WATER

Restoring river catchment function using payments for ecosystem services

WATER
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The Catchment Approach

Why work on river catchments?

Humans have developed many and varied geographic units to manage society, such as parish, borough and county boundaries. However, while these units may be the most appropriate for managing people, there is now an increasing recognition that we actually need to manage people within the context of their environment.

River catchments offer a natural unit (the ecosystem) where water moves over and through the landscape to the sea via streams and rivers. The quality and quantity of the water in the river is closely related to the way we use the land and the services we derive from it.

What key habitats are in a catchment?

The National Ecosystem Assessment (NEA) for the UK sets out 8 broad habitat types of which 5 dominate our river catchments.

Enclosed farmland is the most extensive form of landuse in the UK, accounting for around 40% of land area and producing around 70% of the UK's food. Most is managed for cereal, cattle and sheep production although there is significant regional variation.

Mountains, moorlands and heaths cover 18% of the UK land area. Lowland heaths are highly fragmented, while mountains and upland moors and heaths provide the largest un-fragmented semi-natural habitats in the UK. Mountains, moorlands and heaths are the source of around 70% of the UK's drinking water and hold an estimated 40% of UK soil carbon.

Freshwaters include open-waters, wetlands and floodplains. In the UK there are more than 389,000 km of rivers, 200,000 hectares of permanent lakes and nearly half a million small ponds. There are also estimated to be at least 390,000 hectares of fen, reed-bed, lowland raised bog and grazing marsh and nearly 1 million hectares of floodplain across the UK.

Woodlands include managed plantations as well as ancient and semi-natural woodlands. Woodlands cover 12% of the UK area and, of this, over 80% is less than 100 years old and just 5% is classified as ancient woodland.

Urban areas in the UK cover just under 7% of the land area and are home to 8 out of 10 people who are often living at extremely high population densities.

The remaining habitat types include semi-natural grasslands, coastal margins and the marine environment.

What is the current condition of our river catchments?

In 2005, the international Millennium Ecosystem Assessment (MEA) concluded that, on a global scale, while some services such as food production have increased, the majority of ecosystem services, such as the provision of drinking water and flood risk protection, have been degraded.

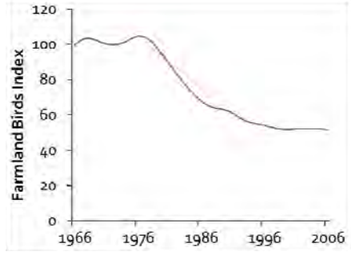
The UK NEA, published in June 2011, also concluded that over 30% of the services provided by our natural environment have declined significantly since the Second World War, although our pre-war industrialisation will also have degraded ecosystems substantially before this baseline period.

Why have our river catchments changed?

Catchment ecosystems and the services they provide have been directly affected by conversion of natural habitats, pollution of land and water, exploitation of terrestrial and freshwater resources, invasive species and climate change.

The population of the UK has grown significantly, from just over 50 million in 1950 to around 62 million today, and from the late 1940s onwards, the emphasis in the UK was therefore placed on maximising production of goods to meet the growing human need for food, fibre, timber, energy and water. During this period agricultural production entered a period of rapid expansion that continued for several decades. In England the area of land under crops increased by 40% from 1940 to 1980 (see graph of wheat production in the UK area over the past 100 years; below left). In addition, thanks to improved plant breeding, increasing chemical inputs and technological innovations, yields per hectare of most crops has also been significantly increased during this period.

Unfortunately, while agricultural productivity was increased, we now know that, during this time, there was a concurrent decline in the delivery of other key ecosystem services, particularly those relating to biodiversity, air, water and soil quality (see graph of farm bird abundance over the past 40 years; below right).



What are we doing about it?

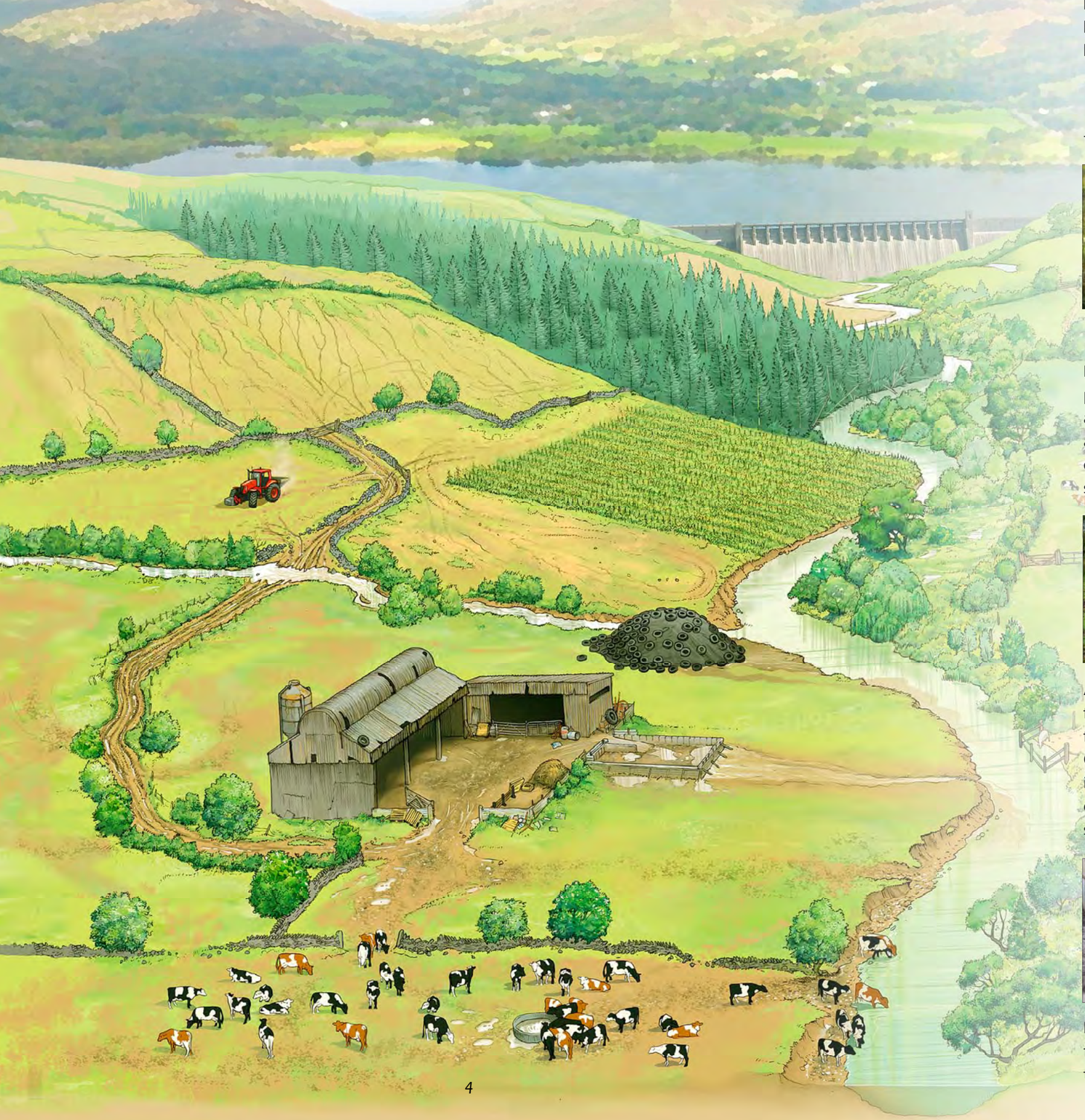
Attempts to address these declines in ecosystem services through legislation and policy reform began in the early 1950s with the designation of the National Parks and in 1981 the Wildlife and Countryside Act was a legal landmark in recognising the importance of biodiversity in law. More recently, many of the responses within the UK have been driven by European Union policy directives.

Since the early 1990s, financial support to farmers under the European Union Common Agricultural Policy (CAP) has been partially de-coupled from production to encourage wider stewardship of the countryside. Fertiliser application rates have also dropped in recent years and we have seen a large decrease in atmospheric sulphur deposition, both of which have contributed to improvements in water quality in both marine and freshwater ecosystems.

Despite these improvements, however, the delivery of many ecosystem services remains well below their full potential, many continue to deteriorate and the adverse impacts of these deficiencies on human health and well being continue to be felt. Together with a growing population and the increasing threat of climate change impacts the future is likely to bring even greater challenges and we must strive for more resilient river catchment ecosystems from which we can derive the full range of ecosystem services.

Threats to river catchments

River catchments come under pressure from a wide array of threats. Many that are derived from the urban environment or human industrial activity can be controlled by regulation and local planning guidelines, but more diffuse pressures that arise in the wider landscape are far more difficult to identify and remedy.



How do problems arise & then move across the landscape?

Pollutants can become available on the land in a variety of locations known as pollution **SOURCES**. Once they have become available for mobilisation they can then be carried through the system along pollution **PATHWAYS** and into the **RECEPTOR** watercourse where they exert their negative impacts.

This **SOURCE > PATHWAY > RECEPTOR** concept is a useful way to assess not only the pressures and potential impacts within a catchment (i.e. a pollution source may not be a problem if there is no pathway), but also to identify potential solutions. Below are some of the SOURCE and PATHWAY pressures within a typical West Country river catchment.

Pressures in the uplands (mountains, moors & heaths)

Historically, moorlands have been drained for peat cutting and agricultural grazing. Alongside this are the physical effects of increased recreational access and use.



Pressures on enclosed farmland

Many of the threats that arise on farmland occur as the result of land management or practice. These pressures, often referred to as **management pressures**, primarily relate to the timeliness of operations and the way basic farm resources are managed (soil, nutrients and water). These include inappropriate application of nutrients (too much applied and in the wrong weather), compaction of soils (over-use during wet conditions), high stocking densities and inappropriate crop management (exposed soils on steep slopes next to the river).

Alongside the pressures resulting from land management practices, there are also impacts which result from the use of inappropriate or poor quality **infrastructure** across the farm. The lack of adequate facilities mean the farmer has a reduced ability to manage the basic farm resources detailed above. Often farms have inadequate storage for silage, slurries and agricultural fuels and oils as well as insufficient guttering to ensure separation of clean and dirty water. In addition, there may also be a lack of appropriate buffers, tracks and culverts separating agriculture from the watercourses as well as poorly sited gateways that can act as pathways to carry pollution to the river.



In addition to the threats arising from agricultural sources, there are also further diffuse rural pressures from other human activities. These threats include discharges from poorly managed private sewage treatment infrastructure, run-off from roads and horticultural activities in parks and gardens.

Finding solutions to diffuse pollution

Diffuse pollution is, by its very nature, difficult to characterise and quantify across a catchment. However, when we do identify locations with an elevated risk of pollution or where pollution is already occurring, there are number of land management and restoration techniques that we can use to mitigate the risk or remediate the problem

What can we do to reduce diffuse rural pollution?

The threat of diffuse pollution in rural landscapes is, by its very nature, derived from many sources and its mitigation requires an approach that integrates several specifically tailored and targeted solutions. Often the approach to catchment management requires a blend of regulation, business management, advice and incentivisation all combined into an integrated resource management plan.

The SOURCE > PATHWAY > RECEPTOR concept helps us to identify where pollution SOURCES are likely to occur and then remedy or remove the risk of the pollutant becoming available. In addition, it helps us to identify and disconnect the pollution PATHWAYS moving pollutants into a watercourse. Below are some of the solutions that can be used within typical West Country catchments.

Solutions in the uplands (mountains, moors & heaths)

Degraded uplands can be restored by blocking drainage channels to trap water and re-wet the peat-based soils. Soon after restoration, wetland plants such as sphagnum moss begin to recolonise the re-wetted area.

Solutions on enclosed farmland

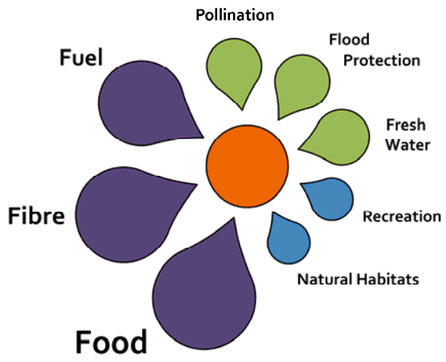
Land management solutions aim to improve the timeliness of operations and the way basic farm resources are managed (soil, nutrients and water). These include the creation of soil and nutrient management plans detailing where and when operations can occur (taking into account soil, slope and proximity to watercourses). These plans include the recommendation of measures such as; ploughing across slopes, avoiding over-wintered tramlines, not planting high-risk crops next to rivers, reducing stocking rates, moving ring feeders, appropriate site selection for out-wintering cattle. Some of these practices are mandatory under current regulations and many can save the farmer money by making his farming practice more efficient. Other measures, which are neither required by law nor financially beneficial to the farmer, can be incentivised through grant aid.

Adequate farm infrastructure gives a farmer the ability to manage the basic farm resources detailed above and makes it easier to develop and comply with a robust soil and nutrient management plan. Infrastructure solutions include the provision of proper yard facilities to store silage, slurries, fuels and oils, as well as sufficient guttering to ensure separation of clean and dirty water. Infrastructure solutions can also include the creation of buffers, wetlands, tracks, culverts and re-siting gateways to separate agricultural activities and livestock from adjacent watercourses. As is the case for management solutions, sufficient provision of some types of farm infrastructure is mandatory under the current regulations and many can save the farmer money by making his farming practice more efficient. Other measures, which are neither required by law nor financially beneficial to the farmer, can be incentivised through grant aid.

River catchments service our needs

River catchments and the ecosystems they support provide our society with a wide array of the services that we need to survive and which enrich our everyday lives. However, in recent years the provision of cheap food, fibre and fuel from our land have been prioritised and in the process the delivery of other services, such as flood protection, sufficient clean water, habitats for wildlife and spaces for recreation, has been compromised.

Ecosystem services are often perceived as a mixture of public and private goods some of which are traded and some that are expected to be delivered by the land for free. Either way, if we are to characterise the declines in these services and develop plans to restore and sustain their delivery in the future, then we must work to gain a more comprehensive understanding of how they are delivered by our ecosystems.



Supporting services provide the basic infrastructure of life. They include primary production, soil formation and the cycling of water and nutrients in terrestrial and aquatic ecosystems. All other ecosystem services – regulating, provisioning and cultural – ultimately depend on them. Their impacts on human well-being are indirect and mostly long-term in nature: the formation of soils, for example, takes place over decades or centuries. Supporting services are strongly interrelated to each other and are underpinned by a vast array of physical, chemical and biological interactions.

Provisioning services are manifested in the goods people obtain from ecosystems, such as food and fibre, fuel in the form of peat, wood or non-woody biomass, and water from rivers, lakes and aquifers. Goods may be provided by heavily managed ecosystems, such as agricultural and aquacultural systems and plantation forests, or by natural or semi-natural ones, for example in the form of fisheries and the harvest of other wild foods. Provisioning services have historically been a major focus of human activities and are thus closely linked to cultural services.

Regulating services provided by ecosystems are extremely diverse and include the impacts of pollination and regulation of pests and disease control on provision of ecosystem goods such as food, fuel and fibre. Other regulating services, include air quality, climate and hazard regulation, and the amount and quality of available freshwater. As with supporting services, regulating services are strongly linked to each other and to other kinds of services (e.g. Water quality is determined primarily by catchment processes and is thereby linked to soil and air quality and nutrient cycling).

Cultural services are derived from environmental settings (places where humans interact with each other and with nature) that give rise to cultural goods and benefits. In addition to their natural features, such settings are imbued with the history of interactions between societies, cultures, technologies and ecosystems. Such places provide opportunities for outdoor learning and many kinds of recreation; exposure to them can have benefits including aesthetic satisfaction and improvements in health and fitness and an enhanced sense of spiritual well-being and access to natural habitats.

Tools for the protection of ecosystem services

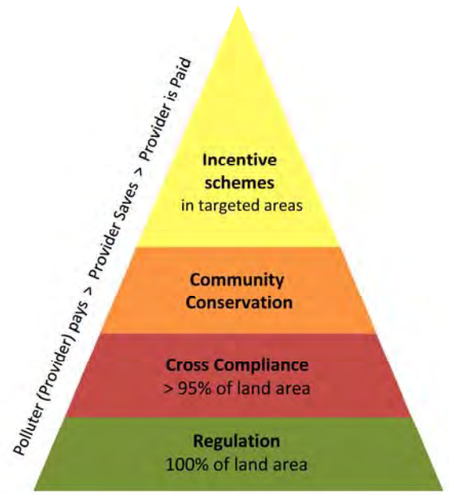
Until now ecosystem services have been managed in a variety of ways:

Regulation: The UK Government has put in place regulations and Statutory Management Requirements that cover all the UK land area and sets out the legal framework for any owner – 'Polluter Pays'.

Cross Compliance: Additional measures are detailed in the Good Agricultural and Environmental Conditions (GAEC) within Cross Compliance that is tied to farmers' European Subsidies. These subsidies are optional and so do not cover all land.

Community Conservation: Often referred to as win-win advice, this type of scheme sets out 'self-interest' economic advantages with certain best management practices that also improve other ecosystem services – 'Provider Saves'.

Incentive Schemes: Referred to as Payments for Ecosystems Services these schemes incentivise additional targeted actions: 'Provider is Paid'.



A new approach to catchment management

We know there are significant pressures exerted on our ecosystem services from both the urban and the rural environment. We need to address these pressures, and their drivers, through a mixture of regulation, self-interest and incentivisation, but this needs to be integrated to take into account the role of the private, public and third sector. Setting out an approach for catchment management requires consideration of three initial steps:

1. **The aims and scope of catchment management:** Sustainable delivery of the services we derive from a catchment based on the needs and aspirations of society. These services need to be publicly formulated, such as 'healthy rivers and waterways', 'viable communities' and 'better livelihoods'.
2. **The geographic scale at which to plan and implement catchment management:** The term 'catchment' can refer to the sub-basins of tributaries or to a whole river basin as defined by the watersheds that divide drainage areas. The need to manage water from its source to its sink, and the inter-dependence of water uses, natural processes and ecosystem services justify assessment and management at a catchment scale.
3. **Levels of governance for decision making and for implementation:** Catchment management involves local responsibilities and requires inclusive deliberation at a local level under the framework of existing multi-level government. There is a need to look to the existing scales and responsibilities of local government as a basis for catchment management, but with provision for cooperation and coordination for catchment areas that span administrative boundaries.

Who are the people involved in local catchment management?

While the roles and responsibilities within any catchment are not fixed to specific groups, there are similar structures across all catchments that need to be detailed in order to develop a framework in which to manage the catchment in terms of enforcement, knowledge and incentives. These structures are occupied by the **BUYERS** of the services we get from our catchments, the **INTERMEDIARIES** that can broker services, provide information on these services and enforce the legal requirements, and the **SELLERS** of these services. Services provided by the urban environment, landowners and farmers make up the dominant ownership within most catchments and thus provision of services. The schematic below sets out the overall governance structure, but individuals can fall into several categories.

Buyers

The **BUYERS** of the services we get from our catchments could include the general public who benefit from reduced flood risk, food, clean water, recreational access, etc. BUYERS also include organisations that operate on behalf of sections of the public (Water companies, Insurance agencies, etc.) and on behalf of all of us (Government).

1º , 2º and 3º Users
General Public, Organisations & Government

Intermediaries

The **INTERMEDIARIES** of the services we get from our catchments link multiple buyers and multiple sellers together within a catchment (e.g. government, charities, business, etc.) to minimise the overheads involved in several separate schemes.

Brokers

Sellers

The **SELLERS** of the services we obtain from our river catchments are predominantly the land-owners and farmers who respond to the regulation, savings, markets and incentives offered to run their business.

Service Sellers

Knowledge Providers

Knowledge Providers

The **KNOWLEDGE PROVIDERS** provide information about the services we get from our river catchments. This can involve the mapping and assessment of the outcomes, monitoring the benefits or resolving technical or legal issues (e.g. Universities, consultancies, research institutes, etc.)

PAYMENTS FOR ECOSYSTEM SERVICES

Payments for Ecosystem Services (PES) schemes are market-based instruments that connect **SELLERS** of ecosystem services with **BUYERS**. The term Payments for Ecosystem Services is often used to describe a variety of schemes in which the beneficiaries of ecosystem services provide payment to the stewards of those services. Payments for Ecosystem Services schemes include those that involve a continuing series of payments to land or other natural resource managers in return for a guaranteed or anticipated flow of ecosystem services.

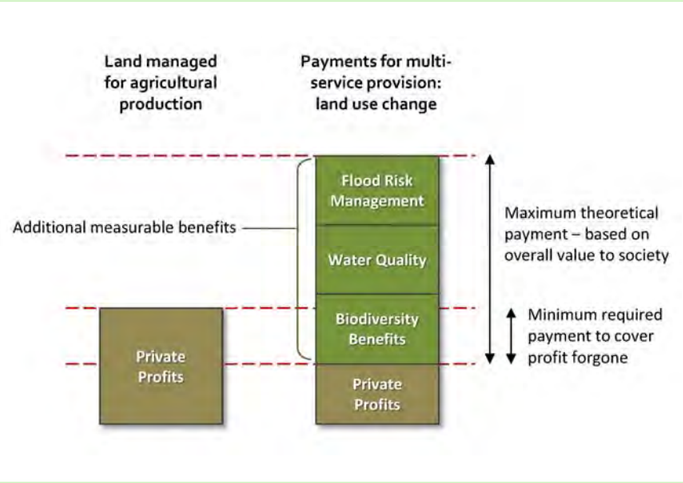
At present, farmers, who represent less than 1% of our society, currently manage nearly 80% of our countryside and are largely responsible for the health of the ecosystems it supports. However, despite this key role for farmers in managing our natural ecosystems, they are currently only paid for the provision of one ecosystem service; food production. The basic idea behind Payments for Ecosystem Services is that those who are responsible for the provision of ecosystem services should be rewarded for doing so, representing a mechanism to bring historically undervalued services into the economy.

A Payments for Ecosystem Services scheme can be defined as a voluntary transaction where (1) a well-defined ecosystem service (or a land-use likely to secure that service) is being 'bought' by (2) an ecosystem service buyer (minimum of one) from (3) an ecosystem service seller (minimum of one) if, and only if, (4) the ecosystem service provider secures ecosystem service provision (conditionality).

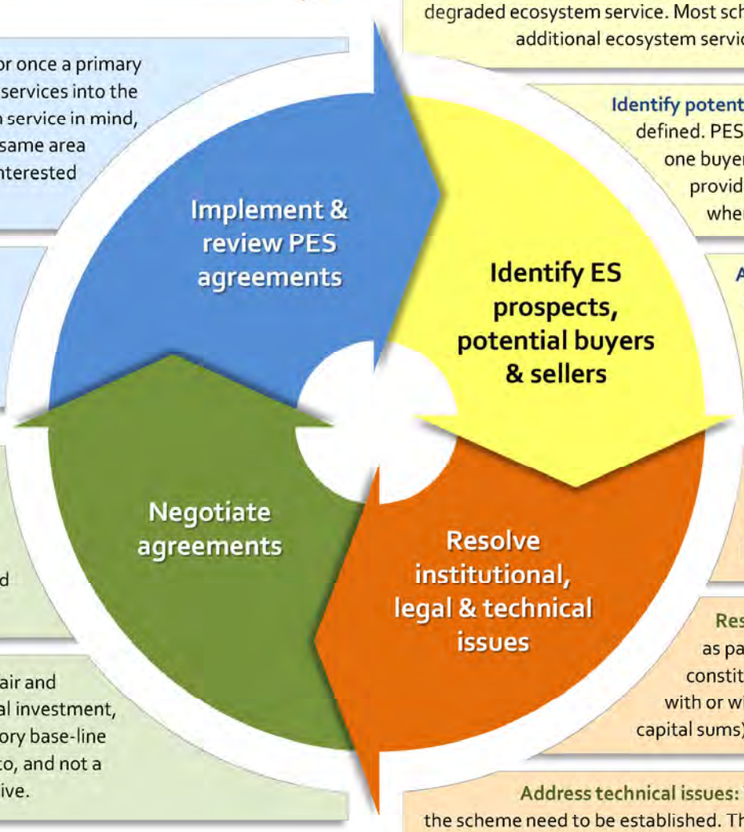
Historically, most Payments for Ecosystem Services schemes fit into 5 broad categories of ecosystem service provision; **fresh water provision**, **water regulation**, **climate regulation**, **habitats for wildlife** and **recreation & culture**.

How the funding works

As the figure on the right illustrates, under the current situation, where land is managed exclusively for agricultural production, only the private profits from this activity are realised. By assessing services that may be provided and offering either a minimum payment to cover profit forgone or a maximum possible payment based on the overall value to society, the seller can change, or even switch, their land use. Funding could be available as an annual revenue payment (either for a fixed term contract or in perpetuity) or as a single lump sum payment.



The 10 steps to starting a Payments for Ecosystem Services scheme



1 **Identify PES opportunity:** Work with either the BUYERS, PROVIDERS or INTERMEDIARIES to establish what ecosystem services are of interest and if the service is well-defined. It may be necessary to review the long term management/asset plan for the buyer(s) to establish if prevention and delay of potential future business costs can be compared against the costs of restoring a degraded ecosystem service. Most schemes concentrate on one primary ecosystem service opportunity although there may be several additional ecosystem services.

2 **Identify potential PES actors:** Once the PES opportunity has been identified the PES structure can be defined. PES schemes have developed across the globe with many permutations: 'one-to-one' where one buyer pays a single major provider; 'one-to-many' where a buyer, via a broker, pays many small providers; 'many-to-one' where multiple buyers invest in a single major provider; and 'many-to-many' where many buyers invest, via a broker, in many providers. PES actors are outlined on page 9.

3 **Assess the prospects for trade:** Bringing together potential buyers, providers and intermediaries to facilitate the generation and exchange of ideas, build trust and establish a willingness to further explore opportunities. This can be done in a variety of ways but usually involves a more detailed desk study of the ecosystem services in question which could included modelling the potential benefits and establishing and analysing the costs.

4 **Agree roles and responsibilities:** Once the prospects for trade have been detailed the organisational arrangements necessary to develop the PES scheme including roles and responsibilities can be established. This might include assessment of the legal organisational structure required to distribute grants or payments.

5 **Resolve legal issues:** Identify the legal, tax and payment issues that will need to be resolved as part of the scheme's development. These might include issues relating to tenancy and what constitutes business-as-usual in terms of service provision (e.g. the regulations that must be complied with or without the scheme). This might also include the terms of the payment (revenue as opposed to capital sums).

6 **Address technical issues:** Within this step, the detailed issues and challenges that must be addressed in rolling-out the scheme need to be established. This may include spatial targeting; appropriate and evidenced-based land management interventions, the definition of what constitutes additionality, contractual details, how to manage uncertainty; and monitoring, review and evaluation arrangements.

7 **Develop 'win-win' markets:** Identify the steps necessary to develop a scheme that is both fair and advantageous to all parties in regards to payment levels, up-front payments to support initial investment, payments schedules and contractual details. Alongside this step is the establishment of a regulatory base-line to demonstrate additionality (funding and actions undertaken are demonstrably supplementary to, and not a substitute for, existing funding and actions. It is important that this framework is clear and objective.

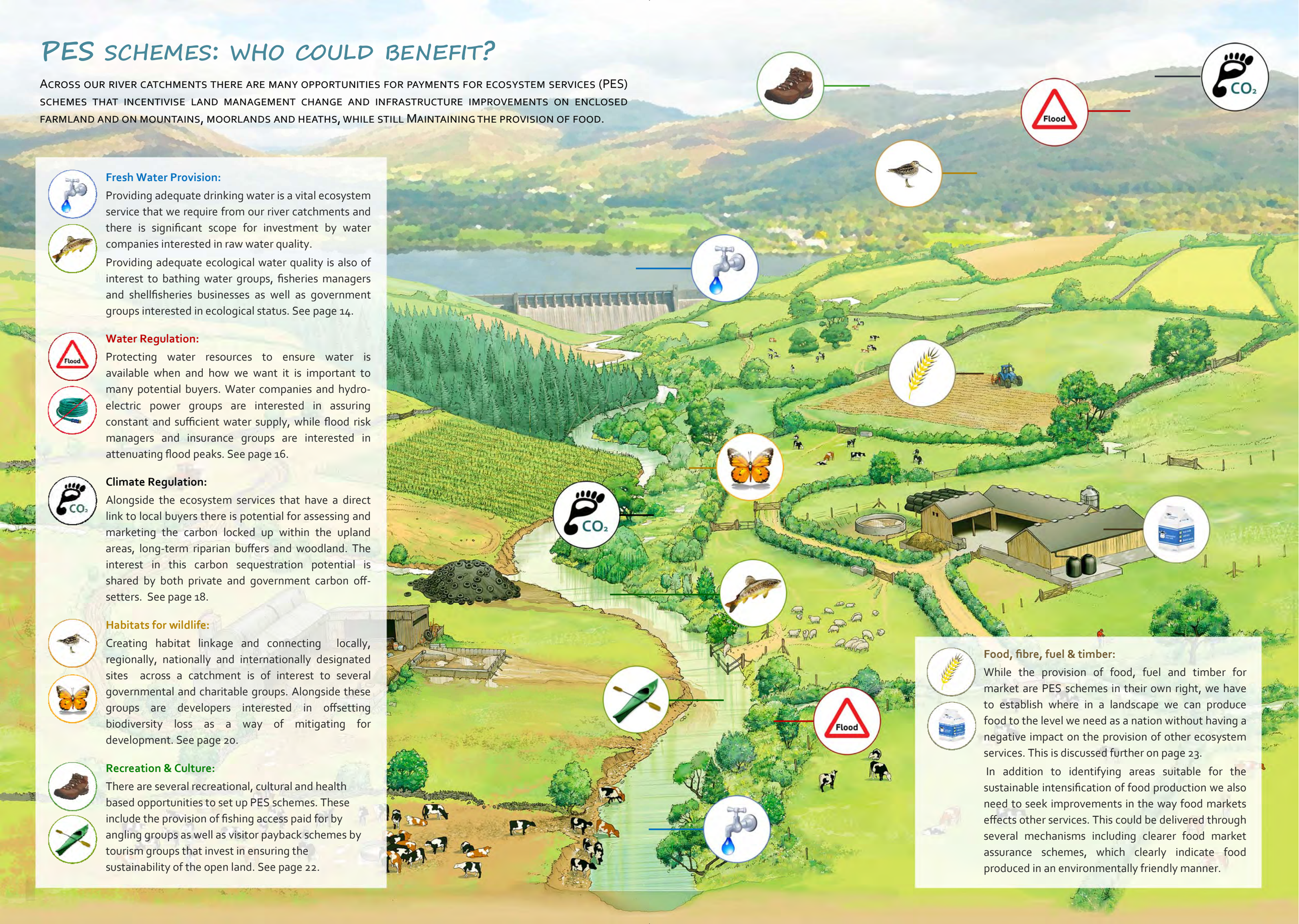
8 **Formalise the PES scheme:** Draw-up and sign the necessary legal and other agreements between parties (contracts, covenants, easements etc.) to formalise the market; these should ideally contain provision for adaptive management to facilitate progress towards agreed end-goals. The land management interventions, monitoring and evaluation arrangements detailed within step 6 should also now be instigated. The outputs of the scheme can be monitored in the short term as a proxy for the ecosystem service outcomes required.

9 **Monitoring, evaluation & review:** Monitor, evaluate and ultimately review scheme implementation to ensure that agreements are honoured, benefits flow and opportunities for adaptive management are identified and acted on. The intervention outputs monitored in stage 8 should be assessed against the delivery of the ecosystem service outcomes required as a condition of the scheme (***Conditionality***).

10 **Identify opportunities for multiple-benefit PES:** Either as part of the initial scheme or once a primary programme has been established the opportunities for bringing additional ecosystem services into the scheme should be explored. Although the scheme might have developed with a single ecosystem service in mind, by changing land use management you may be 'bundling' a suite of ecosystem services from the same area that could be sold whole, as was originally intended, to a single buyer or sold to multiple buyers interested In buying their specific service.

PES schemes: who could benefit?

Across our river catchments there are many opportunities for payments for ecosystem services (PES) schemes that incentivise land management change and infrastructure improvements on enclosed farmland and on mountains, moorlands and heaths, while still Maintaining the provision of food.



Fresh Water Provision:

Providing adequate drinking water is a vital ecosystem service that we require from our river catchments and there is significant scope for investment by water companies interested in raw water quality.

Providing adequate ecological water quality is also of interest to bathing water groups, fisheries managers and shellfisheries businesses as well as government groups interested in ecological status. See page 14.

Water Regulation:

Protecting water resources to ensure water is available when and how we want it is important to many potential buyers. Water companies and hydro-electric power groups are interested in assuring constant and sufficient water supply, while flood risk managers and insurance groups are interested in attenuating flood peaks. See page 16.

Climate Regulation:

Alongside the ecosystem services that have a direct link to local buyers there is potential for assessing and marketing the carbon locked up within the upland areas, long-term riparian buffers and woodland. The interest in this carbon sequestration potential is shared by both private and government carbon off-setters. See page 18.

Habitats for wildlife:

Creating habitat linkage and connecting locally, regionally, nationally and internationally designated sites across a catchment is of interest to several governmental and charitable groups. Alongside these groups are developers interested in offsetting biodiversity loss as a way of mitigating for development. See page 20.

Recreation & Culture:

There are several recreational, cultural and health based opportunities to set up PES schemes. These include the provision of fishing access paid for by angling groups as well as visitor payback schemes by tourism groups that invest in ensuring the sustainability of the open land. See page 22.

Food, fibre, fuel & timber:

While the provision of food, fuel and timber for market are PES schemes in their own right, we have to establish where in a landscape we can produce food to the level we need as a nation without having a negative impact on the provision of other ecosystem services. This is discussed further on page 23.

In addition to identifying areas suitable for the sustainable intensification of food production we also need to seek improvements in the way food markets effects other services. This could be delivered through several mechanisms including clearer food market assurance schemes, which clearly indicate food produced in an environmentally friendly manner.

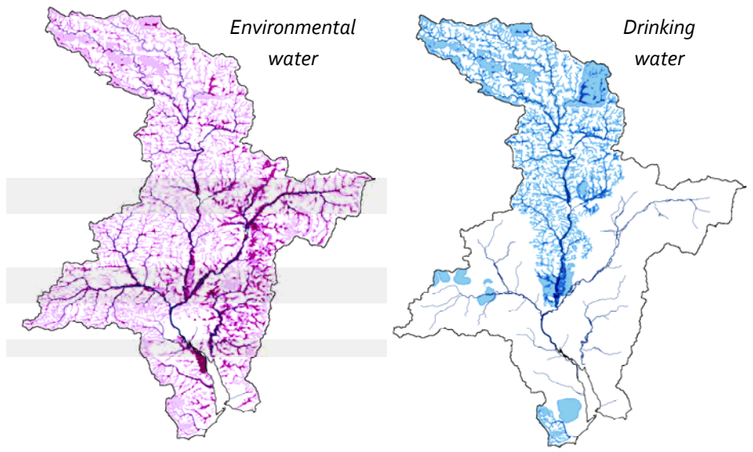
Fresh water provision

The provision of clean water is of interest to various groups. While some of these have a limited ability to set up significant PES schemes (e.g. **Fishery/Shellfishery businesses**), there is potential depending on the catchment for considerable PES schemes to develop around the delivery of clean bathing water (**Local Government**), Water Framework Directive good ecological status (**National Government**) and drinking water (**Water Companies**).

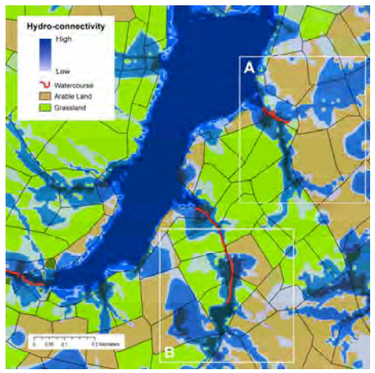
Assessing the prospect for trade

Before any assessment of potential trade can be made the broad areas of land in the catchment that may play a role in the delivery of the ecosystem service need to be identified. For Water Companies this may be as simple as establishing the critical land areas upstream of raw water abstraction points (below right).

For the Government departments interested in bathing water quality or responsible for ensuring that rivers are in 'good ecological status' under the terms of the Water Framework Directive (WFD) all of the important land areas upstream of degraded river sections need to be identified. Once the areas important for the delivery of that ecosystem service have been mapped out (near right), we can then work with the potential buyers to define the scope of the payments for ecosystem services scheme.



Once the scope of the potential PES scheme is defined, a desk study of the available data can provide a baseline for estimating the potential costs and benefits that may be realised through its delivery. The data for this study, which can come from a variety of sources; including Government bodies, private companies and charitable groups, may include:



Hydrometric & hydrological data: modelled from topography and rainfall data or measured at Environment Agency hydrometric gauging stations.

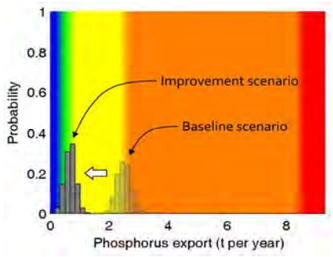
Landuse & agricultural census data: used to explore agricultural practice and trends across a catchment.

Water quality monitoring: chemical and biological data collected as part of the WFD monitoring programme or by other organisations.

Pollution source apportionment: Numerous models exist for a wide variety of pollutants to identify their potential sources and assess pollution risk across a catchment.

Land & river walkover surveys: Undertaken by various groups to identify problems requiring either regulation or incentivised remediation.

Once the baseline is established, the interventions involved in securing the ecosystem service, or a land-use likely to secure that service, can then be identified. The evidence-base behind each intervention (either at a field, farm or sub-catchment scale) also needs to be assessed. From these evidenced-based management interventions or land-uses the likely benefits can then be modeled. One such approach is through a buyer-provider co-generated model that estimates the cumulative effects of intervention (see right for example of output).



Overcoming technical challenges

When setting up a PES scheme to deliver water quality through on-farm interventions there are several technical issues that must be addressed if the scheme is to succeed. Perhaps the two most significant of these challenges are; (1) the spatial targeting of appropriate land management interventions and (2) how to monitor the level of the service that is being delivered before and after the interventions are undertaken.

Establishing spatially specific interventions that deliver the service: Schemes need to assess the evidence and certainty over the success of spatially specific interventions. This may vary considerably with the type of intervention, the location of intervention and the spatial scale of interventions.

There is a large amount of literature detailing the effectiveness of on farm interventions for reducing diffuse water pollution from agriculture on a field scale (Cuttle et al., 2006), but this research is only now being scaled up to examine the effects across farm and sub-catchment areas. Spatial targeting of interventions can be achieved via the desk study.

Establish indicative deliverables for measurement: Once a series of interventions are established that you wish to incentivise you then need to establish how to assess if these are being delivered. You can do this by direct outputs (e.g. area of adequate buffer strip) or indirect outcomes (e.g. improved water quality).

Establishing an adequate assessment output is vital as this will be used to assess performance and often drives work on the ground. If the indicative output is not closely linked to the ecosystem service perverse actions could occur that do not lead to provision of the service (e.g. buffer strips at the top of fields for the protection of water). Alternatively, if the indicative output is closely linked to the service, but hard to accurately measure, you could spend all your time trying to measure the ecosystem and not have the budget to instigate change.

CASE STUDY 1: Upstream Thinking

Catchment: River Tamar & tributaries

Buyer: South West Water (Private)

Seller: Multiple farmers in catchment

Intermediary: Westcountry Rivers Trust (Ethical broker), University of East Anglia (Knowledge Provider), Environment Agency (Regulator)

This scheme was co-developed between the buyer, who recognised the economic, ecological and regulatory benefit of improved raw water quality, and an intermediary, who had a knowledge of the catchment-wide actions that could be sold to farmers and which could lead to improved raw water quality in the river. Payments are based on action through the provision of improved farm infrastructure and agricultural practice. Longevity is ensured through a 10 or 25 year contract and covenant. The scheme will distribute over £1.2 million of investment (at 50% grant rate) and is monitored through implementation of interventions. The delivery of the ecosystem service is assessed though a 'proof of concept' monitoring programme in the Caudworthy Water sub-catchment (being undertaken by DEFRA DTC).

CASE STUDY 2: New York City

Catchment: Rivers Catskills & Delaware

Buyer: New York City (Government)

Seller: Multiple farmers in catchment

Intermediary: Watershed Agricultural Council and the Catskill Watershed Corporation

The New York City Department for Environmental Protection (NYC DEP) funds and implements a comprehensive ***Long-Term Watershed Protection Program***, which maintains and protects the high quality source of drinking water for nine million water consumers (nearly half the state's total population). New York City's partners include the Watershed Agricultural Council (land conservation) and the Catskill Watershed Corporation (community infra-structure and economic development). Both of these organisations are local not-for-profit corporations that were specifically created to assist DEP with the administration and implementation of watershed programs. The program cost US$1.5 billion, compared to the estimated US$8-10 billion for a water filtration plant, and was administered through a formal urban-rural partnership that is considered as a true market.

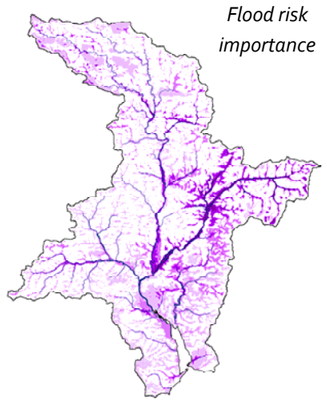
Water regulation

The regulation of adequate water is of interest to various groups. Potential PES schemes have been developed around ensuring adequate water supply for both drinking (**Water companies**) and hydro-electric power (**Energy groups**). Other potential PES schemes have developed around attenuating flood peaks in areas where localised flooding is of concern (**National Government, Water companies** and **Insurance companies**).

Assessing the prospect for trade

Before any assessment of potential trade can be made the broad areas of land in the catchment that may play a role in the delivery of the ecosystem service need to be identified. These may include locations upstream of:

- Threatened water supply areas (reservoirs).
- Threatened water abstractions (boreholes & rivers)
- Low flow threatened sewerage treatment works
- Threatened hydro-electric power stations
- Properties and infrastructure at risk of flooding



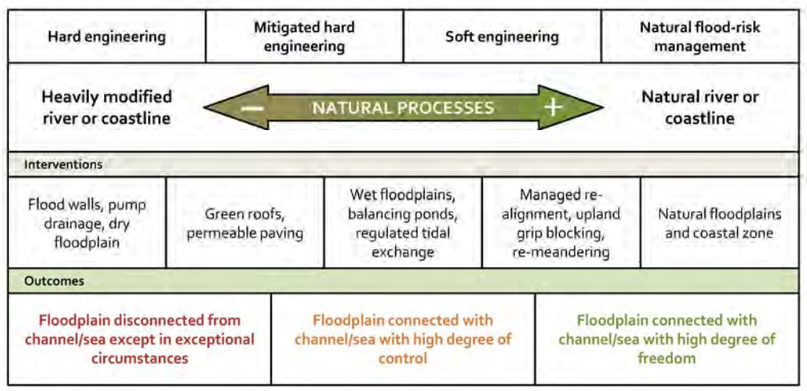
Flood risk importance

By working with the buyer to map areas important for the delivery of the ecosystem service the PES scope can be defined.

This exercise needs input from intermediary knowledge providers who can model the flow and behaviour of water through a catchment and characterise priority areas where tailored location-specific interventions could benefit the regulation of water quantity.

Historically, flood defence budgets have often been spent on hard engineering solutions designed to keep floodwater out of residential and commercial properties. However, following the extensive 2007 floods, the Pitt Review concluded that flooding cannot be managed purely with hard defences and that rural land management approaches should be considered as part of a portfolio of measures. The review also expressed the opinion that flood risk projects using land management can deliver multiple ecosystem benefits.

There have been a few notable initiatives where land management schemes have been adopted to manage flood risk. On the Clyde above Glasgow, farmers are paid compensation to allow their land to flood so as to reduce the pressure on flood defences further downstream. Furthermore, in 2009 Defra launched three Multi-objective Flood Management Demonstration projects. For example, the Slowing Flow at Pickering Project developed a model to predict that the upstream flood storage bunds would provide protection for approximately 50 properties in Pickering affected by low level flood events (1 in 25 year flood). This project also reported that the planned creation of riparian woodland, combined with the construction of 100 large woody debris dams, was expected to assist the delivery of flood risk management, although their contribution was predicted to be reduced with declining flood event magnitude. In addition, opportunity mapping was also undertaken to facilitate the spatial targeting of potential new floodplain woodland.



Potential buyers for flood risk management PES schemes

The following funding streams could be developed into flood risk management PES schemes:

- **Flood Defence Grant-In-Aid:** Funding raised through general taxation for flooding risk management work.
- **Regional Flood and Coastal Committee (RFCC) Local Levy:** Money raised from Lead Local Flood Authorities for additional flood risk and coastal erosion management priorities not funded by FDGiA.
- **Water company investment:** Funds raised through the price review process. Water companies are able to invest in some types of surface water management and invest to increase the resilience of their assets.
- **Community Infrastructure Levy:** A locally set, general charge which local authorities can choose to implement. Levied on developers (charged per square metre) on most new developments across a local authority area.
- **Section 106 (Town and Country Planning Act 1990):** Contributions from developers that are linked to specific developments and the infrastructure required to make them acceptable in planning terms.
- **Landfill Community Fund:** The Landfill Tax Credit Scheme (LTCS) was introduced with the landfill tax and enables Landfill Operators to donate up to 6.5% of their landfill tax liability to implement social and environmental projects.

Increasing river base-flows & drought alleviation

Our need to retain water in our catchments for longer has often been in direct opposition to our flood risk management activities, which have typically used hard engineering to transport water as quickly as possible to the sea without causing damage to property or people. By assessing soft engineering and natural flood risk management it is often possible to store water in the upper catchments within moors, wetlands and ponds. These multiple small scale habitat interventions can, if designed appropriately, attenuate flood peaks as well as hold water back over a longer period of time and reduce the need for large water impoundments (reservoirs).

CASE STUDY 3: Upstream Thinking

Project:	Exmoor MIRES Project
Buyer:	South West Water (Private)
Seller:	Landowners and commoners
Intermediary:	South West Water (Broker), Exmoor National Park (Broker), University of Exeter (Knowledge provider)

South West Water wanted to ensure reliable and sufficient water supply in its Wimbleball Strategic Supply Area. The estimated cost of creating a second strategic reservoir was estimated to be around £90 million. However, the estimated costs of restoring upland function by blocking up drainage ditches on the moorland was £5-10 million. SWW have been working with landowners, commoners, Exeter University and Exmoor National Park to re-wet upland peat-bogs. Drained moorlands respond quickly to rainfall and have little storage capacity, as all the water runs through the ditches and into the rivers. Blocking up the ditches slows down the flow of water and increases the time it takes to get to the river. This is good for water customers as more storage in the uplands means a more reliable supply and less expensive reservoir pumping or construction.

CASE STUDY 4: USA

Project:	BEF Water Restoration Certificates
Buyer:	Corporations (Private)
Seller:	Multiple farmers in catchment
Intermediary:	Bonneville Environmental Foundation (Broker)

The Bonneville Environmental Foundation (BEF) has launched the Water Restoration Certificate Program (WRC), which was the first nationally marketed, voluntary environmental flow restoration program.

BEF provided a collaborative mechanism to allow private sector urban water users (e.g. brewers) to invest in critically and chronically dewatered ecosystems. The surface water in waterways across the American West had historically been fully or over-appropriated, to the detriment of their ecological function.

BEF's WRCs represent measurable, certified and endorsed, registered and audited certificates that provide confidence to buyers that water flow is being restored by limiting abstraction. This market-based mechanism has resulted in billions of gallons of water being 'left in the stream'.

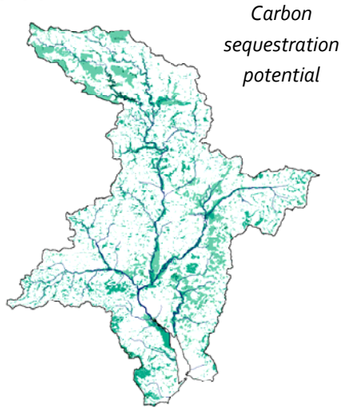
Climate regulatation

The regulation of the climate through the emission and capture of greenhouse gases (grouped here as Carbon equivalent gases) is of interest to various groups. There are current and potential PES schemes that offer to offset carbon emissions through carbon capture projects under Voluntary Carbon Offsetting Schemes (**private companies** and **general public**) and through government land use change schemes (**woodland grant scheme**)

Assessing the prospect for trade

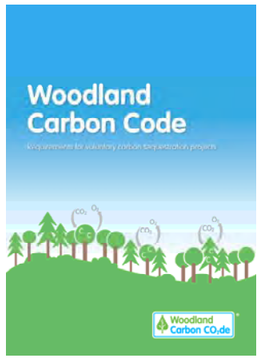
Before any assessment of potential trade can be made the broad areas of land in the catchment that may play a role in the delivery of the ecosystem service need to be identified. These may include locations of:

- Existing high carbon soil (peat soils, moorland, woodland)
- Potential high carbon areas with minimal impact on food
- Carbon sequestering land management practices



Carbon sequestration potential

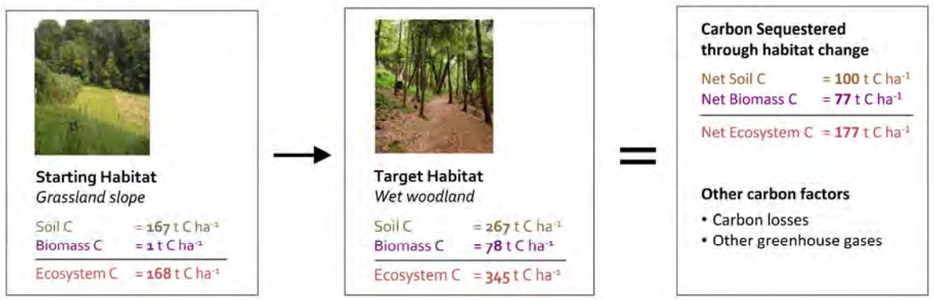
Carbon Storage (sequestration) schemes involving landuse/management interventions have, thus far, been slow to develop worldwide. The majority of the carbon offsetting market has been dominated by energy efficiency or renewable energy projects. The reason for this stems from the fact that sequestration schemes can take many years for the environmental benefits to be realised and measuring carbon sequestration is not an easy task. Accordingly, very few sequestration schemes have been approved by the United Nations' accreditation scheme under the Kyoto Protocol.



In the UK, there are a small number of unaccredited carbon offsetting projects in existence based on woodland planting schemes. These appear attractive to corporate sponsors on Corporate Social Responsibility (CSR) grounds rather than the acquisition of carbon credits *per se*. Defra provide a Code of Best Practice for Carbon Offset Providers (accreditation requirements and procedures), which together with the Woodland Carbon Code has helped to formalise some of these schemes.

To meet the requirements of the Code, projects need to: (1) register with the FC, stating the exact location and long-term objectives; (2) meet UK standards for sustainable forest management; (3) have a long-term management plan; (4) use approved methods for estimating the carbon that will be captured; and (5) demonstrate that the project delivers additional carbon benefits than would otherwise have been the case.

There are currently no carbon offsetting projects in the UK based on soil carbon sequestration. This is because the ability of soils to sequester carbon under different management practices is subject to significant variability and measurement of soil carbon is not a straightforward process. Below is an example of how this could be delivered through a scheme to permanently change land use.



Carbon storage in the uplands: an example from south west England

Wetlands cover approximately 6% of the Earth's surface and contain about 35% of global terrestrial carbon. Around 50% of the dry organic matter in peat is carbon and peatlands are the most efficient carbon stores of all terrestrial ecosystems. Peatlands are estimated to store twice as much carbon as is present in the world's entire forest biomass. Exmoor National Park has roughly 190 km^2 of moor and heath with peat soils, which includes up to 30 km^2 of blanket bog and 3.5 km^2 of fens and flushes.

Accumulation rates for healthy blanket bog or other mire vegetation communities, such as wet heath or fen, vary from less than 0.1 mm/yr to more than 3 mm/yr in the fastest growing bogs. Drained uplands, however, and especially those which are regularly burnt, are not thought to accumulate any significant amounts of peat.

The Exmoor MIRES project (Case study 3) aims to increase the area of actively growing peatland mire by blocking up ditches and recreating the optimal conditions required for peat accumulation.

It is estimated that there are approximately 10 million m^3 of peat on Exmoor holding a total estimate of (1 million tons) of carbon. Restoration of each hectare of drained moorland will lock up approximately 1 ton of carbon from the atmosphere each year and so, by re-wetting 300 hectares of peat bog each year, the project aims to sequester 300 tons of carbon per year.

PES schemes could develop around carbon sequestration through upland and wetland restoration, but there needs to be an equivalent UK Peatland Carbon Code and Government guidance to help regulate and expand this emerging market to ensure long-term, additional climate benefits and avoid trade-offs with other important services.


Photo: Leguan

CASE STUDY 5: USA

Project: Chicago Climate Exchange
Buyer: U.S. carbon markets (Private)
Seller: Multiple farmers
Intermediary: Climate Exchange PLC

The CCE Trading System closed in 2010 but had the three main elements. (1) A trading platform acted as a marketplace for executing trades among registered account holders. For example, the US National Farmers Union's Carbon Credit Program was a multi-state program that allowed farmers and landowners to earn income by storing carbon in their soil through no-till crop production and long-term grass seeding practices. The Farmers Union earned approval from the Chicago Climate Exchange to aggregate carbon credits. The Farmers Union was enrolling producer areas of carbon into blocks of credits that were traded on the Exchange, much like other agricultural commodities are traded. (2) The clearing and settlement platform processed all transaction information. (3) The registry was the official database for Carbon Financial Instruments owned by registered account holders.

CASE STUDY 6: Woodland Trust

Project: Warcop Training Area
Buyer: North Pennines AONB & a private company
Seller: Ministry of Defence (Government)
Intermediary: The Woodland Trust (Broker)

The Woodland Carbon Code (WCC) provides standards for the creation of woodland with the aim of removing atmospheric carbon dioxide. The WCC operates in the UK voluntary carbon market, where it seeks to bolster market confidence in forest carbon projects, thereby increasing private investment in forest creation. The Warcop Training Area (WTA) pilot scheme was co-developed between the Ministry of Defence (MOD), who wished to develop new woodlands on its training areas; the Woodland Trust, who had knowledge of woodland creation and management; and retail companies wishing to mitigate for unavoidable greenhouse gas emissions. The sale of sequestered carbon and a significant funding contribution from North Pennines AONB allowed the project to be 100% financed from sources not traditionally associated with woodland creation.

Habitats for wildlife



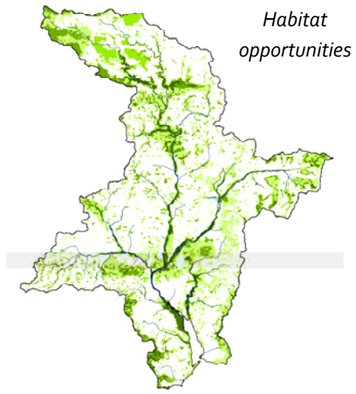
The provision of natural habitats is of interest to a large variety of groups. There is considerable potential for catchment-scale PES schemes to develop around the delivery of protected and well linked habitats. Current schemes include the protection and management of designated sites (**Government** and **private NGO groups**) as well as the creation of ecological networks through the development of biodiversity offsetting schemes (**developers**).

Assessing the prospect for trade

The Lawton Review (Making Space for Water, 2010) proposed that the overarching aim for England's ecological network should be to deliver a natural environment where biodiversity is enhanced and the diversity, functioning and resilience of ecosystems re-established in a network of spaces for nature that can sustain these levels into the future, even given continuing environmental change and human pressures.

This is underpinned by three objectives:

1. To restore species and habitats appropriate to England's physical and geographical context to levels that are sustainable in a changing climate, and enhanced in comparison with those in 2000.
2. To restore and secure the long-term sustainability of the ecological and physical processes that underpin the way ecosystems work, thereby enhancing the capacity of our natural environment to provide ecosystem services such as clean water, climate regulation and crop pollination, as well as providing habitats for wildlife.
3. To provide accessible natural environments rich in wildlife for people to enjoy and experience.



Habitat opportunities

Biodiversity off-setting

Biodiversity offsetting involves a developer taking account of any biodiversity loss (species/habitats) associated with a development and buying credits from a provider of equivalent biodiversity established elsewhere. The approach is an example of a 'cap-and-trade' mechanism, which has been applied widely in the creation of wetland mitigation banks in the USA, and is developing in the UK through the Environment Bank, which has established a biodiversity credits market for offsetting the impacts of development (see case study 8).

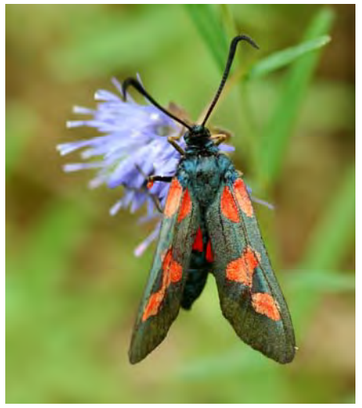
DEFRA have set out some guiding principles for the development of biodiversity offsetting schemes suggesting that they should:

- Not change existing levels of protection for biodiversity
- Deliver real benefits for biodiversity by: improving the compensation for biodiversity loss; expanding and restoring habitats; using offsets to contribute to enhancing England's ecological network; providing additionality; creating habitat which lasts in perpetuity; and requiring avoidance and mitigation of impacts to take place first.
- Be managed at the local level as far as possible: within national priorities for managing biodiversity; within a standard framework; through partnerships at an appropriate geographic level; with the right level of national support and guidance to build capacity where it is needed; and involving local communities
- Be as simple as possible, for developers, local authorities and others
- Be transparent, giving clarity on how the offset calculations are derived and allowing people to see how offset resources are being used
- Be good value for money

Enhancing habitat provision through Environmental Stewardship

Environmental Stewardship is an agri-environment scheme which offers payments to farmers and land managers in England for effective land management to protect and enhance the environment and wildlife. The scheme's primary objectives are to:

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



Nearly 6.5 million hectares (nearly 70% of England's farmland) are in agri-environment schemes (43,000 Environmental Stewardship agreements covering 5.5 million hectares).

While there is some debate as to whether the individual strands, namely Entry Level Stewardship (ELS, Organic ELS & Upland ELS) and Higher Level Stewardship (HLS), are genuine PES or 'PES-like' schemes, HLS payments have been used by many groups to protect designated habitats and deliver the Government's Public Service Agreement to secure 95% of Sites of Special Scientific Interest (SSSIs) in England in favourable or recovering condition by 2010. This target has not been reached, but it did lead to the establishment of the three broad objectives set out in the Lawton Review.

Alongside Biodiversity Offsetting and Environmental Stewardship programmes other funding routes that could be loosely developed into 'PES-like' schemes include the Community Infrastructure Levy, Section 106 payments and Landfill Community Fund (see page 17 for further details).

CASE STUDY 7: USA

Project: Conservation Reserve Program
Buyer: U.S. Department of Agriculture
Seller: Multiple farmers
Intermediary: US Farm Service Agency

The Conservation Reserve Program (CRP) offers farmers 10-15 year contracts to take land out of crop production in return for financial assistance to establish cover (usually grass or trees) and an on-going annual payment. Land is eligible either if it has a history of crop production and is regarded as highly erodible, is located in a Conservation Priority Area or will be devoted to wetland restoration, streamside or conservation buffers. The scheme is competitive and farmers offer bids for the funds. Offers are then evaluated using an Environmental Benefits Index (EBI) to select farmer bids which comprises a benefit-cost index that accounts for a broad range of environmental concerns and the administration cost involved in managing the contract. Farmers can improve their EBI scores by offering to take lower annual payments or foregoing cost-sharing on cover establishment.

CASE STUDY 8: Environment Bank

Project: Biodiversity Offsetting Scheme
Buyer: Developers (Private)
Seller: Multiple landowners
Intermediary: Environment Bank (Broker)

The Environment Bank Ltd undertakes a review of schemes and, in consultation, on behalf of the client (developers), with statutory nature conservation advisers, planning authorities and other stake-holders, an appropriate mitigation strategy is developed and 'signed-up'.

A costing programme is calculated and the developer purchases credits from the Environment Bank which are used to fund the creation and/or management of an ecological or environmental resource.

The delivery of the resource is made at either the local or wider environment level. Situations also arise where credits from a range of development schemes are pooled and large sites created, providing substantial added value through landscapes that people can visit and enjoy, thereby improving their health and well being. This benefit is linked to the recreational PES.

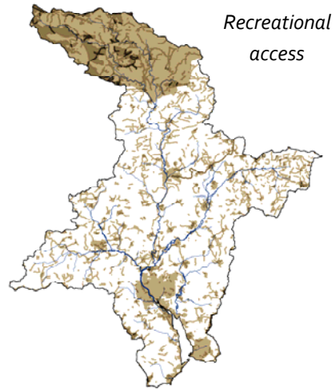
Recreation & culture

The provision of an adequate quantity and quality of recreation areas is of interest to various user groups and for a variety of reasons (tourism, culture, well being, etc…). Some of these may be on a small scale (e.g. **angling groups**), but there is potential, depending on the catchment, for considerable PES schemes to develop around popular high 'foot-fall' areas that have the potential to set up visitor payback schemes run by **National Parks** and **Local Communities groups**.

Assessing the prospect for trade

Before any assessment of potential trade can be made the broad areas of land in the catchment that may play a role in the delivery of the ecosystem service need to be identified, including potential access areas and density of visitors.

Visitor payback schemes (VPS) have evolved to secure financial contributions from the tourism sector to fund a range of environmental conservation and access development projects. These schemes encourage people who visit a particular location, and who have an impact on that location, to make a financial contribution to ensuring their impact is mitigated.



Recreational access

VPS are not a 'tourist tax' (used elsewhere in Europe) as payments are completely voluntary. VPS can also involve sponsored products (a percentage of product proceeds donated to projects), membership and 'Friends' schemes, fundraising events and donations through collection boxes.

Challenges for future application

The experiences of VPS operators is that it has been easier to get support from contributing visitors and business partners for tangible projects (e.g. footpaths, red squirrel protection) than it has for less tangible projects (such as carbon storage or nutrient management). It has also been easier to generate funds from VPS in areas perceived to be 'special' with a strong sense of individual identity for which visitors have an affinity or connection. Barriers to establishing VPS have ostensibly been down to tourism businesses; (1) perceiving the schemes to be time intensive and costly for them to participate in and (2) being confused regarding the specific benefits of the schemes to themselves and the local environment. In particular, businesses can find the processing of contributions a significant transaction cost and anything that can be done to make processing easy is therefore a distinct advantage. It has also been the experience of VPS operators that the human resources needed to promote schemes and mange participating tourist businesses can be significant. Future PES recreation and eco-tourism schemes could be significant, but need a clear demand as buyers are ordinarily formed by the general public rather than large consumer groups.

CASE STUDY 9: Lake District

Project: Nurture Lakeland

Buyer: Visitors (General Public)

Seller: Landowners and commoners

Intermediary: Lake District National Park Authority

The scheme supports the upland ecosystem services pilot project, Nurture Lakeland, which developed a pilot Visitor Payback Scheme (VPS) in the Bassenthwaite Water Catchment. The VPS allows visitors to contribute to landscape management through a small donation towards park maintenance. Nurture Lakeland has raised almost £2 million over an 18 year period.

CASE STUDY 10: Angling Passports

Project: Angling Passport Scheme

Buyer: Fishermen (General public)

Seller: Multiple farmers in catchment

Intermediary: Rivers Trusts (Broker)

This scheme was developed by several River Trusts who help farmers and landowners to identify sections of river that could be protected and marketed as fishing beats. Fishermen buy tokens to fish the beats and the Rivers Trust distributes the funding directly back to the farmers, who are encouraged to use it to improve the beat and river environment. Scheme marketing is usually through selling local advertising.

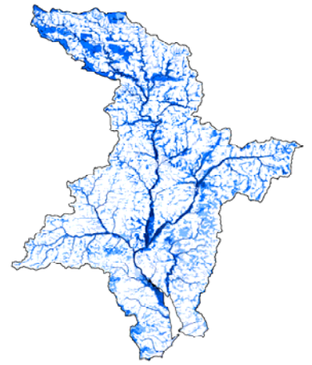
Finding multi-functional land

Each of the broad ecosystem services described on the previous pages has indicated the importance of mapping the provision of that service across the catchment. The five broad services mapped are the:

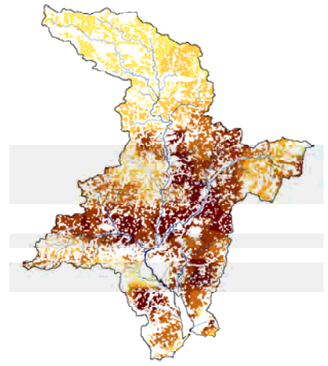
1. Provision of water quality (page 14);
2. Provision of water resources (flooding and drought – page 16);
3. Regulation of climate gases (carbon – page 18);
4. Provision of habitat and ecological networks (page 20); and
5. Provision of adequate recreation (page 22).

These ecosystem service maps have been developed to be informative at a whole-catchment scale and, when combined together, reveal that there are many multi-functional areas of land that play a key role in the delivery of multiple ecosystem services (top right).

The ecosystem service models also allow us to identify sections of the catchment where these multifunctional areas come into direct conflict with intensive agricultural production (right) and where their delivery may therefore be compromised (lower right). This exercise reveals that intensive agriculture, when undertaken in these conflict areas, may simultaneously compromise the provision of several ecosystem services. However, it also shows that the resolution of these conflicts, through catchment management interventions designed to improve ecosystem function could yield improvements in ecosystem service provision.

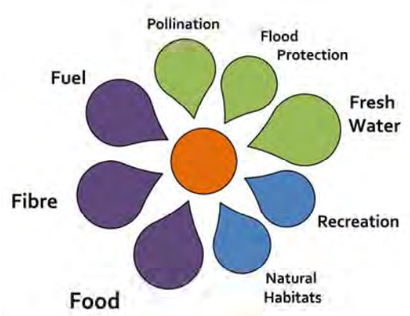


Multiple ecosystem service delivery areas

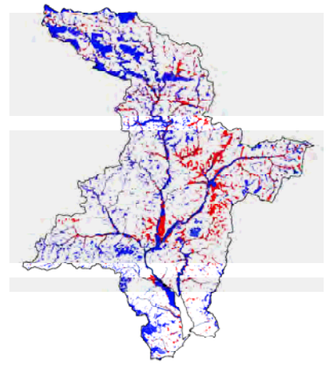


Current Farming Intensity

Future Ecosystem Service Provision



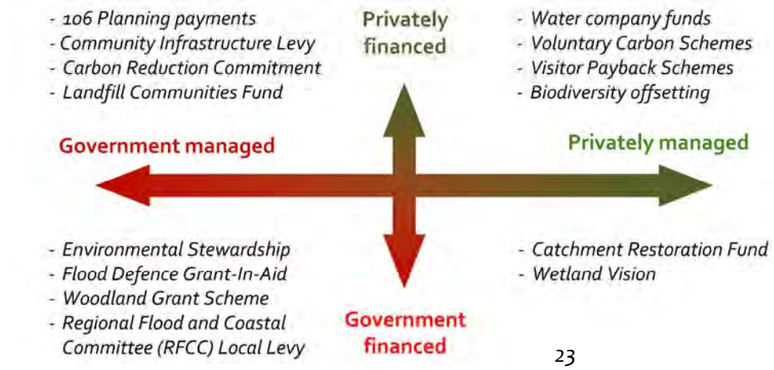
The reverse of these multifunctional areas are the parts of the catchment that are not connected with the provision of wider ecosystem services and highlights areas where intensive and sustainable food, fuel and fibre production can occur with limited effect on wider services. In these areas the sustainable, intensive production of food should continue to be incentivised and encouraged.

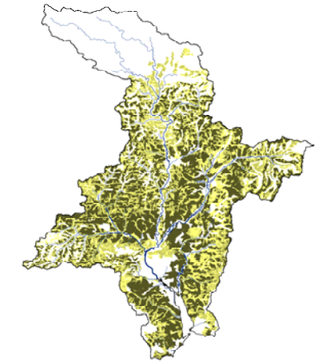


Areas of potential competing interest or conflict

Joining up funding routes

Although the potential PES schemes have been split into the five broad ecosystem services it is worth noting that the potential funds operational across any catchment often deliver over a suite of services. These funds can be split by the way the are managed and financed (government versus private).





Areas Sustainable Farming

WATER

Restoring river catchment function through Payments for Ecosystems Services

This handbook explores the history of why our river catchments are in their current condition, the nature of the threats and challenges they face and sets out in practical terms some of the solutions we have to restore them. It also sets out the governance structure that has evolved to address these problems and where the various funding comes from to deliver change.

This guide is designed to be read in conjunction with the ecosystems service evidence case studies that document some of the work being done estimating and monitoring ecosystem service delivery.

The WATER (Wetted land: The Assessment, Techniques & Economics of Restoration) project is a €3.9 million programme funded by the France (Channel) England Interreg IVA Programme and led by the Westcountry Rivers Trust, which aims to revolutionise the way we restore and manage our environment by developing innovative funding mechanisms.

Westcountry Rivers Trust

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Cover photo: Exmoor landscape by Mark Robinson