, for example starling and dragonflies, alongside rare and scare species; bittern, great white egret, silver diving beetle and greater water parsnip.

2.7 Optimum land use to deliver the service involves maintenance of high water tables, particularly in winter and early summer, extensive grazing with cattle and/or sheep and no agricultural inputs of fertilizer or pesticides.

**Storage of soil carbon**

2.8 There are significant areas of peat soils on the Levels and Moors which have supported extensive extraction industries to supply peat to horticulture. The central and western area has soils with a
carbon content of up to 10 per cent while in the north-east soil carbon content is up to 20 per cent and areas in the south-east have a soil carbon content of between 20 and 50 per cent.

2.9 In addition, there are relatively high levels of organic carbon contained in the mud flats and estuarine silts fringing Bridgwater Bay.

2.10 Optimum land use to deliver the service on the peat soils involves maintaining high water tables so that the organic carbon is kept hydrated and does not oxidise. In lowland raised mire habitats where conditions such as pH are suitable, sphagnum moss and other wetland plants can support the formation of new peat deposits, enhancing this service.

**Flood risk management**

2.11 There is considerable and extensive flood risk across most of the Somerset Levels and Moors. Much of the history of the area is intrinsically linked to flooding and the management of water levels. The area, once part of the Severn estuary, is now the largest area of lowland wet grassland and flood plain remaining in England. The area forms the flood plain of eight major rivers or drains. The river catchment systems of the surrounding NCAs influence water flows within the area; the catchment outside of the NCA is four times the size of the NCA. Rivers drain from the Mendips, Quantocks and Blackdown Hills through low lying levels, coastal plains and moors to the Severn estuary.

2.12 Gradients to drain water within the NCA are very limited and the ground level is lower than the high spring tides in the Severn estuary (see also ‘regulating coastal erosion’). Management of flooding is often dependent on pumped drainage.

2.13 Floodwater storage across the area during periods of high or prolonged rainfall is a natural process and an essential part of; the flood defence system to prevent the flooding of urban areas, and; the maintenance of raised water levels necessary to support nature conservation interests. Uncontrolled flooding causes damage to property and agricultural interests.

2.14 The use of productive agricultural land to store flood water, whether deliberately (as occurs when sluices are opened and pumping stopped) or inadvertently (as occurs when flood defences are overtopped or when rivers are full and can not take more water pumped from land) undoubtedly provides a valuable ecosystem service, reducing the risk of flooding to towns such as Bridgwater and Taunton. However, prolonged deep flooding, especially in the summer, also involves a significant ‘ecosystem cost’ harming biodiversity, reducing food production and the livelihood of the farmers affected. Extreme flood events, such as that which occurred in February 2014 bring wider economic and social disruption to households whose properties are flooded and to transport infrastructure.

2.15 Defining the forms of land use and management that are optimal in delivering this service is somewhat problematic, particularly because of the unpredictable timing and severity of flood events. Activities such as the regular dredging of river channels, the maintenance of flood defence structures and pumping equipment and the deliberate raising of water levels to store flood water might be sufficient to cope with ‘regular’ flood events (although they come with a cost for other services). However these measures are completely overwhelmed by ‘irregular’ and more severe events when the designed capacity of the river channels and flood storage areas is inadequate to deal with the volumes of water involved. Predicting the frequency of these larger events and deciding when the cost to benefit ratio justifies prior mitigation measures is the ‘dark art’ that makes delivering this service so difficult.

**Sense of history**

2.16 The area has a strong sense of history and a record of human occupation that is recognised, although not designated, as being of international importance. The underlying geodiversity also contains a nationally important record of ancient landscapes and climates.

2.17 The deep peat deposits of the Brue Valley are particularly rich in buried archaeology; some of the oldest records of human occupation of the English landscape have been recovered from this area. Probably best-known is the ‘Sweet Track’; a more than 6,000 year old example of a timber trackway used to traverse the wetlands of the Brue Valley. Many artefacts from prehistory, the Bronze and Iron Ages, Roman activity, notably saltings, and a wealth of medieval evidence have been recovered from the area.
The history of the area is closely associated with water; the drainage of the landscape, flooding and occasional catastrophic inundation. The historical settlement pattern across the area is also closely related to the availability of land safe from flooding and access to productive pastoral ground. Many farmsteads and villages are positioned on small raised areas of land little more than a metre higher than the surrounding area. The abbeys of Glastonbury and Wells were influential in shaping this landscape and played an important role in the early history of Christianity.

19th and 20th century heritage is equally apparent in this landscape, for example the engineering infrastructure for water level management and the military installations and defences along the rivers and drains and particularly along the River Parrett.

Optimum land use conditions to maintain buried archaeological artefacts in peat soils require the maintenance of high water tables and no disturbance of the soils.

**Food provision**

Eighty-six per cent of the area is under pasture. This supports the principal food producing activity of livestock farming. Almost two-thirds of farms are engaged in livestock farming, mainly dairy and beef production.

Lamb, bought in from upland breeding flocks and finished on the flood plain pastures is a notable output from the area and beef cattle are also finished on the productive summer grass. There is also a significant amount of yard-based finishing of dairy-beef (pure-bred dairy bulls and cross-bred dairy heifers) although this is relatively disconnected from land use at a landscape scale (accepting that the cattle are fed on cereals, most of which is grown outside the area). The beef and lamb grown on the Somerset Levels and Moors are slaughtered at a number of abattoirs, a few of which are in or close to the project such as Southern Counties Fresh Foods at Langport but many of which are much further afield. The large majority of the beef and lamb produced in the area enters the national food supply network and is sold to the public through supermarkets.

During the twentieth century, land drainage and improvement led to a significant expansion of dairy farming in the area (being the dominant form of farming in most of the rest of Somerset, excluding Exmoor). The soils on much of the project area have a relatively high agricultural potential (as will be seen later there are significant areas of Grade 1 and 2 agricultural land) which is constrained by the high water tables. It was primarily the cause of dairy farming that led to the clashes between farmers and the Nature Conservancy over the designation of SSSI on the Levels in the early 1980s. This led to compensation payments and the ESA scheme that have, over most of the project area, maintained the more extensive beef and sheep grazing regimes in preference to dairy farming that relies on more agricultural productive but less environmentally beneficial grassland leys and forage crops such as silage and maize. In other parts of the project area, where the SSSI designation and agri-environment agreements have not constrained the conversion of land to dairy production, the frequency of flooding has effectively done the same thing.

Despite the relatively high levels of potential agricultural productivity that can be achieved from the soils of the project area (with suitable land drainage and agricultural inputs), food production as an ecosystem service has therefore been constrained by policy decisions favouring other services.

**Conclusions on the most significant ecosystem services delivered by the project area**

Natural England’s recently prepared National Character Area profiles provide useful evidence of the extent of 19 different ecosystem services in the project area. Five of these services stand out as being particularly significant because of their international importance (biodiversity and sense of history), their national importance (storage of soil carbon), their very high local socio-economic importance (flood risk management) and because they provide the dominant land use (food provision).
The natural assets and pathways associated with the services

2.26 Table 2.2 takes each of the selected services in turn according to its scale of benefits and lists the natural assets (such as the habitats and species, land use patterns, and the landscape and heritage features) that contribute to service delivery.

Table 2.2. Ecosystem services and the assets contributing to them

<table>
<thead>
<tr>
<th>Service</th>
<th>Assets contributing to the service</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biodiversity</td>
<td>1. Wetland habitats including large areas of flood plain and coastal grazing marsh, open water and watercourses</td>
</tr>
<tr>
<td></td>
<td>2. Coastal and estuarine habitats; salt marsh and sand dunes</td>
</tr>
<tr>
<td></td>
<td>3. Large areas designated for their nature conservation interests including SAC, SPA, Ramsar, SSSI and local sites</td>
</tr>
<tr>
<td></td>
<td>4. Rare, scarce and common species</td>
</tr>
<tr>
<td>Storage of soil carbon</td>
<td>5. Peat soils</td>
</tr>
<tr>
<td></td>
<td>6. Estuaries</td>
</tr>
<tr>
<td>Flood risk management</td>
<td>7. Flood banks, levees, water control infrastructure, including sluices and pumps</td>
</tr>
<tr>
<td></td>
<td>8. Rivers, drains, ditches and rhynes</td>
</tr>
<tr>
<td></td>
<td>9. Flood plain and coastal grazing marsh over permeable soils</td>
</tr>
<tr>
<td></td>
<td>10. Moors</td>
</tr>
<tr>
<td>Sense of history</td>
<td>11. Internationally important buried, ‘found’ and above ground archaeological and heritage assets</td>
</tr>
<tr>
<td></td>
<td>12. Geological and palaeoenvironment records</td>
</tr>
<tr>
<td></td>
<td>13. Wealth of sites and features illustrating human occupation and management of a wetland and coastal landscape</td>
</tr>
<tr>
<td></td>
<td>14. Strong surviving pastoral land use and character</td>
</tr>
<tr>
<td>Food provision</td>
<td>15. Fertile soils and high water levels producing lush and plentiful vegetation</td>
</tr>
<tr>
<td></td>
<td>16. Dairy products Beef</td>
</tr>
<tr>
<td></td>
<td>17. Lamb</td>
</tr>
</tbody>
</table>

Source: Adapted from the Natural England profile for the Somerset Levels and Moors NCA

2.27 This analysis shows the high importance of the rivers and man-made waterways, the wetland habitats and high water tables in providing for the selected services.

2.28 Figure 2.1 shows the distribution of rivers and waterways and the extent of the coastal and floodplain grazing marsh in the project area.
Figure 2.1. Distribution of wet grassland and drainage patterns in the project area
Mapping priorities areas for service delivery

2.29 An obvious pre-requisite for including the ecosystems approach in the planning of land use and management is to get an understanding of which areas of land are most important in delivering different services. The mapping of ecosystem services has been a strong thread in research on the ecosystems approach in recent years, with Geographic Information Systems (GIS) being used with increasing sophistication.

2.30 Spatial data are sometimes available to measure directly the delivery of the service (such as counts of the number of walkers on a route, measuring the delivery of public recreation; or analysis of the chemical and biological constituents of river water, measuring the provision of clean water). More often, data describe the extent of the natural assets that provide the service (such as the area of habitats that deliver biodiversity value; or the area of agricultural land producing food). As well as the area of these natural assets, it is desirable to have information on their condition. Data on the statutory designations is often the most freely available and can also come with information on the condition of sites. A review of the which habitats are best suited to mapping different services has been undertaken for JNCC.

2.31 The spatial representation of service delivery can be used to inform technical studies and, perhaps more significantly, as a way of activating and guiding dialogue between stakeholders. In order to stimulate this dialogue, it can be helpful to map the effect of alternative patterns of land use and management on service delivery. The following four examples of the use of ecosystem service mapping to guide debate are worthy of note:

- The Westcountry Rivers Trust has developed its ‘Participatory Ecosystem Services Visualisation Framework’ with funding from Defra and The Rivers Trust. This involves stakeholders in reviewing available data and then developing a series of conceptual models or ‘rules’ that can be used to define areas most likely to play a critical role in the provision of the different ecosystem services, singly or in combination. This approach was recently used by the East Devon Catchment Partnership to prepare its ‘Environmental Services Evidence Review’, preparing a series of maps describing the overall characteristics of the catchment and different elements of six selected ecosystem services.

- Natural Resources Wales, and its predecessor the Countryside Council for Wales, have been developing the SCCAN project (System Cynorthwyo Cynllunio Adnoddau Naturiol which is Welsh for Natural Resource Planning Support System). SCCAN brings together information on a wide range of ecosystem services to allow users to weigh up and set priorities for the many competing demands that are placed on our natural resources. Case studies of the approach have been developed in Bridgend and Torfaen County Boroughs.

- The University of York has funding from Defra and NERC to develop the Ecosystem Service Interactions – Spatial Interactive Tool (ESI-SIT). This is a web-based decision support tool for visualising how ecosystem services may change across the landscape in response to changes in landscape management. The model is underpinned by a spreadsheet which provides details of the nature of the specific interactions, based on the scientific literature. The model is being developed using the Humberhead Levels NIA as a case study, and then being tested in the Tees Valley.

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25 The WRT Participatory Ecosystem Services Visualisation Framework – see http://wrt.org.uk/project/ecosystem-services-visualisation/
26 The East Devon Environmental Services Evidence Review is available as an interactive report here http://issuu.com/westcountryriverstrust/docs/east_devon_evidence_review_1-1?e=13233808/9445611
28 http://esi-sit.com
LUCI is an online ecosystem service mapping application being developed by the University of Victoria, New Zealand and Bangor University based on the Polyscape framework. The first release is expected in 2016.

2.32 For this study, it was important to identify existing sources of data that were publicly available and gave a good direct or proxy measure of the extent of delivery for the selected services. Figure 2.3 describes the sources of data used for each of the services.

Table 2.3. Source of spatial data available for mapping service delivery

<table>
<thead>
<tr>
<th>Service</th>
<th>Contributing assets</th>
<th>Data selected to show spatial extent of service</th>
<th>Comments on data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biodiversity</td>
<td>Designated nature conservation sites</td>
<td>Sites of Special Scientific Interest (Natural England)</td>
<td>Nature conservation designations range from locally important Sites of Importance for Nature Conservation (SNCIs) to internationally important Nature 2000 sites. Sites of Special Scientific Interest (SSSI) show areas of national importance are are subject to statutory regulation.</td>
</tr>
<tr>
<td>Storage of soil carbon</td>
<td>Soils with high organic carbon content</td>
<td>National Soils Research Institute soilscapes – soils with high and medium/high carbon content (NSRI)</td>
<td>The Soilscapes viewer provided by the Cranfield Soil and AgriFood Institute, supported by Defra, is freely available and conveys the broad pattern of the characteristics of soils based on 27 types. The ‘carbon’ field for each type identifies areas with low, medium, medium/high and high carbon content.</td>
</tr>
<tr>
<td>Flood risk management</td>
<td>Areas subject to flooding which store flood water</td>
<td>Maps showing the extent of flooding in February 2014 (Environment Agency)</td>
<td>Although the Environment Agency flood map is commonly used to show areas of high flood risk (Flood Zones 2 and 3), the extent of flooding in Feb 2014 represents first hand evidence of a real event.</td>
</tr>
<tr>
<td>Sense of history</td>
<td>Designated archaeological sites</td>
<td>Scheduled monuments (Historic England)</td>
<td>Sites with recognised historical importance range from those on the Historic Environment Record (which carries no statutory protection and varies from individual archaeological finds to complex landscape features) to Scheduled Monuments (which have statutory protection).</td>
</tr>
<tr>
<td>Food provision</td>
<td>Land of high agricultural quality</td>
<td>Agricultural Land Classification (ALC): Grades 1 and 2 (Defra)</td>
<td>ALC data for the project area is available from the MAGIC web-portal (Multi-Agency Geographic Information for the Countryside) at <a href="http://www.magic.gov.uk">www.magic.gov.uk</a>. The data was developed from remote sensing and is suitable at a general landscape scale, with less accuracy at a field scale. The top three grades of 1, 2 and 3a show the ‘best and most versatile agricultural land’. Since the GIS data does not distinguish between 3a and 3b, Grades 1 and 2 are used.</td>
</tr>
</tbody>
</table>

Biodiversity

2.33 Figure 2.1 shows the extent of the coastal and flood plain grazing marsh, the priority UK Biodiversity Action Plan (BAP) habitat which covers the large majority of the non-urban land in the project area. It also shows the areas designated as Sites of Special Scientific Interest (SSSIs, being of national nature conservation importance), the large majority of which are also designated as Special Projection Areas (SPAs, of European importance). Whereas the SSSI designation (covering 8,534 ha or 16% of the project area) recognises the broad biodiversity value of the wet grassland and associated wetland habitats (such as in the rhynes), the SPA designation (7,341 ha or 14% of the area) focuses on populations of over wintering bird species, particularly Bewick’s swans, golden plover, shoveler, teal and widgeon and on a further assemblage of birds including snipe, lapwing, pintail and gadwall.

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http://www.lucitools.org
2.34 The quality of these sites for delivering high biodiversity value can be measured through the condition assessments of the SSSIs undertaken by Natural England\textsuperscript{10}. These show that the large majority (85%) of flood plain grassland habitat is in unfavourable condition, most of this (67% of the total area) now considering to be recovering following improved management. Nine percent are assessed as being in favourable condition for biodiversity and 5% in unfavourable and declining condition. Unfavourable management has included over-grazing which has reduced botanical diversity and damaged soil structure, scrub encroachment in the rhynes and the effects of prolonged deep flooding events. A high proportion of the SSSI area has been subject to management agreements under the Environmental Stewardship scheme (and before that the Environmentally Sensitive Area scheme) but most these agreements are coming to an end and may, or may not, transfer to the Countryside Stewardship scheme.

\textbf{Figure 2.1. Areas of high biodiversity value}

\begin{figure}
\centering
\includegraphics[width=\textwidth]{figure2.1.png}
\caption{Areas of high biodiversity value}
\end{figure}

\textbf{Storage of soil carbon}

2.35 \textbf{Figure 2.2} shows the extent of the soils with high, medium/high and medium carbon content. A total of 2,500 ha, or 5% of the project area is covered by peat soils derived from raised mire habitats and classified as having a high carbon content. These occur in the central part of the Brue Valley on Shapwick Heath, Westway Moor and Street Heath and include areas of past and present commercial peat extraction areas where the depth of peat soils have been much reduced.

2.36 A further 12,000 ha, or 23% of the project area, is covered in soils with medium/high carbon content. These include thinner peat soils and loam soils with a peaty surface layer. They occur in large areas in the central Axe valley, in the central Brue Valley in areas such as the Tealham and Tadham, Catcott, Edington, Chilton and Greylake Moors; and in the central Carey valley in areas such as King’s Sedgeemoor and Moorlinch. Most of the remainder of the project area (56%) is covered in loamy soils with a medium carbon content.

\textsuperscript{10} https://designatedsites.naturalengland.org.uk/
Figure 2.2. Areas of significant soil carbon content

2.37 Figure 2.3 shows the river network and the areas that were subject to flooding in February 2014, which was the ‘high point’ in recent flood events. There are some 520km of main river and waterway channels in the project area, the levels of much of which are maintained above the water table in surrounding fields by banks and sluices, and a much larger network of rhynes and ditches from which water is pumped into the main channels. It is this activity, shared by the Environment Agency (responsible for the main rivers and associated sluices and pumps) and Internal Drainage Boards (the rest of the network), that is responsible for delivering this service during ‘normal’ conditions. There has been recent controversy about the level of maintenance of the main river channels, by dredging, to maintain their capacity to store water and renewed investment by Government to ensure design capacities are maintained. However, the storage capacity of the rivers is finite and rising sea levels are effectively reducing this capacity, albeit slowly over a period of decades.

2.38 When main river channels become full and are unable to store and carry away more water (due to the state of the tides, the volume of water coming down from higher in their catchments and to the amount of water being pumped from surrounding land), the network of rhynes and ditches become the next flood storage resource. If these become full from rainfall falling on the fields or, in extreme conditions, from water overtopping the river banks, the fields start to flood.

2.39 When this occurs, maintenances of sluices allows policy decisions to be made by the Environment Agency and IDBs about which areas should be allowed to flood first, and pumped dry last, with the goal of protecting the most important assets (top of the list being urban areas) from flooding. The process by which these decisions are made is also somewhat controversial and farmers whose land tends to be flooded most frequently and for longest (for instance Curry Moor and Hay Moor on the lower Tone in the south of the project area) have long complained that their land is ‘sacrificed’ to protect areas like Taunton from flooding without them receiving any compensation for damaged crops.

2.40 As noted earlier (para. 1.39), the most recent major flood event in February 2014 resulted in 12,200ha of land being flooded with an estimated 65 million cubic metres of water. This volume of water overwhelmed all the flood defence structures and mechanisms and meant that the flooding of these areas was unavoidable. Under these extreme circumstances, there is little that
can be done to through land use and management in the project area to avoid flooding. If the frequency of these unavoidable flood events increases, as is predicted by climate change modelling\(^{31}\), the focus of policy changes to adapting to the effects of flooding so that land is more resilient to the effects of flooding.

2.41 The previous paragraphs have described the decisions that are currently made to prioritise land and water management for the service of flood risk management. However, it is important to recognise that other measures have been discussed and, in part, trialled. These involve activity at each end of the river catchments, above and below the project area.

- Firstly there has been discussion and trialling through initiatives such as the Parrett Catchment Project (para. 1.19) of changes to land use and management in the headwaters of the catchments to reduce and desynchronise peak river flows. This involves maintaining soils and vegetation, and creating flood storage areas, so that rainfall is held in the upper catchment for longer and released more slowly into the rivers. The cost effectiveness of these measures and their ability to reduce the impact of extreme flood events is the subject of ongoing assessment and debate.

- Secondly there has been interest in the construction of a large barrage across the mouth of the River Parrett to reduce the effect of tides (which have a particularly high range in the Bristol Channel) on the capacity of the Parrett and its tributaries to store water. The barrage would be opened at low tide to allow the river to empty to the sea and then closed as the tide rose to allow the river to store flood rather than sea water. Again, the cost effectiveness of this proposal, which would have a high capital cost, has been the subject of assessments and debate.

2.42 This section has shown that identifying and managing the assets that provide this service is complex and subject to dynamic forces of change, also involving complex decisions about who benefits most from, and who bears the cost of delivering, this service.

**Figure 2.3. Areas of highest flood risk (based on February 2014 flooding)**

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\(^{31}\) As is the case from the UK Climate Projections UKCP09 – see [http://ukclimateprojections.metoffice.gov.uk](http://ukclimateprojections.metoffice.gov.uk)
Sense of history

2.43 This is a cultural service which can only be partly measured in terms of the way that land is used and managed. As noted earlier (para. 1.15) the communities of the Somerset Levels and Moors have an independent spirit which probably relates to living in a hostile environment and to the processes of drainage and land reclamation that have taken place over the last millennium and more. The use of the marshy communities in the ninth century by King Alfred as a hideaway from the Danes, while planning his conquest of Wessex (and the associated story of him burning the cakes) is a powerful part of English national history.

2.44 The physical manifestations of this cultural history are found in the artefacts of Neolithic communities preserved in peat soils, in the settlements that developed as the land was reclaimed and in the flood defence structures that have sought to keep the sea and rivers at bay. The most significant of these (those deemed to be of national historical importance) are designated as Scheduled Monuments.

2.45 There are 60 Scheduled Monuments in the project area, the location of which is shown in Figure 2.4. A few are relatively large (for instance the 27 ha site of a Romano-British settlement on Stoke Moor in the Axe catchment) but most are much smaller amounting to only part of a field or a single building. Particularly significant is the complex of Neolithic sites preserved in peat in the central Brue catchment, including the Sweet Track (one of a series of discovered wooded walkway that were constructed nearly 6000 years ago to give the community access over the mire). Also significant are the remains of monastic communities and landscapes created as the land was drained (such as the early Christian settlement and monastic site at Marchey Farm near Theale on the Axe).

2.46 Preserving these sites, and therefore delivering this service, requires protecting them from change, seeking to keep them in optimal condition. This is contrast to the dynamic management required to deliver other services such as biodiversity and flood risk management.

Figure 2.4. Areas of high cultural heritage value

Food provision

2.47 Analysis of data from the annual June agricultural survey suggests that about 80% of the project area is farmed and that the majority of this area (70%) is kept as permanent pasture (grazed by beef and sheep), 11% as ley grassland (for silage production and pasture for dairy cows) and
about 12% cropped for cereals and maize. About 58,000 cattle (most reared for beef many of them yard-based, with about 16,000 dairy cows) and 41,000 sheep (most of them store lambs finished on pasture) are kept on farms in the project area. Wheat is the largest harvested crop and most of this is sold, or used on farm, as animal feed (particularly to the poultry sector in the region).

2.48 Patterns of agricultural land use are fluid and it is not possible to identify the areas used for different forms of agricultural production at any level of detail (although the areas of coastal and floodplain grassland shown in Figure 2.1 are a good indication of permanent pasture used for beef and lamb production). Instead the Agricultural Land Classification provides a good way of mapping the agricultural potential of land.

2.49 Figure 2.5 shows that nearly a quarter (23%) of the project area is classified as Grades 1 and 2 land, which has the highest potential for agricultural productivity. A further 52% is classified as Grade 3 and the remainder in lower grades.

2.50 As noted earlier (para. 2.23) this agricultural potential is significantly constrained by the delivery of other services (particularly biodiversity and by flood risk). These spatial interactions are examined in more detail at the end of this Chapter.

**Figure 2.5. Areas of high potential agricultural productivity**

Conclusions on mapping areas of service delivery

2.51 A range of methodologies have been developed in the UK for mapping ecosystem services to inform decision making. This study has used publically available spatial data which either directly or indirectly represents ecosystem service delivery to map each of the selected services.

2.52 Biodiversity is represented by the extent of the UK BAP habitat coastal and flood plain grazing marsh which covers the large majority of the non-urban land in the project area, onto which can be mapped areas designated as SSSI or SPA which cover 16% of the project area.

2.53 Storage of soil carbon is represented by the area of soils with high and medium/high carbon content on the Cranfield Soil and AgriFood Institute’s Soilscapes viewer. Soils with high carbon content occur on raised mire habitats covering 5% of the project area whereas soils with medium/high carbon content occur on peaty loam soils covering 23% of the project area.
2.54 Mapping of flood risk management is complex. The areas subject to flooding in February 2014 (the 'high point' in recent flood events) covered 26% of the project area but mapping of the assets delivering this service also needs to identify the flood defence structures (sluices, flood banks and pumping stations) which is more difficult, requiring value judgements to be added to existing spatial data.

2.55 Mapping the areas contributing to the sense of history is also complex. The physical assets of the 60 Scheduled Monuments such as the Neolithic and Romano-British settlement sites can be easily represented but these do not show the full picture of cultural associations with the area, such as its role in harbouring King Alfred from the Danes prior to his conquest of Wessex.

2.56 Food provision can be represented indirectly by the areas of highest agricultural productivity, in terms of the Grades 1 and 2 of the Agricultural Land Classification which cover 23% of the project area.

The synergies and trade-offs between services

2.57 The previous section has already indicated that the types of land management that produce some services are compatible with other services but not others. This section considers this issue in more detail. It looks at the complementarity between services and the scope for synergies and trade-offs so that the way land is used and managed can be planned for optimal service delivery.

2.58 Table 2.4 summarises the relationships between the five selected services in the project area. It provides a matrix for comparing how land use or management decisions to promote the services shown in the columns affects the delivery of the services shown in the rows. It is based on an understanding of the optimal land use and management conditions to deliver each of the services. The plus and minus symbols show whether the impact on the services shown in rows is positive (i.e. there is synergy of service delivery) or negative (i.e. there is a trade-off between the two services). The key at the bottom of the table provides further explanation of the symbols.

Table 2.4. Matrix of synergies and conflicts between services
(See paragraph 2.59 for explanation)

<table>
<thead>
<tr>
<th>Services impacted on</th>
<th>Biodiversity</th>
<th>Soil carbon storage</th>
<th>Flood risk management</th>
<th>Sense of history</th>
<th>Food provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biodiversity</td>
<td>++</td>
<td>+/−</td>
<td>++</td>
<td>+/−</td>
<td>−</td>
</tr>
<tr>
<td>Soil carbon storage</td>
<td>++</td>
<td></td>
<td>+/−</td>
<td>++</td>
<td>−</td>
</tr>
<tr>
<td>Flood risk management</td>
<td>+</td>
<td>+</td>
<td></td>
<td>++</td>
<td>+/−</td>
</tr>
<tr>
<td>Sense of history</td>
<td>++</td>
<td>++</td>
<td>+/−</td>
<td>−</td>
<td></td>
</tr>
<tr>
<td>Food provision</td>
<td>+</td>
<td>−</td>
<td>+/−</td>
<td>+</td>
<td></td>
</tr>
</tbody>
</table>

**Key:**
- Decisions to favour the service in the column heading are likely to have:
  - ++ a strongly positive impact on delivery of the service in the row
  - + a moderately positive impact on delivery of the service in the row
  - +/− an impact that may be either positive or negative depending on the land use / management decision
  - − a moderately negative impact on delivery of the service in the row
  - -- a strongly negative impact on delivery of the service in the row

2.59 Table 2.4 shows that management to pursue biodiversity tends to have positive effects on delivery of the other services, giving a synergy of land use types and management decisions, whereas land use designed to pursue food provision tends to conflict with the delivery of other services. The table suggests that land use and management to regulate flood risk can have both positive and negative effects on other services, depending on the precise nature of the decisions.
Biodiversity

2.60 Land use and management to enhance biodiversity, through extensive grazing of seasonally wet (but not deeply inundated) permanent grassland is likely to lead to strongly positively delivery of carbon sequestration (maintaining wet peat soils) and a sense of history (preserving buried archaeology in tact). It is also likely to lead to moderately positive flood risk management (providing capacity for shallow flood storage but not deep or prolonged flooding which would damage swards) and food provision through relatively low output production of beef and lamb.

Soil carbon storage

2.61 Maintaining wet fen habitats over undisturbed peat soils to prevent oxidation of the soil carbon and encourage growth of peat-producing vegetation (such as mosses and sedges) has a strongly positive effect on biodiversity and on preserved archaeology. It also produces moderately positive conditions for flood risk management (ideal conditions would maximise capacity for flood storage, requiring a lower water table prior to flooding occurring). However, it is not suitable for agricultural production of food (although it can be compatible with the production of basket willow and thatching reed).

Flood risk management

2.62 Table 2.8 shows that the effect of land use and management designed to reduce flood risk can have both positive and negative effects on the other services. The maintenance of flood defence structures such as banks and spillways tends to have little impact on the other services. The critical activity is the management of water levels before and during flooding. If the water table is drawn down by pump drainage so as the maximise capacity for flood storage, this may benefit food production but is likely to diminish the other services. If, during a flood event, an area of land is used for deep and prolonged flood water storage to reduce flooding in other areas, biodiversity and food production will be reduced. Flooding during the summer rather than winter months tends to be more damaging to biodiversity (for instance disturbing ground nesting birds and killing vegetation which rots more quickly in the higher water temperatures) and to food production (killing growing crops).

2.63 Although the impact of flood management actions on the other services is strongly influenced by natural events (rainfall and tides), decisions over which sluices are opened and when pumps are turned on, which are made by the Environment Agency and Internal Drainage Boards, also have an influence on how the other services fare. Farmers on Curry and North Moors (where the River Tone joins the Parrett) have complained for many years that decisions over the height of spillways and the timing of pumping to remove water from rhynes to the main rivers have, for many years, led to longer flooding on their land than on other areas.

Sense of history

2.64 Land use and management to enhance the sense of history (for instance preserving buried archaeology) is likely to be strongly compatible with biodiversity objectives and with the sequestration of soil carbon and have a positive impact on extensive livestock production and on flood storage.

Food provision

2.65 As noted above, the extensive grazing of beef and sheep for meat production tends to be compatible with the other services. However, agricultural improvement of land through drainage and the use of fertilisers and pesticides allow more profitable and higher output forms of food production such as dairy production and arable cropping. These forms of land use and management are less compatible with the other services. Decisions to maximise food production (particularly when measured in terms of the financial returns to the farmer) therefore tend to reduce the provision of the other services. The exception to this is where lowering the water table on farmland increases the capacity for flood water storage (accepting that prolonged flooding of the land when crops are present would be bad for farming).
Conclusions on the synergies and trade-offs between services

2.66 This section has shown that there are strong synergies between the delivery of biodiversity, a sense of history and soil carbon storage. Broadly speaking, the same forms of management (usually raised water levels and extensive livestock grazing) are compatible with the delivery of all these services.

2.67 A moderate level of food provision is derived from this management, but high levels of food production from dairy and arable farming are not compatible with the other services, requiring a separation of land uses.

2.68 The interactions between flood risk management and the other services are complex. The maintenance and operation of flood defence structures tends to operate independently of the other services but it is when these are overwhelmed by flooding that interactions become evident. Shallow and short term flooding is broadly compatible with other services but long term and deep storage of flood water causes conflicts, particularly with food production and biodiversity. However, the generally unavoidable nature of severe flood events means that the opportunities to plan for win-win trade-offs where such conflict is minimised, are limited.

The vision of future service delivery

2.69 The previous section shows that there is no single regime of land use or management that will deliver all of the selected services equally. Indeed, as noted in the first Chapter (para. 1.15 and 1.25), the area has a history of past disagreements over the services and benefits that the land should provide. This has made it difficult for policy makers at both national and local level to develop co-ordinated approaches to land use and flood risk management in particular.

2.70 In the wake of the floods of 2012/13 the Defra environment minister, Richard Benyon, challenged local stakeholders to reach a consensus that guide water and land management policies over the years ahead. As a result, a Task Force was set up in 2013 with the aim of preparing a vision of what the Somerset Levels and Moors should look like in 2030. The Task Force consisted of representatives from Somerset County Council, Somerset District Councils, NFU, Somerset Wildlife Trust, Somerset Consortium of Drainage Boards, FWAG and RSPB.

2.71 The Vision produced by the Task force (see Box 2.1) is significant in the synergistic way that it seeks to recognise the range of benefits that the area can provide and the need to find land use and management systems that deliver these ‘across the board’. The Vision includes a desire for farmers and landowners to be explicitly rewarded for the ecosystem system services they provide (see item 9 of the Vision). The ecosystems approach provides a way of identifying the commonly held values of the area and developing a consensus over future priorities.

2.72 As the Acting Chairman of the Task Force, Anthony Gibson commented at the launch of the Vision "The really encouraging thing is the degree of consensus which the Vision represents. ... We all want the Levels’ landscape to remain the green grid-iron of withies, rhynes, meadows and droves that we know and love; we all want it to continue to be farmed productively, but in ways that enhance the nature conservation interest; we all want the water to be managed, so that the flood risk is reduced; we all want an even richer mix of wildlife than we’ve got already; and we all want a thriving local economy, built around the Levels’ special qualities.”

2.73 The Vision seeks a win-win situation where there is a place for all the priority services to be optimised, recognising that spatial differentiation will be needed to avoid conflicting objectives.

Box 2.1. A Vision for the Somerset Levels and Moors in 2030

We see the Somerset Levels and Moors in 2030 as a thriving, nature-rich wetland landscape, with grassland farming taking place on the majority of the land. The impact of extreme weather events is being reduced by land and water management in both the upper catchments and the flood plain and by greater community resilience.
1. The landscape remains one of open pasture land divided by a matrix of ditches and rhynes, often bordered by willow trees. Extensively managed wet grassland dominates the scene with the majority of the area in agriculture in 2010 still being farmed in 2030.

2. The floodplains are managed to accommodate winter flooding whilst reducing flood risk elsewhere. These flood events are widely recognised as part of the special character of the Levels and Moors.

3. The frequency and duration of severe flooding has been reduced, with a commensurate reduction in the flood risk to homes, businesses and major roads in the area.

4. During the summer months there is an adequate supply and circulation of high quality irrigation water to meet the needs of the farmers and wildlife in the wetlands. On the low-lying peat moors, water levels have been adopted which conserve peat soils and avoid the loss of carbon to the atmosphere. Water quality has improved and meets all EU requirements.

5. The Levels and Moors are regarded as one of the great natural spectacles in the UK and Europe with a mix of diverse and valuable habitats. Previously fragmented habitats such as fen and flower-rich meadows have been re-connected and are widely distributed. In the north of the area over 1,600 ha are managed as reed-bed, open water and bog. Elsewhere the populations of breeding waders exceed 800 pairs. Each winter the wetlands attract large numbers of wintering wildfowl and waders regularly exceeding 130,000 birds. Wetland species such as Crane, Bittern and pollinator populations flourish.

6. Optimum use is being made of the agricultural potential of the Levels and Moors, particularly on the higher land, whilst unsustainable farming practices have been adapted or replaced to secure a robust, sustainable base to the local economy.

7. New businesses, including those based on ‘green tourism’, have developed, meeting the needs of local people and visitors alike, while brands based on the area’s special qualities are helping farmers to add value to the meat, milk and other goods and services that they produce.

8. The internationally important archaeological and historic heritage of the area is protected from threats to its survival and is justly celebrated, providing a draw to visitors and a source of pride and identity to local communities.

9. Farmers and landowners are rewarded financially for the public benefits and ecosystem services they provide by their land management including flood risk management, coastal management, carbon storage and the natural environment.
3 Mechanisms to achieve integrated and optimised service delivery

Chapter summary: This Chapter reviews the tools and evidence that can be used to plan more co-ordinated and effective action for ecosystem service delivery in the project area, with the objective of promoting synergies and avoiding conflicts between services. The Chapter is split into two main sections. The first looks at how economic valuation can be used to understand the relationship between services. The second section looks at the social and human side of ecosystem service planning, considering which ‘actors’ are involved in delivering, regulating and consuming the services and how engaged they are in decision making.

Using economic valuation to understand and prioritise the benefits provided by the selected services

3.1 This section of the report examines the following questions. How can the principle of Total Economic Value (TEV) be applied to the services delivered in the Somerset Levels? How can the Benefits Transfer approach be applied and how does this help identify the interactions between services?

3.2 Economic valuation is often used to quantify the benefits that different services provide, as a way of prioritising and understanding the relationship between them. A number of guidance and process documents have been prepared to aid the economic valuation of ecosystem services, including an introductory guide to valuing ecosystem services published by Defra in 200732.

Economic valuation has several distinct advantages, as follows.

- **Firstly**, economic valuation provides an objective way of comparing the benefits derived from one service, or one policy affecting ecosystem services, against another. This ensures that trade-offs between ecosystem services where a course of action increases one service but diminishes another can be properly evaluated (such as the decision on whether to plant forestry for timber on a wetland valued highly for its biodiversity). It also provides a way of comparing the costs and benefits of delivering an ecosystem service in one location compared to another (for instance the sequestration of atmospheric carbon dioxide for climate regulation in peat soil in the uplands compared to peat soils in the lowlands).

Using a currency value as the metric for making this comparison is not essential (other metrics such as the effect on human lifespans could be used). However, since many of our decisions, as individuals and society, are made on the basis of financial costs and benefits, the use of currency values tends to be easily understood.

- **Secondly**, economic valuation provides a way of comparing the benefits of public investment in the regulation or delivery of ecosystem services with the benefits of other policy programmes such as in the health service or defence. For instance, there has been much interest in recent years in the benefits to human health and well-being from living close to high quality natural green spaces. Economic valuation provides a useful policy tool for comparing the effect of these spaces on people’s physical and mental health outcomes with the cost of treating illness and conditions caused by the absence of these spaces (South et al, 2012).

- **Thirdly**, economic valuation provides a way of understanding how the operation of markets and commercial activity by businesses can be used to enhance service provision. Some services are reliant on the efficient operation and regulation of private markets, such as food

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production, while others, such as energy production from wind or biomass, involve
government interventions in markets to stimulate the service. There is growing interest in
the UK and elsewhere in the concept of Payments for Ecosystem Services (PES), in which
policy is used to stimulate market demand for service delivery (Defra, 2013)³³.

Different types of value

3.3 Economists have developed a variety of different ways of understanding and quantifying the value of goods and services and these can be applied to ecosystem services. The Millennium Ecosystems Assessment (MEA, 2005, also quoted in RSPB, 2009) identified four causes of value that reveal the broad range of ways we benefit from nature.

- **Direct use values.** These include the benefits we get from eating food, fish, using timber or enjoying outdoor recreational activities. These values can often be obtained from examining the operation of existing markets (although externalised costs of production that may not be properly reflected in market values – such as the cost of treating water pollution caused by farming – need to be taken into account).

- **Indirect use values.** These include the processes that contribute to the production of goods and services like soil formation, water purification and pollination. These are frequently not reflected in market values (i.e. they are externalised) but can be established by understanding the market costs incurred in providing them.

- **Non-use values.** Many people derive pleasure from simply knowing a resource exists or because they wish to bequeath it to future generations. These are more difficult to attach a monetary value to because they are usually not traded commodities. However, people are usually able to state how important they consider these things to be in comparison with other goods or services which are traded and can be valued – this is covered further below.

- **Option values.** Despite the fact that people may not currently be gaining any benefits from them, many ecosystem services still hold value for preserving the option to use such services in the future either by the individual (option value) or by others (bequest value). Again, these are frequently not traded and they may be difficult for people to assign relative importance to because doing so requires an understanding of future uncertainty.

<table>
<thead>
<tr>
<th>Service type</th>
<th>Direct use</th>
<th>Indirect use</th>
<th>Non-use</th>
<th>Option value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provisioning</td>
<td></td>
<td>●</td>
<td></td>
<td>●</td>
</tr>
<tr>
<td>Regulating</td>
<td>●</td>
<td></td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Cultural</td>
<td>●</td>
<td>●</td>
<td></td>
<td>●</td>
</tr>
<tr>
<td>Supporting</td>
<td>Supporting services are valued through the other categories of ecosystem services</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Defra (2007)

3.4 For each of these categories there are two different ways that the value generated by ecosystem services can be calculated. The first is the **absolute value** derived by an ecosystem service (or the loss of value if the service were to be entirely removed). These values are usually very large but may not be helpful to inform public policy because completed removal (or creation) of a service is rarely an option that needs to be addressed by policy. The alternative is to calculate the **marginal value** of ecosystem service delivery that will arise from pursuing a particular policy option. For instance, a decision on whether re-wet an upland blanket bog (for instance blocking drainage ditches to raise the water table) would be informed by a marginal valuation of the improved delivery of a range of services such as climate regulation (the sequestration of carbon in

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peat), flood regulation (the storage and slow release of rainfall), water provision (the supply of high quality water to downstream reservoirs) and aesthetic and cultural services (the benefits to people from knowing that this internationally important habitat, and associated wild species, is present and can be appreciated).

3.5 The use of marginal valuation to provide evidence for policy decisions is the reason why Defra, in its guide to the valuation of ecosystem services (Defra, 2007), recommends that valuation is based on an understanding of the impact pathway of policy change (Figure 2.6). In this approach, valuation is used to quantify the marginal (additional) benefits of changes in ecosystem delivery from different policy options.

Figure 2.6. Overview of impact pathway of policy change

Source: Defra (2007).

Economic valuation techniques and Total Economic Value

3.6 As noted above, economic valuation seeks to attach a monetary amount to the outputs of ecosystem services. This can be done in two ways.

- Firstly, there are pricing approaches which make use of ‘real world’ market-derived data to establish this monetary value. This is relatively easy for goods and services that are traded in commercial markets (such as supply of drinking water or energy) but is more difficult for services that are not (such as landscape quality).
- Secondly, there is the Total Economic Value (TEV) approach which uses a variety of techniques to assign a monetary value where one cannot easily be obtained from ‘real world’ markets. These techniques involve estimating public preferences for changes in ecosystem services and can also accommodate real world values from ‘pricing approaches’.

3.7 Some of the main economic techniques used in these approaches are summarised in Table 2.5 and their suitability for valuing different services is shown in Table 2.6.

Table 2.5. Summary of different valuation techniques

| Revealed preference (RP) methods rely on data regarding individuals’ preferences for a marketable good which includes environmental attributes. These techniques rely on actual markets. Included in this approach are: market prices, averting behaviour, hedonic pricing, travel cost method, and random utility modelling. Market prices and averting behaviour can also be classified under pricing techniques. |
| Stated preference (SP) methods use carefully structured questionnaires to elicit individuals’ preferences for a given change in a natural resource or environmental attribute. In principle, SP methods can be applied in a wide range of contexts and are the only methods that can estimate non-use values which can be a significant component of overall TEV for some natural resources. The main options in this approach are: contingent valuation and choice modelling. |
| Pricing approaches provide a different, albeit overlapping, classification to TEV, referring to approaches that use observed market prices either as direct measures of economic value of an ecosystem service (e.g. market prices, avertive expenditure, damage costs avoided) or as a proxy for the value (referred to as cost-based approaches). |
| Cost-based approaches to valuing environmental goods and services consider the costs that arise in relation to the provision of environmental goods and services, which may be directly observed from markets. Included under this heading are: opportunity cost; cost of alternatives, and replacement costs. However, as these methods are based on costs, they do not strictly measure utility (and are therefore not included under the TEV framework), that is, they are non-demand curve methods and need to be used with care. |
Non-economic valuation – deliberative or participatory – approaches tend to explore how opinions are formed or preferences expressed in units other than money. The choice is not a case of either economic or non-economic valuation methods but of using a combination of both, as required by the context of the decision.

Source: Defra (2007)

Table 2.6. Choice of valuation methods for different ecosystem services

<table>
<thead>
<tr>
<th>Valuation method</th>
<th>Element of TEV captured</th>
<th>Ecosystem service(s) valued</th>
<th>Benefits of approach</th>
<th>Limitations of approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market prices</td>
<td>Direct and indirect use</td>
<td>Those that contribute to marketed products e.g. timber, fish, genetic information</td>
<td>Market data readily available and robust</td>
<td>Limited to those ecosystem services for which a market exists.</td>
</tr>
<tr>
<td>Cost-based approaches</td>
<td>Direct and indirect use</td>
<td>Depends on the existence of relevant markets for the ecosystem service in question. Examples include man-made defences being used as proxy for wetlands storm protection; expenditure on water filtration as proxy for value of water pollution damages.</td>
<td>Market data readily available and robust</td>
<td>Can potentially overestimate actual value</td>
</tr>
<tr>
<td>Production function approach</td>
<td>Indirect use</td>
<td>Environmental services that serve as input to market products e.g. effects of air or water quality on agricultural production and forestry output</td>
<td>Market data readily available and robust</td>
<td>Data-intensive and data on changes in services and the impact on production often missing</td>
</tr>
<tr>
<td>Hedonic pricing</td>
<td>Direct and indirect use</td>
<td>Ecosystem services that contribute to air quality, visual amenity, landscape, quiet i.e. attributes that can be appreciated by potential buyers</td>
<td>Based on market data, so relatively robust figures</td>
<td>Very data-intensive and limited mainly to services related to property</td>
</tr>
<tr>
<td>Travel cost</td>
<td>Direct and indirect use</td>
<td>All ecosystems services that contribute to recreational activities</td>
<td>Based on observed behaviour</td>
<td>Generally limited to recreational benefits. Difficulties arise when trips are made to multiple destinations.</td>
</tr>
<tr>
<td>Random utility</td>
<td>Direct and indirect use</td>
<td>All ecosystems services that contribute to recreational activities</td>
<td>Based on observed behaviour</td>
<td>Limited to use values</td>
</tr>
<tr>
<td>Contingent valuation</td>
<td>Use and non-use</td>
<td>All ecosystem services</td>
<td>Able to capture use and non-use values</td>
<td>Bias in responses, resource-intensive method, hypothetical nature of the market</td>
</tr>
<tr>
<td>Choice modelling</td>
<td>Use and non-use</td>
<td>All ecosystem services</td>
<td>Able to capture use and non-use values</td>
<td>Similar to contingent valuation above</td>
</tr>
</tbody>
</table>


3.8 It should be noted that undertaking these techniques is usually a complex process that can be resource intensive (for instance requiring public surveys). There are also very real difficulties in meaningfully quantifying the non-use values that arise from services such as biodiversity, especially when public understanding of these values may be relatively weak (given that the valuation is derived from stated preference surveys of the public)\(^{34}\). However, the important point in terms of the objectives of this report, is that there is an accepted means of adopting the results of existing valuation studies and applying them is broadly similar circumstances. This is known as benefits transfer.

\(^{34}\) See the discussion in Bateman et al. (2014) (WP3 of the UKNEA) pp. 13 and 17.
Expressed mostly simply, the benefits transfer method involves a four stage process, as shown in Figure 2.7.

**Figure 2.7. Application of the benefits transfer Method**

- **Step 1:** Identify existing studies or values that can be used for the transfer, where the benefits being valued in these studies are the same or similar to those required.
- **Step 2:** Decide whether the existing values are transferable. The existing values or studies would be evaluated based on several criteria, including: comparability of service delivered and of the characteristics of the population surveyed.
- **Step 3:** Evaluate the quality of studies to be transferred. The better the quality of the initial study, the more accurate and useful the transferred value will be. This requires the professional judgment of the researcher.
- **Step 4:** Adjust the existing values to better reflect the values for the service under consideration, using whatever information is available and relevant. The researcher may need to collect some supplemental data in order to do this well.

Source: Adapted from a US website: [http://www.ecosystemvaluation.org/benefit_transfer.htm](http://www.ecosystemvaluation.org/benefit_transfer.htm)

**Existing research and guidance**

3.10 An advantage of the benefits transfer approach is that valuation studies undertaken in other countries can be applied (with suitable adjustments). For instance research on the recreational value provided by National Parks in the United States or studies in France on the value to communities of flood water storage on farmland might be transferred to the UK. There are obvious risks in applying values out of their original context. Not only may societal values be significantly different in different countries or regions (for instance the cultural importance of services such as biodiversity, heritage or landscape) but the biophysical situation may be very different (for instance the existence of ecological thresholds or tipping points). However, providing care is taken to contextualise values acquired through benefits transfer, the technique can provide a useful starting point to inform stakeholder dialogue.

3.11 Internationally, The Economics of Ecosystems and Biodiversity (TEEB) Programme has examined the many benefits that society gains from natural systems ([http://www.teebweb.org/](http://www.teebweb.org/)). Different strands of this large programme have reported on the valuation of ecosystem services in different sectors of the economy and in different biomes. A consortium of Universities in Belgium and the Netherlands undertook a valuation study for the Flemish Government on the ecosystem services in Flanders, also producing a toolkit on valuation techniques (LNE, 2010). In France, the Government’s Centre for Strategic Analysis has reviewed the policy context, evidence and methodological approaches for establishing reference values for ecosystem service delivery in France that could be spatially disaggregated to Departmental level (Chevassus-au-Louis et al. 2009).

3.12 Such is the level of international interest in the valuation of ecosystem services that a number of academic institutions have started to provide online compendia of valuation studies. These include the Environmental Valuation Reference Inventory (EVRJ)\(^\text{35}\) which includes summaries of around 380 UK valuation studies and is a source recommended by Defra\(^\text{36}\). In the UK, there are a number of sources of information about existing valuation studies that can be adopted or adapted

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\(^{35}\) Accessible online at [www.evri.ca/Global/Home.aspx](http://www.evri.ca/Global/Home.aspx)

\(^{36}\) [https://www.gov.uk/ecosystems-services](https://www.gov.uk/ecosystems-services)
for new ecosystem service valuation studies. These include the Valuing Nature Network\(^{37}\) which has links to other projects in the UK and overseas.

3.13 The UK National Ecosystems Assessment (NEA) provided the first comprehensive overview of the state of the natural environment in the UK (UKNEA, 2011) and this large research programme, which is now in its second phase, has involved a number of research outputs that provide an economic valuation of ecosystem services (see for instance Morris and Camino, 2011).

3.14 A number of guidance documents have been prepared by bodies like the UN Environment Programme (UNEP, 2013) and Defra (eftec, 2009) to ensure that consistent standards are maintained in the use of benefits transfer in the valuation of ecosystem services.

3.15 A number of relatively sophisticated software tools are being developed that streamline the process of benefits transfer and also add other elements such as baysian decision networks (which help the user understand levels of uncertainty in the data). These include ARIES (Artificial Intelligence for Ecosystem Services)\(^{38}\), InVEST (Integrated Valuation of Environmental Services Tradeoffs)\(^{39}\) and Co$t$ing Nature\(^{40}\).

**Assessment of the value of the selected services in the project area**

3.16 Undertaking a valuation of the five selected services in the project area is beyond the scope of this study. Instead, the following section considers the resources that are available to undertake such a valuation and the potential benefits and drawbacks of this valuation for better understanding the interactions between the services.

**Biodiversity**

3.17 Biodiversity has a non-use value (para. 2.51) since (with a few minor exceptions) it is not a traded commodity but is considered important by society due to the way it enriches our lives and the lives of future generations. The concept of biodiversity to members of the public, who may be asked to indicate the value they place on it through stated preference surveys, can be nebulous and poorly understood (see para. 2.56). As a result valuation studies usually focus on a particular aspect of biodiversity which can be measured in the field and which the public can relate more strongly to. In the case of the Somerset Levels and Moors, the aspect of biodiversity which gives the area its international significance is the population of overwintering wading birds. These can be enjoyed directly by people living in, or visiting the area, but are also likely to be valued by people who will never experience them directly, but will be pleased that they exist.

3.18 Studies which have assessed valuations for the conservation of wading birds include Foster et al (1997), which applied data from project-based fundraising appeals by the RSPB to assess public preferences, and Brouw

3.19 Notwithstanding the availability of these studies to provide a ‘benefits transfer’ valuation of this aspect of biodiversity in the project area, it should be noted that Work Package 3 of the UK National Ecosystems Assessment (which covers economic valuation) concludes that the difficulties of generating a meaningful value for biodiversity (see para above and 2.56) mean that biodiversity should be excluded from the Total Economic Value approach. Instead biodiversity should be regarded as an external constraint, requiring a judgement on how much reduction in biodiversity can be justified by the benefits provided to other services. It might be concluded that by placing biodiversity in the ‘too difficult’ box, economists are putting the onus back on informed debate between policy makers and stakeholders.

**Soil carbon storage**

3.20 The establishment of a traded price for carbon emissions which has arisen from the EU Emissions Trading Scheme has led to the Department of Energy and Climate Change (DECC) publishing short-term traded carbon values for use in UK public policy appraisal (specifically for valuing the

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\(^{37}\) Accessible online at [http://www.valuing-nature.net/](http://www.valuing-nature.net/)

\(^{38}\) http://www.ariesonline.org

\(^{39}\) http://www.naturalcapitalproject.org/InVEST.html

\(^{40}\) A tool being development by King’s College London and partners.
impact of government policies on emissions in the traded sector). These indirect use values provide an accepted benchmark for measuring the benefits of sequestered soil carbon.

3.21 In order to apply these values to the project area, it would be necessary to estimate the stock of soil carbon and calculate the changes that would occur under different land use options. Both of these requirements are achievable based on work in other areas, but both would require specialist expertise and a dedicated research project.

**Flood risk management**

3.22 The benefit provided by flood storage in the project area has an indirect use value which can be estimated from the economic benefits received by households and businesses whose flood risk is reduced as a result. This value might be calculated as the reduction in insurance premiums that households and businesses receive from the reduced flood risk or as the avoided losses that would occur if flooding took place.

3.23 The Environment Agency’s cost benefit analysis which is used to assess public spending on flood defence employs sophisticated models for estimating these benefits (based on avoided losses). At a local scale (for instance examining the benefits of raising a flood bank protecting a settlement by 10cm), valuing the benefit can be done with a reasonable level of confidence. However, at a larger catchment scale, the level of confidence associated with hydrological modelling is low and, even if this confidence were improved, the valuation data would be highly dependent on complex assumptions about weather and tidal events and flood defence responses to these. Valuing this service would therefore be open to high levels of uncertainty, producing a wide range of values.

**Sense of history**

3.24 Like biodiversity, the sense of history that people receive from an area has a non-use value. Having said that, the benefits that visitors to the Somerset Levels and Moors receive from the sense of history might be estimated, in part, by valuing the tourism economy derived from archaeological or cultural sites (such as the Shapwick Heath National Nature Reserve), but this would give only a partial assessment, taking no account the value to local residents or future generations. It is probably unlikely that a benefits transfer approach would be of much value to the project area since the historical associations of Neolithic communities living on the wetlands, the mediaeval use of the area as a refuge to King Alfred and the agricultural improvement of the wetlands to create productive farmland are unique to this area.

3.25 If the resources were available to undertake a stated preference survey of the sense of history that people received from the area, a local value might be placed on this service. However, the survey would need to ensure that the people questioned had sufficient knowledge of the historical associations to be able to provide informed answers. Changes to these values arising from different land use options (for instance leading to reduced protection of archaeology or enhanced interpretation of historic events) could be estimated.

**Food provision**

3.26 The food produced from agricultural production in the study area has a direct use value, in terms of the revenue farmers receive for the milk, livestock and crops they produce (to which might be added the value added through processing in the area). Data from Defra’s annual June census of farms can be used to calculate the number of productive livestock and cropped areas to which yield estimates and commodity prices could be applied. Changes to these values arising from different land use options (for instance removing or increasing environmental constraints on production) could be estimated.

**Conclusions on service valuation in the project area**

3.27 Of the five selected services, food provision is the only one that has a direct use value. It is the service for which a meaningful valuation could be generated most easily. The units of service production on which the valuation (livestock numbers and crop areas) are relatively accessible and the assumptions needed to generate the valuation (yields and market prices) would be present a significant challenge.

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41 DECC (2014)
3.28 For the two services that have indirect use values (soil carbon storage and flood risk management) there are recognised methodologies that could be applied. In the case of soil carbon the process would be relatively straightforward, although estimates of the volume of carbon present in soils would need to be made, to which DECC’s approved values could be applied. In the case of flood risk management, the levels of uncertainty in hydrological modelling and the complex assumptions required would produce a wide range of values that would probably not give a good evidence base to inform stakeholder dialogue.

3.29 The remaining two services of biodiversity and sense of history have non-use values and, in the absence of a local choice experiment survey to calculate people’s willingness to pay for these services in the project area, values would need to be estimated through benefits transfer. However, the difficulty of obtaining applicable and meaningful valuations for these two cultural services, as discussed above, suggests that neither value is likely to be particularly helpful in informing dialogue with local stakeholders.

3.30 What is perhaps more helpful is the way in which thinking about how the services are valued sheds light on how these values are currently (and might in the future be) received by the people providing the services and paid for by the people who gain the benefits. This is important when thinking about whose views should be taken into account in deciding future land use policy.

3.31 The situation is relatively straightforward for food production. Farmers and landowners are paid for the food they provide and, in theory at least, traceability in the food chain provides consumers with the means to influence the value of food produced in different ways and from different places. The situation is much more complex for the other services. Agri-environment payments (covering a range of environmental benefits including biodiversity, the historic environment and landscape) are based on profit foregone calculations incurred by the land manager. This is not the same as the overall value of the services to society and the taxpayers who are indirectly financing the agri-environment payments have no way of influencing the payments received.

3.32 There are currently no mechanisms for recompensing farmers and landowners who provide carbon storage or flood regulation (neither being explicitly recognised to a significant extent in agri-environment payments) and, in the case of carbon sequestration, the supply chain to the global beneficiaries of a more sustainable climate is very diffuse. On the other hand, there are much stronger connections to the beneficiaries of flood regulation (e.g. the residents of villages such as Moorland and towns such as Taunton and Bridgwater), but these people do not have a clear means of levering improved service provision, other than democratically through public policy.

3.33 These conclusions demonstrate that, despite the well-recognised methodology for valuing ecosystem services, generating a set of values for the selected services that would give a sound basis for dialogue or decision making in the project area would be very difficult. However, thinking about how services are valued does produce useful analysis of who gains and losses from their provision. This is considered further in the following section.

Engagement of the key actors involved in the delivery of the selected services

3.34 Dialogue and agreement over the prioritisation of different services is only possible if the people affected by the services, and responsible for their delivery can be identified and involved. This section assesses who is involved in consuming, supplying and regulating the selected services and how engaged they are in decision making processes.

Biodiversity

3.35 The international SPA designation of significant areas of the Somerset Levels and Moors show that the beneficiaries of this service are international. The sites are part of the Natura 2000 network of habitats and features that benefit the people of the EU as a whole. The UK Government (delegated to the UK Joint Nature Conservation Committee and through them to Natural England) is responsible for maintaining the designation and protecting the designated features which it does through the SSSI designation.
3.36 There are also important local beneficiaries of biodiversity who gain from direct and indirect experience of the service. Direct beneficiaries are the people who visit nature reserves (such as the Shapwick Heath National Nature Reserve, the RSPB’s West Sedgemoor Reserve and the Somerset Wildlife Trust’s (SWT) Catcott Complex Nature Reserves) or who experience the spiritually uplifting sight of flocks of wading birds or huge ‘murmurations’ of starlings that are well known in the area. Indirect beneficiaries are the communities and businesses who may experience a high quality of life from the knowledge that these things exist in their vicinity.

3.37 Responsibility for providing the service lies mainly with the farmers whose stock graze the wet grassland and with the IDBs who maintain the raised water levels. It could be argued that farmers who are subject to land management restrictions on SSSIs receive a disbenefit from provision of the service (which may or may not be compensated financially). Landowning bodies such as the RSPB and SWT and regulatory bodies such as Natural England and the Environment Agency also have important roles in maintaining the service.

**Soil carbon storage**

3.38 The beneficiaries of the climate regulation service provided by the storage of organic carbon in soils are truly global, although at this scale the contribution provided by the project area is very small. It is difficult to discern any more local beneficiaries unless one takes into account the knowledge that local people may have about the way their soils are helping to mitigate the impact of climate change (this knowledge is likely to be at a low level).

3.39 Responsibility for providing this service lies with the farmers and landowners who manage the soils and the vegetation that grows on them. It is probably true to say that awareness of this service amongst these people is low and maintaining the soil conditions that are optimal for organic carbon (e.g. no disturbance and a high water table) is low on their land management priorities. The companies involved in extracting peat for horticultural use (now limited to working out extant planning permissions) are a key audience in terms of their depletion of this service.

**Flood risk management**

3.40 The beneficiaries of this service are the downstream residents in towns like Taunton and Bridgwater who benefit from reduced flood risk as a result of the storage of water in the waterways and land in the project area. The Parrett Catchment Flood Management Plan states 3,300 properties are at risk from a 1% annual probability flood event and that this is expected to increase to over 6,600 properties in the future. The cost of providing this service is borne by the farmers and landowners whose land is routinely flooded (such as those on Curry and Hay Moors) and from local IDB rate payers (and national tax payers) who pay for the maintenance of flood defence measures.

3.41 A failure in the delivery of this service, as has occurred in the summer of 2012 and, most significantly between December 2013 and March 2014, affects the communities whose properties are flooded (see Table 2.7). Around 600 houses were affected by flooding during the latter event. A lower level of disruption is experienced by a much larger number of people when transport routes are disrupted by flooding (as occurred during the first few months of 2014 with the closure of the A361 for three months and the mainline railway for three weeks).

<table>
<thead>
<tr>
<th>Catchment</th>
<th>Parishes with significant areas subject to flooding in February 2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Brue</td>
<td>Wedmore, Meare, Godney and Wells</td>
</tr>
<tr>
<td>The Parrett</td>
<td>Chedzoy, Westonzyoland, Moorlinch, Middlezoy, Greinton, Walton, High Ham, Aller, Othery, Burrowbridge,</td>
</tr>
<tr>
<td></td>
<td>North Petherton, Curry Rivel, North Curry, Huish Episcopy, Kingsbury Episcopy, Muchelney, Five Head,</td>
</tr>
<tr>
<td></td>
<td>Drayton, Long Load, Long Sutton and Ash</td>
</tr>
</tbody>
</table>

Table 2.7. Parishes affected by flooding

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**Sense of history**

3.42 As with biodiversity, identifying beneficiaries of this cultural service is not a precise science as there is no clear ‘supply chain’. It is likely that international awareness of the historic importance of the area is limited to a relatively small number of archaeologists but that awareness of the areas historical significant is greater in the UK and greater still amongst people living in and visiting Somerset.

3.43 Responsibility for providing the service, in terms of maintaining the heritage assets, lies with a relatively small number of landowners and with bodies such as Historic England and the Somerset County Council Historic Environment Service.

3.44 It is likely that this service has the lowest profile (i.e. is least known and valued) and involves the fewest number of people in its delivery, amongst the services considered here.

**Food provision**

3.45 The main agricultural products from the area, which are beef, lamb and dairy products, enter national supply chains and could be consumed anywhere in the UK (with lamb in particular also exported), although there is probably a bias towards the southern part of the UK because of distribution patterns. Relatively little of the food produced in the area will be identifiable as such at the point of sale. Exceptions to this are the small amount of products sold direct at farmers markets and meat sold through local High Street butchers which may be identified by the name of the farm or as ‘Somerset lamb’. Overall the proportion of UK consumed food that is produced in the project area will be small.

3.46 Responsibility for food production obviously lies with the farmers, of whom there are around 700 involved in full-time agriculture (para. 1.26). In addition to these primary producers there are the businesses supplying and buying from them such as vets, feed merchants, hauliers, abattoirs and meat wholesalers, dairies and cheese producers.

3.47 This brief assessment of the different ‘actors’ with a stake in the selected services shows that there is a variation between large distant populations who received relatively diluted benefits (such as the global population receiving a small benefit from the carbon stored in soils in the project area) and smaller closer populations who receive a much more significant benefit (for instance the 3,300 households at risk of flooding in the Parrett catchment). There are also some people who receive a disbenefit from service provision such as the farmers whose land is flooded to provide flood relief to others. These relationships are shown conceptually in **Figure 2.8**. The practical working relationships that exist between different interest groups within the project area to develop and implement policy is examined in the following chapter.
Figure 2.8. Conceptual diagram showing relationships between beneficiaries of services
4 **Anticipating changes and planning positive outcomes**

**Chapter summary**: This Chapter of the report looks to the future of ecosystem service delivery in the project area, taking account of the expected drivers of change, the policy levers that are likely to be deployed to address them and evidence of the ways that local interests are working together through new local initiatives.

**The drivers of change acting on the services**

4.1 Each of the selected services has a number of drivers of change acting on them that will, individually or in combination, result in increases and declines in their delivery. The report of the Living Landscapes Project prepared by the Somerset Wildlife Trust in April 2015 lists the drivers of environmental change that it considers will act on the Brue Valley over the next ten years (Box 3.1). Most of these apply equally to the whole project area as a whole

**Box 3.1 – Likely drivers of environmental change within the Brue Valley in the next decade**

1. Expiry of ESA agreements and the availability and take up of ESS agreements.
2. Implementation of Water Level Management Plans by the Somerset IDBs.
4. Decreased local investment in flood risk management by the Environment Agency
5. Building of a new tourist hub at the Avalon Marshes Centre leading to increased tourism and recreation interest in the area.
6. Increased government emphasis on value of ecosystem services and landscape scale conservation.
7. Increased local and governmental interest in the availability of local produce
8. Increased concern over food security.
9. Alterations to land tenure as the current ageing population of farmers, many of whom have no successor, retire.
10. Increased local and governmental concern about the impacts of climate change.
11. Increased political pressure on peat extraction industry leading to falling extraction and demand.


**Biodiversity**

4.2 The C20th saw major declines in biodiversity in the project area due to the drainage and agricultural improvement of wet grassland and fen habitats. Although continued habitat fragmentation on undesignated sites is likely to continue from commercial farming practices, the implementation of Water Level Management Plans (see para. 4.29 below) and the targeting of agri-environment scheme agreements has secured favourable or improving management conditions on Sites of Special Scientific Interest. Conservation bodies who own or manage land such as the RSPB and Somerset Wildlife Trust, working with local graziers, are demonstrating how optimal conditions for wildlife can be maintained.
4.3 Less positive drivers of change that will put pressure on these improvements include the changing climate which is increasing the risk of severe flood events (see further below) as well as the spread of non-native species, particularly wetland plants such as Himalayan balsam (*Impatiens glandulifera*). The economic volatility of agricultural commodities and inputs is likely to constrain long term planning by farmers and landowners although the effects of the current depressed prices for dairy products and arable crops (if they continue) may favour a return to more extensive beef and sheep grazing. Bovine tuberculosis and Government’s policies to control it have been a significant practical constraint on cattle farming but it remains to be seen whether this will continue to be an issue in the medium to long term. Finally, in the short term, the Government’s austerity programme of reduced public spending is reducing the budget for agri-environment agreements which is likely to mean that sites of lower (undesignated) biodiversity value may not receive agri-environment funding.

**Soil carbon storage**

4.4 With no new permissions being granted for the commercial extraction of peat and worked out sites being restored to wetland, the future of the peat soils in the project area is likely to be generally positive. The future development of carbon accounting procedures that place a value on well maintained soil carbon resources (for instance allowing payments to maintain them by carbon emitting industries) should further secure their future. Measures to deliver favourable biodiversity conditions will also be positive.

4.5 On the other hand, a more volatile climate, with rising temperatures and possibly occasional periods of drought, is likely to set a challenge for bodies seeking to conserve soil carbon resources.

**Flood risk management**

4.6 The risk of flooding in the project area is almost certain to rise steadily in coming decades as a result of two forces acting in tandem. First, sea levels relatively to the land are expected to rise as a result of the changing climate and also post glacial isostatic recovery. Secondly, the changing climate is projected to result in wetter winters and drier summers, with more frequent storm events (including in the summer) in the South West and an increased frequency and height of tidal surges in the Bristol Channel. The speed and magnitude of the changes are uncertain which adds to the difficult in planning flood risk management and investment in flood defence structures and land use change.

4.7 As noted earlier in this report, land use change in both the upper catchment (influencing river flows in the project area) and in the lower catchment (affecting flood storage and the need to protect high value assets such as housing and industry) will also affect how flooding occurs. In the face of rising flood risk, it is likely that public policy will seek to take more control over land use and management (through either compulsory or voluntary measures) to protect the assets of greatest economic, social and environmental importance but, in doing so, will be more tolerant of flooding on other land.

**Sense of history**

4.8 In terms of changes in land use and management and their effect on the preservation of buried archaeology, the same factors described above for biodiversity will apply. Buried archaeology on designated land (whether as SSSI or Scheduled Monuments) is likely to remain relatively well preserved but on undesignated land it is likely to be subject to less sympathetic management and may suffer loss.

4.9 Drivers of change in public understanding and appreciation of the area’s sense of history is difficult to predict. It may be that more frequent flood events of the kind that occurred in 2014 will increase the profile of the area at a regional or even national level. If the livelihoods of farmers and the future of small low-lying settlements come under increased pressure and more

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Fragile, it is possible that the area’s origins as a reclaimed coastal wetland will become better known.

**Food provision**

4.10 The two factors of public policy towards the protection of designated land and the effect of the changing climate and increased flood risk, described above, will continue to constrain food production in the project area. Within designated sites, extensive beef and sheep production on seasonally wet grassland will continue to be incentivised. Outside the designated sites it is likely that commercial pressures and opportunities will encourage further intensification of improved grassland and arable farming by large farming businesses where lower flood risk allows and more economically marginal low input grassland farming by smaller part-time businesses where it does not.

4.11 This suggests that there will be increased polarisation of farming types between designated and undesignated land. However, it is possible that this trend will be countered by the increased severity of flooding which will make farmland less suitable for intensive grassland and arable production. In additional, international price pressure (volatile and falling agricultural commodity prices) and the high costs of pump drainage, may make high input/output farming (such as dairying) uncompetitive.

**Conclusions on drivers of change**

4.12 The most significant driver of change that will effect land and water management and the condition of all the selected ecosystem services is flooding, which the changing climate is likely to make more frequent and severe. Public policy will be used to focus flood protection on the most economically significant assets and on sites of international biodiversity and archaeological importance. Sites of highest biodiversity value will continue to receive targeted support to encourage favourable management. Outside these areas, there is likely to be divergence between more intensive commercially driven agriculture on the best land (with lower flood risk) and lower input and more part-time farming on other land.

**The national and local policy framework for delivering change**

4.13 This section considers the potential role of public policy instruments in addressing the drivers of change and enhancing the selected services in a way that delivers the locally agreed vision for the area. A concluding section briefly considers whether there are gaps in the policy framework that is required to plan for more integrated delivery.

**National and local planning policy**

4.14 The National Planning Policy Framework (NPPF) for England, published by Government in March 2012 to replace previous planning policy statements and guidance, makes clear that the planning system should contribute to and enhance the natural and local environment including "recognising the wider benefits of ecosystem services". The NPPF emphasises the importance of directing built development away from designated sites, the best and most versatile agricultural land, balancing sustainable development with the needs of biodiversity and the historic environment.\(^{45}\) Supporting the "transition to a low carbon future in a changing climate and taking full account of flood risk and coastal change" are cited as being among the core principles of the planning system.\(^{46}\)

4.15 These principles are implemented in practice through Local Plans. In the project area this means the Core Strategies and other Development Plan Documents produced by each of the District Councils: Sedgemoor, South Somerset, Mendip and Taunton Deane. The Sedgemoor Core Strategy (covering the majority of the project area) sets out nine strategic objectives which the planning policies will deliver. The first of these recognises the threat of flooding, seeking "To address the challenges of Climate Change and vulnerability to Flood Risk". Another strategic

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\(^{46}\) Ibid. Paragraph 17.
objective is “To conserve and enhance the natural assets and heritage of Sedgemoor including its natural resources, wildlife habitats, landscape character and historic environment, including appropriate adaptation to climate change”. The value of agriculture to the rural economy in the District is recognised through a number of individual policies.\textsuperscript{47}

4.16 While clearly recognising the importance of the selected ecosystem services (particularly, in the local context, flood risk management), both national and local planning policy are concerned primarily with controlling built development. They therefore have relatively influence over other forms of land use, such as farming, that lie outside the planning system.

The Common Agricultural Policy

4.17 Public policy towards agricultural production is directed mainly through the EU Common Agricultural Policy (CAP). Whereas it used to be the case that the CAP’s price support and supply control mechanisms had a strong influence on patterns of agricultural land use, successive reforms since the early 1990s have ‘decoupled’ agricultural policy from particular forms of agricultural production. The mainstay of the CAP is currently the ‘Basic Payment Scheme’ (BPS) that provides farmers with an annual income. The benchmarking data from the annual Farm Business Survey shows that for most lowland livestock farms (and indeed other sectors), this payment represents a very significant proportion of business income without which the business would trade at a loss\textsuperscript{48}. The BPS is therefore an important policy instrument in maintaining farming as the dominant land use in the project area and supporting the delivery of services such as food production and (for grazed wet grassland habitats) biodiversity.

4.18 The influence of the BPS in encouraging favourable forms of agricultural management is more difficult to detect. Farmers receiving the payment must abide by a set of ‘cross-compliance’ rules covering legal and best practice standards of environmental management and animal welfare. In addition, three ‘greening’ rules were introduced in 2014, tied to the payment of 30% of the BPS, which affect the area of permanent grassland (at a country scale) and the diversity of arable crops and the protection of ‘ecological focus areas’ (at a farm scale). However in practice, it is unlikely that the ‘greening’ rules will have significant impact, beyond existing regulatory requirements, on delivery of ecosystem services in the project area. This is because the rules apply equally to all farmers receiving the BPS and there is no discretion or targeting to address local environment objectives.

Agri-environment schemes

4.19 Agri-environment schemes form an important voluntary element of the CAP. As already noted, the Environmentally Sensitive Area (ESA) scheme and its successor Environmental Stewardship have had high levels of uptake in the project area (paras 1.17 and 2.32). These have encouraged the retention of extensively grazed wet grassland in the project area since the mid 1980s, helping the delivery of all of the selected ecosystem services. ESA agreements were targeted to deliver biodiversity, landscape character and the historic environment, and other objectives including water quality and flooding were added to the higher tier of Environmental Stewardship.

4.20 An evaluation of the impacts of ESA agreements in 2002 concluded that "most ESAs were successful in maintaining wildlife value, but enhancement was at best partial" and that "historic environment values ... were maintained in almost all ESAs".\textsuperscript{49} There has been no equivalent monitoring of the impacts of Environmental Stewardship, but it is likely (because the management prescriptions are similar) that the similar conclusions apply to this scheme – i.e. that the scheme has been effective at maintaining pre-existing values but less effective at enhancing and extending them.

4.21 Environmental Stewardship closed to new agreements in 2013, with agreements signed before then being allowed to run to completion. It was replaced in 2015 by Countryside Stewardship which is focussed less on maintaining existing values (with the withdrawal of the entry level tiers that where present in both the ESA and Environmental Stewardship) and more on proactive


\textsuperscript{48} The Farm Business Survey is prepared for Government by Rural Business Research, a consortium of six University Research Centres. See http://www.farmbusinesssurvey.co.uk

\textsuperscript{49} Ecoscope et al (2003). Quotes from paragraphs 0.36 and 0.37 of the executive summary.
conservation and enhancement (but with a lower overall budget). The new scheme is more tightly focussed on delivering the core objectives of biodiversity and water quality (with secondary outcomes including flood management, the historic environment and landscape character). It is likely that during the 2014-2019 Rural Development Programme period the Government’s austerity programme will lead to tighter funding of Countryside Stewardship, targeting agreements to designated and other high value sites. It is unclear what level of agri-environment support will be offered to land outside these areas. This could result in land outside SSSIs in the project area that have been under agri-environment agreements for up to 30 years losing this support.

**Biodiversity 2020**

4.22 The Biodiversity 2020 Strategy (sub-titled 'A strategy for England’s wildlife and ecosystem services') sets out the Government’s strategic director for biodiversity policy over the period 2010 to 2020. It includes a mission to “halt overall biodiversity loss, support healthy well-functioning ecosystems and establish coherent ecological networks, with more and better places for nature for the benefit of wildlife and people” 50 It strongly advocates the ecosystems approach (following on from the 2011 Natural Environment White Paper 'The Natural Choice' and UK National Ecosystem Assessment (NEA) also published in 2011) but the primary focus of the actions arising from the Strategy relate to biodiversity conservation. The actions in the Strategy are at a relatively high level covering issues such as reform of the CAP and planning system and operating of agri-environment schemes. It is through implementing measures such as these that the Biodiversity 2020 strategy will influence ecosystem service delivery in the project area.

**Flood risk management policy**

4.23 National policy towards flood risk management is contained in the the National Flood and Coastal Erosion Risk Management (FCERM) Strategy for England which takes it authority from Section 7 of the Flood and Water Management Act 2010. The Strategy sets out the responsibilities of the various authorities responsible for planning and delivering action for FCERM. In the project area these are Environment Agency, Somerset County Council, the District Councils and Internal Drainage Boards. It also describes the approach taken by Government in allocating resources to flood defense.

4.24 The detailed assessments of flood risk and the preferred long term approaches that will be taken to address them at a local scale are contained in the Catchment Flood Management Plans (CFMP) prepared by the Environment Agency. The project area is covered by the Parrett CFMP (for the rivers Parrett and Tone) and the North & Mid Somerset CFMP (for the Brue and Axe). These acknowledge the significant and rising risk of flooding of properties and land (in the Parrett 3,300 properties are at risk of a 1% annual probability flood event and this is expected to double in the future). The CFMPs record and take account of key environmental issues that are relevant to management of the flood risk and any impacts that may arise as a result of the CFMP. These are focused primarily on designated sites, with water level management plans a key tool in addressing these issues (see below).

4.25 A contentious issue with farmers and landowners in the project area has been the distribution of flood water to certain areas (such as Curry and Hay Moors) such that they remain flooded for longer than other areas, reducing agricultural production and potential. This is acknowledged in Policy Option 6 of the Parrett CFMP which states: "We will take action with others to store water or manage runoff in locations that provide overall flood risk reduction or environmental benefits. By adopting this policy and redistributing water some areas will be subject to increased flooding while others will benefit from reduced flooding. The aim is to achieve a net overall benefit. The distribution of floodwater between moors can be determined to some extent by the use of sluices and other structures on the rivers. The distribution of floodwater has developed to some extent by historical 'accident' rather than design. When considering the distribution of assets across the sub-area it makes sense to direct water to areas which have limited assets at risk". The way in which 'net overall benefit' and 'assets' are defined in this Policy is not explicitly spelled out. The economic value of assets (property and land) is likely to be a major consideration and it is clear that the international Natura 2000 designations are also a significant factor. It is less clear how

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50 Defra (20110
other services such as food production, sense of history and also biodiversity on undesignated sites are factored into the assessment of ‘net overall benefit’. Incorporating the ecosystems approach into the decision making process might enable greater clarity in decisions over flood storage.

4.26 Following the flood events of 2013/14, local stakeholders including the Environment Agency prepared a 20 year Flood Action Plan for the Somerset Levels and Moors in 2014. This is covered further below.

Protection and management of designated sites

4.27 Designated sites (in the context of the project area these are SSSIs, SACs and Scheduled Monuments) are subject to protection through legislation. The two agencies charged with enforcing this legislation, Natural England and Historic England, have programmes to monitor the condition of designated sites (for instance, SSSI condition assessments and heritage at risk registers). In terms of support for proactive protection and management, agri-environment schemes are the main mechanism and, as noted above, conservation of biodiversity on designated sites is a key objective of the new Countryside Stewardship scheme.

4.28 Water Level Management Plans (WLMPs) are required for all SSSIs where water level management is important for the maintenance, or rehabilitation, of their scientific interest. Internal Drainage Boards are responsible for preparing WLMPs with the agreement of Natural England and the Environment Agency. The Somerset Drainage Board Consortium of IDBs has prepared ten WLMPs covering all relevant areas of the Somerset Levels and Moors. These describe the responsibilities of the Environment Agency and IDB for maintaining flood defence structures and water bodies and set out the target water levels that will be maintained during the summer and winter months by use of pens, sluices and pumps.

4.29 WLMPs therefore provide an important means of balancing the requirements of biodiversity and flood risk management. In practice, the requirements of two of the other selected ecosystem services – carbon storage and sense of history - also tend to be met in the WLMPs because their optimal management closely meets that of biodiversity. The needs of agricultural management are addressed in so far as they are needed to deliver biodiversity objectives but are not an objective in their own right.

Conclusions on the suitability of the policy framework in relation to ecosystem interactions

4.30 This section of the report has briefly reviewed the key national and local policy strategies and measures affecting ecosystem service delivery in the project area. It has shown that all of these policies, to varying extents, recognise and seek to address the multi-functional and ‘multi-benefit’ nature of land use and management.

4.31 The policy framework that influences land use and management (and in turn ecosystem service delivery) in the project area gives high priority to biodiversity (particularly on designated land) and to flood risk management. The agricultural value of land for food production and for the rural economy is also recognised in planning policy.

4.32 In contrast, the value of the carbon-rich soils for climate regulation and the historical significance of archaeological sites and traditions receive much less recognition. This maybe because there are fewer perceived threats to these services or because the the evidence of their value is less well known.

4.33 The need to balance trade-offs between different ecosystem services, and seek win-win outcomes, is acknowledged in principle but there are fewer practical policy mechanisms available for achieving this. This is particularly the case in undesignated areas of countryside where the Countryside Stewardship scheme is the primary policy mechanism available to influence land use and management. Its reduced budget (compared to Environmental Stewardship) means that it is likely to be more tightly focussed (spatially and in its outcomes) on the primary objectives of biodiversity and water quality than was the case with its predecessors.

4.34 While local flood risk management policy (through the CFMP) acknowledges the need to achieve ‘net overall benefit’ there is no explicit mechanism on how this outcome can be defined or achieved in practice.
Getting local agreement on priorities and achieving co-ordinated action

4.35 Within the context of the national and local policy framework outlined above, there have been a number of local initiatives that have sought to gain local agreement for, and deliver on the ground, action that meets the challenges facing the area – particularly the threat of increased flooding.

Lobbying positions of different interest groups

4.36 The aftermath of the 2013/14 flood event saw a number of interest groups express their frustration at what they saw as a lack of concerted action to address flood risk, particularly the long term dredging and maintenance of the main rivers that carry flood water out to sea. Organisations such as the Flooding on the Levels Action Group (FLAG) formed and put forward a seven point plan. A facebook community ‘Stop the Floods - Dredge the Somerset Levels’ was created, with its own Six Point Agenda. Established organizations were also active in developing their own proposed solutions. The Somerset Drainage Boards Consortium advocated a ten point plan, the Royal Society for the Protection of Birds (RSPB) and Somerset Wildlife Trust (SWT) joined forces to promote Five Key Principles. Community groups such as the Athelney Transition Group debated and responded to the issues raised. The National Farmers’ Union (NFU) and Country Land and Business Association (CLA) published position statements.

The Vision for the Somerset Levels and Moors

4.37 The work undertaken by a task force of local stakeholders, triggered by the flooding in 2012/13 to agree and publicise a Vision for land use and management in the area was described at the end of Chapter 2 (para. 2.62). This Vision was a reaction to the perceived lack of consensus in the objectives of different stakeholders and a lack of clarity in policy documents such as the Catchment Flood Management Plans. As noted at the end of Chapter 2, the Vision recognises the wide range of benefits provided by the area (including all of the selected ecosystem services covered by this study) and advocates land use and management that delivers a win-win mix of activities. This Vision has been broadly accepted by stakeholders as the starting point for detailed project development and delivery.

The Somerset Levels and Moors Flood Action Plan

4.38 This Plan was prepared, at the behest of the Secretary of State for Environment, Food and Rural Affairs, Owen Paterson, in the immediate aftermath of the flooding of 2013/14. It was launched in March 2014 by a broad partnership of local and national organisations, coordinated by Somerset County Council, and covers the catchments of the rivers Parrett, Tone, Axe and Brue (i.e. the whole of the catchments, not only the areas subject to flooding).

4.39 The Flood Action Plan (FAP) has adopted the Vision (above) as the eventual goal it wishes to see delivered. It recognises that achieving this will be part of a long term process taking place over a 20 year period, requiring further evidence (on issues such as the cost effectiveness of flood defence measures) and agreement with businesses and communities (on issues such what are acceptable levels of risk and what is a reasonable standard of protection for people, property, agriculture and the environment).

4.40 Funding has been identified from a number of sources. From national government, Defra has allocated £10m for flood risk management, the Department for Transport (DfT) has allocated £10m for transport work and Communities and Local Government (CLG) has allocated £0.5m for community resilience. Locally, partners have identified over £1.5m towards future flood risk reduction work. In addition, Somerset business, farms and households are eligible for support under a variety of national level flooding recovery programmes.

51 http://www.flagsomerset.org.uk/Media/7-Point-Plan.aspx
The Plan groups its actions into two types of activity, as shown in Table 4.1. Each of the action themes is summarised in the following section, and their potential contribution to delivering the selected ecosystem services is considered.

Table 4.1. Summary of the key activities being taken forward under the Flood Action Plan

<table>
<thead>
<tr>
<th>Type of activity</th>
<th>Action themes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk reduction actions</td>
<td>• Dredging and river management</td>
</tr>
<tr>
<td></td>
<td>• Land management across the whole of the catchments</td>
</tr>
<tr>
<td></td>
<td>• Urban run-off</td>
</tr>
<tr>
<td>Mitigation actions:</td>
<td>• Infrastructure resilience</td>
</tr>
<tr>
<td></td>
<td>• Building local resilience</td>
</tr>
</tbody>
</table>

**Dredging and river management**

4.42 Responding to claims that a decline in the maintenance of river channels had been a major factor contributing to the severity of the flooding, the FAP has prioritised the dredging of 8km of the Rivers Tone and Parrett near their confluence at Burrowbridge (completed in October 2014). Further work is underway to identify the cost effectiveness of dredging a further ten sections along parts of the Rivers Parrett, Tone, Yeo, Axe and their tributaries, and also of increasing capacity of the Sowy/Kings Sedgemoor drain system. Design options for a Bridgwater tidal barrier are being reviewed. In addition, ongoing maintenance of riparian vegetation, bank profiles and spillways along the rivers and smaller watercourses is taking place.

**Land management**

4.43 The FAP recognises that what the way land is managed in the upper and mid catchment can affect flood risk in the lower catchment. Modelling work suggests that the benefit of appropriate land use management on reducing peak flood flows, flow volumes and times to peak flooding diminishes as the scale of the catchment increases. On-farm storage is likely to be more effective than land use change but co-ordinated actions by a large number of landowners is likely to be required to have any discernible effect on catchment scale flood events. Improving soil management in the mid and upper catchments will also reduced siltation of downstream river channels, reducing the need for dredging. The FAP includes provision for a new pilot approach to Catchment Sensitive Farming that covers flood risk management as well as water quality, through integrated advice and support to assist land managers.

**Urban run-off**

4.44 The role of Sustainable Drainage Systems (SuDS) that are ‘built into’ new developments is included in the FAP. As with rural land management, SuDS have limited scope to effect the outcome of severe flood events, and the Plan acknowledges that use of SuDS is already a requirement of the planning system. Nevertheless, the Plan includes provision for more effective targeting of these measures and for improving standards.

**Infrastructure resilience**

4.45 The effect of flood events on the road, road, rail, sewerage, power and telecommunications networks and the resulting economic and social disruption is considered by the FAP. Actions include more effective maintenance of road gullies, culverts and road surfaces and proactive planning for the electricity, drinking water and sewerage systems.

**Building local resilience**

4.46 The final theme in the FAP identified how households and businesses can be helped to prepare for, and respond to, flooding. Actions address the provision of targeted and co-ordinated support during flood events from the range of agencies that need to be involved; work to help

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54 Letter from the National Farmers’ Union South West office to Defra Minister, Dan Rogerson, 23 January 2014. This assertion was challenged (CIWEM 2014), suggesting that dredging would have not prevented the flooding but could have reduced its duration.

55 Most recently reviewed in CIRIA (2013)

communities be better prepared (through the Community Resilience in Somerset Partnership); and providing advice on sources of property insurance.

4.47 The FAP stops short of putting forward more radical options (such as creating more flood storage areas or building new flood defence structures) partly because of a lack of evidence of their effectiveness and partly because of a lack of funding sources. However, a short ‘Section 2’ of the Plan lists the range of options, their potential cost and responsibility for their further consideration.

**Establishment of a new Somerset Rivers Authority**

4.48 The Somerset Rivers Authority (SRA) was established on 31 December 2014 as the umbrella organisation to coordinate implementation of the Flood Action Plan. The SRA is officially sanctioned by both Defra and the Department for Communities and Local Government as well as Somerset County Council, through a Memorandum of Understanding.

4.49 The SRA has an interim budget of £2.7m (£1.9m from central government and the remainder from local government), with additional funds being raised externally by the Somerset Levels Development Fund (see below). The primary focus of the SRA is the co-ordination and delivery of flood risk management work undertaken by the Environment Agency, IDB and local authorities though a Common Works Programme. Natural England is a partner organisation on the SRA because of its statutory role in water level management planning on SSSIs.

4.50 The creation of this Authority is significant step to ensure policy is delivered in a more integrated and focussed manner. Although its focus is on flood risk management and protection, there is strong implicit agreement that this work must take account of, and advance, the delivery of the range of ecosystem services in the area. This will be done both by assessing and mitigating the impacts of flood defence work and by working with other projects that address these issues. One important source of funding for these other projects is the Somerset Levels Development Fund.

**Somerset Levels Development Fund**

4.51 Fortuitously, in the months before the severe flooding in 2013/14, the Royal Bath and West of England Society launched a ‘fighting fund’ to address the long term issue of flooding on the Somerset Levels and Moors (initially called the Somerset Levels Relief Fund). The original aim of the fund was to raise £2-3 million to dredge key rivers on the Levels. The Society saw its role as bringing together the responsible parties, including landowners, to ensure that this work was done in the face of what was seen, by landowners, as a lack of commitment by the Environment Agency. Following the flooding in 2013/14 the fund was able to take advantage of the national news coverage and public sympathy this produced and, with a substantial sum to spend on long term solutions, the name of the fund was changed to the Somerset Levels Development Fund. Following the preparation of the Flood Action Plan (see above), money from the fund has been used to address work identified in the FAP that outside the scope of the statutory funds handled by the SRA.

4.52 This work has included a catchment-wide water management programme led by the Farming and Wildlife Advisory Group and also a number of economic diversification projects such as converting biomass waste from wetland nature reserves to energy, promoting ecological tourism, developing value-added food and drink from the area, and piloting the establishment of an ‘Ecological Enterprise Zone’ where businesses are encouraged and supported to collaborate in making more use of the economic value of the outstanding environmental quality of the Levels and Moors.

4.53 There are also plans for the Fund to establish a pilot Payment for Ecosystem Services scheme on one key Moor. The pilot study will investigate the range of ecosystem services provided by one Moor, examine how this might change under different land and water management, and investigate new and innovative funding mechanisms that can incentivise change and provide land managers with new income streams.

4.54 Another initiative being developed from the fund is the potential for a Community Land Trust. This could provide a mechanism for the community to purchase, own and manage land on some of the wettest parts of the Somerset Levels and Moors where the most significant changes in land management are required. Such a Trust could facilitate a collaborative approach to the management of the floodplain enabling farmers to work together with their local communities.
Conclusions on locally developed co-ordination and delivery

4.55 A key feature of the initiatives that have taken place in response to the flood events of the last few years has been a broad range of interest represented, including the Local Authorities, Environment Agency, Natural England, IDBs, RSPB, Somerset Wildlife Trust, Country Land and Business Association and National Farmers Union. A conscious effort has been made to put aside previous differences of approach and reach a consensus on the way forward.

4.56 Although the focus of most of the work, particularly that using public funding from central and local government, has been on flood defence and flood risk management, the value of the ecosystem services provided by the area is better understood and taken into account (as reflected in the Vision for the Somerset Levels and Moors). It is significant that much of the additional funding acquired by the Somerset Levels Development Fund is being used to enhance these values. Initiatives such as the exploration of an Ecological Enterprise Zone, a pilot Payment for Ecosystem Services scheme and conducting research into the creation of a Community Land Trust represent novel and innovative approaches that take a more integrated and ecosystem service-centred approach than has been taken previously.

4.57 It would be wrong to assume that all the concerns of different bodies have been resolved. The decisions taken about flood storage on the Moors (about where and for how long water is stored on certain moors) and whether farmers and landowners who suffer losses as a result of these decisions should be compensated remains subject to debate and potential legal challenge, led by the NFU.

4.58 It is also worth noting that the consensus and joint action has been developed in response to the major threats posed by future flooding. This consensus will no doubt be tested by major flood events that may occur, or alternatively, by a period without significant flood events if this were to occur.
5 Findings and transferability of results

Chapter summary: This final chapter recaps on the overall conclusions arising from the study. It covers the characteristics of the project area and how this has affected the research. It reaches conclusions on the relationships between the selected ecosystem services and on the way public policy and local initiatives encourage positive outcomes that optimize service delivery. Finally the lessons from this study for other areas of England are briefly reviewed.

Overall findings

The project area

5.1 The Somerset Levels and Moors were selected as the project area for this study because of the range of ecosystem services provided by the area’s land and water and because of the history of debate and initiatives that have sought to reconcile different land and water management objectives. In many ways, the area is typical of much of the rural lowlands of England. Land use is dominated by agriculture, the changing nature of which has brought significant changes to the landscape and natural resource use over the last 70 years and more. The landscape, while considered special by many, has not been designated as an Area of Outstanding Natural Beauty or a National Park.

5.2 However, in two important respect, the area is different from most of the rest of lowland England. Firstly, the area has one of the largest areas of coastal and flood plain grazing marsh habitat in the country and this attracts large populations of overwintering wading birds which give the area international importance for biodiversity.

5.3 Secondly, the area lies at or below sea level at the lower end of relatively large river catchments. Although the area has a sophisticated system of raised river banks, drainage ditches and pumping stations, the projected changes to the climate and rising sea level pose a significant risk of increased flooding.

5.4 Unforeseen flooding events took place twice during the period of study. This understandably resulted in a concentration of attention from stakeholders on the impacts and contributing factors of flooding and made it impossible for this study to engage in dispassionate dialogue about the changes needed to enhance other services. As a result, the study changed from seeking to directly influence local policy development and practice to a position of observation and passive assessment.

Ecosystem interactions

5.5 This study has reviewed the ecosystem services provided by the project area and the value that is placed upon them. The information on ecosystems services contained in the National Character Area profiles prepared by Natural England (available for all areas of England) provided value evidence from which to make this assessment, leading to the selection of the five ecosystems services where were considered most significant for this study.

5.6 In terms of value, biodiversity came out as the most important service provided by the area on account of the internationally important populations of overwintering wading birds. This importance is strongly reflected in the national and local policies that affect land use and management in the area. Biodiversity objectives can be considered a constraint on other services such as flood storage and food production because of incompatibilities in the land management requirements, but they have strong management synergies with others such as the sense of history and soil carbon storage.

5.7 Even more than biodiversity conservation, flood risk management is the service that has the greatest influence on policy (particularly since the recent flood events). Increasing flood risk is
the most significant driver of change and the cause of most disagreement over land and water management policy. Understanding the service is complex and subject to scientific uncertainty, such as the role of upstream land management in reducing flood run-off and peak river flows. Whereas the management of small and moderate events through the temporary storage of flood water on land is broadly compatible with the other services (less so food production), the impact of severe flood events is more problematic for delivery of the other services, particularly biodiversity and food production.

5.8 Food production has less significance as a service in its own right, being important at a local scale, but is important because farming is the dominant land use and because beef and lamb production from grassland can provide the most suitable land management for all the other services. On the other hand, moving to forms of farming with higher economic output of food (such as dairying and arable) produces conditions which conflict with the other services. Changes in farming and food production both as a result of market pressures and policy reform are also likely to be significant future drivers of change, affecting the other services.

5.9 The two other services covered by this study, sense of history and soil carbon storage, have international or national importance, based on the value of their assets. However, both these services are much less evident in policy objectives than the other three. This can be seen in planning policy, in agri-environment scheme objectives and in the measures in place to deliver biodiversity and flood risk management. The lower profile of these services may not matter in practical terms however because the management conditions required to conserve biodiversity (extensive livestock grazing with seasonally high water levels) also favour these services.

Planning positive outcomes

5.10 One of the impacts of the severe flood events that have occurred in recent years has been better local dialogue between stakeholders and the search for consensus and a common vision for future land and water management. The ecosystems approach has played a part in this process since it provides an objective way of establishing the values that the area provides. The Vision for the Somerset Levels and Moors developed by a local Task Force emphasises the role that farmers and landowners play in providing ecosystem services (specifically “flood risk management, coastal management, carbon storage and the natural environment”).

5.11 Achieving this Vision will be challenged by the external drivers of change acting on the area, particularly by the rising risk of flooding and also volatile agricultural markets and austerity cuts in agri-environment funding. An understanding of how these changes will effect the ecosystem services of the area will be important. Shallow seasonal flooding is broadly compatible with biodiversity, carbon storage and the sense of history but deeper flooding for long periods will harm the existing biodiversity interest. The economic value of extensive livestock grazing for food production is likely to continue to decline and its future is likely to be reliant on its value in delivering other ecosystem services, provided this value is recognised and rewarded. Arguably, the primary rationale for livestock farming on the Somerset Levels has been gradually changing from one of food production to conservation management over the last 30 years. However, consolidating this long term change may have unforeseen social and cultural changes in the way the landscape is perceived and ‘lived’.

5.12 Public policy at a national level emphasises the ecosystems approach and the need to economically value and incentivise the provision of ecosystem services. In practice however, there is less evidence of this being implemented either in CAP support and agri-environment schemes or in flood risk management measures. The main focus of land and water management programmes being implemented in the area is on flood protection (particularly through the £2.7m interim budget co-ordinated by the new Somerset Rivers Authority) and on biodiversity conservation (through water level management plans). Benefits accruing to other services such as carbon storage in soils appear to be fortuitous rather than planned.

5.13 However, it is significant that innovating policy development that takes a more integrated and ecosystem-centred approach is being developed locally, particularly through funding acquired by the Somerset Levels Development Fund. These include continued work on whole catchment land management planning, the piloting of a Payment for Ecosystem Services scheme and the exploration of land swaps through a Community Land Trust to achieve better spatial zoning of
land uses. These innovative approaches are seeking long term solutions to the challenges the area will face over the coming decades.

5.14 It is possible to envisage a much more radical future for the area, involving dramatic changes in land use and in land and water management leading to a return to the extensive wetland habitats that existed before people drained and agriculturally improved the area. There would appear to be little local support at the moment for such large scale ‘rewilding’ of the landscape, not least because of the economic and social impacts it would have on local residents and businesses. Such a change would challenge the understanding of ecosystem services, particularly cultural services such as biodiversity and sense of history. It would require answers to challenging questions such as ‘Do large blocks of relatively inaccessible reed marsh deliver higher biodiversity values than the current chequerboard pattern of grazed wet grassland?’ or ‘Does allowing the forces of nature to retake control of large areas add to or diminish the cultural heritage of the area?’.

Lessons for achieving co-ordinated planning of service delivery in other areas

5.15 This final section of the report briefly considers how the experiences and knowledge gained in the Somerset Levels might be transferred to other areas. It looks at the analytical techniques used to understand the interactions between ecosystems services and the ways in which these can feed into dialogue and decision making with stakeholders to achieve more integrated outcomes.

Other areas facing similar challenges for ecosystem service delivery

5.16 Increasing flood risk is a significant threat to many other low-lying coastal areas of England. There are strong similarities to the Somerset Levels where these areas contain wetland habitats of high environmental value. They include the Humberhead Levels in the north east of England, the edge of Morecambe Bay in the north west, the Pevensey Levels in the south east, and also the Caldicot Levels in south east Wales.

5.17 The challenge common to many of these areas is the delivery of flood risk management policies that balance the protection of key economic assets with the maintenance of biodiversity and the continuation of viable agriculture. Areas such as the Vale of York have seen vigorous debate about flood risk management decisions over where to store flood water and about the economic impact of these decisions on landowners.

5.18 The impact of intensive agriculture on high biodiversity value is another theme affecting policy delivery in many parts of England. The Meres and Mosses (on the Shropshire / Cheshire border) and the Norfolk Broads contain important wetland habitats surrounded by arable cropping. These areas share with the Somerset Levels the presence of historically significant archaeology and soils rich in organic carbon. However, the management challenge in these areas is somewhat different to that in the Somerset Levels, where it is the reconnection of semi-natural habitats and mitigation of agricultural impacts that is the main priority, rather than the maintenance of traditional systems of livestock grazing (although this does also apply).

5.19 In this latter respect, the economically marginal nature of extensive grazing on the Somerset Levels as the preferred form of land management, delivering a range of services, can be likened to the continuation of common land grazing in the uplands.

5.20 Although these similarities with other areas exist, it should be noted that the size and environmental significance of the wet grassland habitats and the severity of recent flood events on the Somerset Levels make the area unique in the UK.

Better informed evidence of ecosystem interactions

5.21 A growing interest in the ecosystems approach as a way of understand the range of benefits provided by the natural environment is evident throughout the UK. Paragraph 2.31 described some of the mapping tools that are being developed to better inform stakeholder dialogue. Although valuable work has been undertaken in the Somerset Levels (for instance the Brue Valley Living Landscapes Project – para 1.19, and also this study), the approaches taken in areas such
as the Humberhead Levels (the Ecosystem Service Interactions - Spatial Interactive Tool, see para. 2.31) and East Devon (the Participatory Ecosystem Services Visualisation Framework, *ibid.*) have been more rigorous and could be usefully adopted in the Somerset Levels as a way of giving spatial expressed to the Vision statement that has been agreed in the area.

5.22 There is considerable expertise in the Somerset Levels on the practices of water level management to balance flood risk with environmental objectives. This is held by the engineers and ecologists of the Environment Agency and the Somerset Consortium of Drainage Board and also by conservation bodies such as the RSPB and Somerset Wildlife Trust. Such expertise is available to be shared with other areas through organisations such as the Association of Drainage Authorities.

**Stakeholder representation and partnership working**

5.23 The mix of cultural identities, social capital and local governance is unique to each area and it would be foolish to seek to transfer specific ways of work to other areas. In the case of the Somerset Levels, the distinct cultural identity of the villages represented by local authorities, the large land holdings of conservation bodies such as the RSPB, the statutory role of the Environment Agency and IDBs, and the representation of farming and landowning interests by the NFU and CLA have all shaped the way local policy objectives have developed. These precise conditions are unlikely to apply in the same way to other areas.

5.24 The programme of Nature Improvement Areas (NIA) in England, which incorporates the ecosystems approach in locally-based partnerships delivering landscape-scale ecological restoration, includes many other examples of stakeholder engagement processes. The Humberhead Levels NIA Partnership includes a similar mix of local authority representation, IDBs and conservation bodies. The Meres and Mosses NIA has included a public dialogue project, part funded by Scienewise ERC⁵⁷, which sought to embed public dialogue in local decision making to the delivery of ecosystem services. In the Somerset Levels, the local experience of flooding probably makes this kind of ‘sensitisation’ of the public unnecessary, but a more structured approach to involving local residents in policy development might be worthwhile.

5.25 In the Somerset Levels, the significant progress that has been achieved in recent months in producing stronger consensus between stakeholders and co-ordination of action through the new Somerset Rivers Authority, was very largely the result of the severe flood events in 2012 and 2013/14. The shock of these events and the national funding that they brought to the area brought a willingness to engage and compromise that had previously been lacking.

5.26 An important lesson from this situation is that, rather than waiting for extreme events to create a willingness for dialogue and coordinated action, policy makers need to create a sense of urgency that brings parties together. Under these circumstances, the concepts of values, benefits and services provided by the ecosystems approach can provided a common language for productive dialogue and the development of more integrated policies.

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