New routes to decarbonise land use with Natural Infrastructure Schemes

green alliance...

National Trust

New routes to decarbonise land use with Natural Infrastructure Schemes

By James Elliott and Angela Francis

Green Alliance
Green Alliance is a charity and independent think tank focused on ambitious leadership for the environment. We have a 40 year track record, working with the most influential leaders from the NGO, business and political communities. Our work generates new thinking and dialogue, and has increased political action and support for environmental solutions in the UK.

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Executive summary

The UK's farming and land management support system is changing fast, with the government signalling in its 25 year environment plan that greater private investment will be important in securing nature's recovery, alongside government funding.

The UK and devolved governments are currently redesigning their farming support systems and delivering on the Clean Growth Strategy to rapidly decarbonise the economy. This is an opportunity to set a global example in low carbon land management.

In this report, we outline how the Natural Infrastructure Scheme (NIS), a mechanism to lever private money for positive environmental land management, eg for flood prevention and water quality, could also be used to achieve land based carbon reductions.[1]

We argue that offering land based carbon credits alongside other marketable benefits, through the NIS mechanism, will increase both the number of projects that can contribute to climate change mitigation, and the environmental value of privately funded schemes which help to deliver the goals of England's 25 year environment plan.

Specifically, this mechanism can:

1. Increase the viability of natural infrastructure projects by adding carbon credits to the funding mix

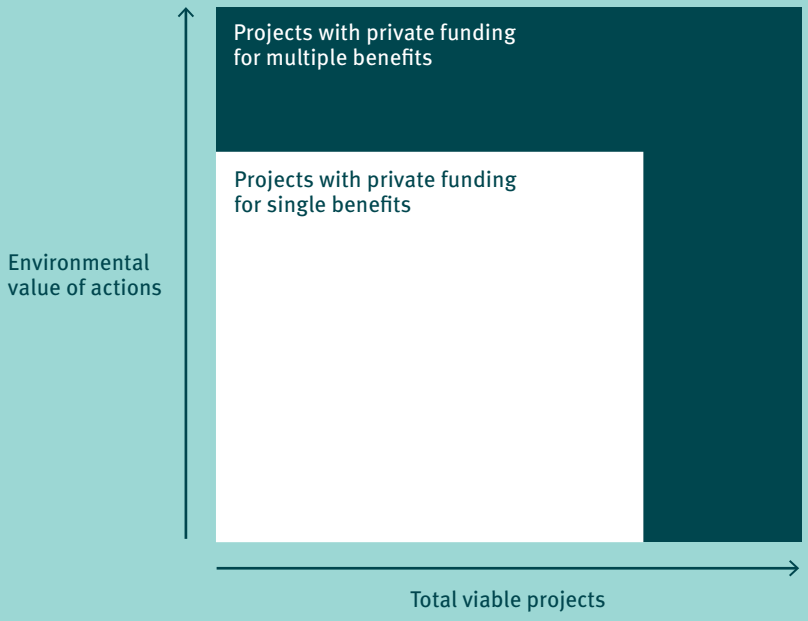
Many potential NISs, designed for broad environmental benefit, could also help to mitigate climate change. In circumstances where the projects are marginal, adding new carbon credit funding to the mix can make them viable. This could increase the number and size of privately funded projects, encouraging practices that were not sufficiently valuable for farmers and land managers to adopt before carbon credits were available.

2. Enable privately funded interventions of higher environmental value

Buyers only interested in a single benefit, such as flood risk reduction, will choose the most cost effective interventions to deliver them. But these may not maximise all the environmental improvements the project could provide. For example, attenuation ponds may be the most cost effective

natural infrastructure option for flood mitigation but are likely to be of lower environmental value than woodland planting and peat restoration, which can sequester carbon as well as reduce flood risk. A funding framework that supports multiple benefits makes the delivery of measures with higher environmental value more possible .

Funding multiple benefits can increase the quality and quantity of environmental restoration projects



As the England's 25 year environment plan concedes, increased government funding for the environment under the new environmental land management (ELM) system will not be enough on its own to meet the scale of the challenge to restore habitats and wildlife, tackle and adapt to climate change, clean up water and return soils to good health. Land based carbon reduction schemes could help to support the low carbon transition for farming and land use sectors, providing new revenue streams for land management that delivers environmental benefits alongside sustainable food production.

To make this possible there are two major challenges to address. First, while there is an existing voluntary market for projects delivering carbon credits, it is small and demand is limited. Second, land based carbon credits can be expensive and difficult to deliver as they often require fundamental

changes to a farming business, involving access to new income streams and adopting new land management approaches. Voluntary market prices, currently averaging around £6 per tonne of CO_2e globally, are not enough of an incentive for most environmental restoration projects in the UK.

Securing more private funding for environmental restoration projects will depend on finding new ways to enable both land managers and private investors to make a return on their investments. To encourage the take up of more privately funded, environmentally beneficial projects, we recommend that the government should do the following:

Increase private sector demand for land based carbon credits

To achieve this, the Department for Business, Energy and Industrial Strategy should conduct a systematic review of the options for boosting domestic demand for land based carbon credits.

Fund a new Farming and Soil Carbon Code

The Department for Environment Food and Rural Affairs (Defra) should:

- provide a strategic framework for farmers and land managers to generate carbon credits in the forthcoming emissions reduction plan for agriculture to give confidence to farmers, land managers and potential credit buyers;
- work with farmers and businesses to develop a Farming and Soil Carbon Code.

Demonstrate how environmental projects with multiple benefits can lever in private investment

Defra should:

- use the test and trials for the new ELM system to show how the government could be included as a 'buyer' in schemes such as the NIS alongside private sector buyers.
- publish clear guidelines on how, when and where private funding can be used to complement the new public payments system.

Introduction

The UK government has set ambitious goals to protect and restore the natural environment within a generation. As England's 25 year environment plan concedes, achieving these goals to restore habitats and wildlife, tackle and adapt to climate change, clean up water and return soils to good health will require new private investment as well as increased government funding.

We have previously shown how private markets for 'slow, clean water' which provides flood mitigation and improved water quality benefits could be created with a Natural Infrastructure Scheme (NIS) (see page ten). In this report, we argue that broadening the range of environmental services which can be delivered through a NIS will increase both the quantity and the quality of land based environmental projects.

We illustrate how carbon reduction can be included as a fundable service in a NIS scheme. Improving biodiversity is another possible area where the NIS could be applied, as a market in offsets is likely to emerge from Defra's proposal to embed the principle of 'net gain' into housing and infrastructure developments. The challenges faced by the carbon market and suggestions for how it could be improved, using offsets to contribute to wider environmental improvements, will have transferable lessons for biodiversity.

The focus on carbon is timely because there is now significant attention on how to decarbonise the agriculture and land use sectors and develop new carbon markets. We believe that generating carbon credits through a NIS could be a valuable tool in achieving overall environmental recovery.

1
New opportunities for private investment in environmental restoration

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Land use decarbonisation is a rising political priority. The Intergovernmental Panel on Climate Change's (IPCC's) special report in 2018 found that, to limit global warming to 1.5°C above pre-industrial levels, emissions need to reach net zero by around 2050.[2] Recent evidence suggests that land based greenhouse gas emissions reduction and sequestration schemes could play a central role in the world's response to climate change: in total, they could "provide over one-third of the cost-effective climate mitigation needed between now and 2030 to stabilize warming to below 2°C."[3]

"Agriculture currently accounts for about ten per cent of UK emissions and, without further action, is expected to be the second largest emitter by 2050."

The UK government has commissioned the Committee on Climate Change to explore how the UK can achieve net zero emissions by 2050. Our analysis suggests that land use and agriculture will have an important role to play in achieving this goal.[4] Agriculture currently accounts for about ten per cent of UK emissions and, without further action, is expected to be the second largest emitter by 2050.[5] Other land uses in the UK, such as woodland, are net carbon sinks. Converting more land to these uses and changing agricultural practices to keep more carbon in soils will be necessary to achieve our climate targets (see pages 18-26).

The increasing urgency to decarbonise should create new funding opportunities for land based environmental projects. The UK's Clean Growth Strategy commits the government to create "a stronger and more attractive domestic carbon offset market that will encourage more businesses to support cost effective emissions reductions, such as through planting trees."[6] It also commits to explore how this could be extended to other land based activities. However, the only action so far has been to require more businesses to report on their emissions, and there is mixed evidence about whether reporting on carbon emissions leads to emissions reductions.[7,8] More action is needed to increase private sector demand for UK carbon credits to achieve the government's goals.

New compliance markets are starting to emerge for international emissions not captured elsewhere. In 2020, CORSIA, a scheme to address the growth in emissions from international aviation is planned. A similar arrangement is proposed for international shipping. Globally, the aviation scheme alone is projected to require 158MtCO_2e of credits per year by 2025, rising to 520MtCO_2e per year by 2035.[9] While this target has been criticised for not being ambitious enough, it would significantly add to the voluntary demand for carbon credits which currently stands at around 100MtCO_2e per year.[10] Final negotiations for the scheme are underway and improvements could further strengthen the demand for the carbon credits that land based projects in the UK could provide.

Why the UK is a good place for land based carbon reduction projects

1. Policy enables public and private money to work together

The government is replacing the EU's Common Agricultural Policy in England with the new ELM system. Based on the principle of 'public money for public goods', the government will provide funding directly for land management changes that deliver environmental benefits which, amongst other things, will help to manage and mitigate the effects of climate change.[11] This focus on environmental benefits is a unique opportunity to develop a system that encourages private investment in environmental restoration alongside public funding.

Under the new ELM system, the government will fund activities which help to manage and mitigate the effects of climate change [12]

"The government will purchase up to £50 million of carbon credits to boost tree planting."

The UK already has a good track record of designing systems where public and private funding can work together. In the 2018 budget, the government announced a new Woodland Carbon Guarantee scheme through which it will purchase up to £50 million of carbon credits to boost tree planting.[13] It already provides grant funding for woodland creation through the Woodland Carbon Fund. Projects are encouraged to sell credits to voluntary carbon markets if grants are not enough to make the project possible.[14]

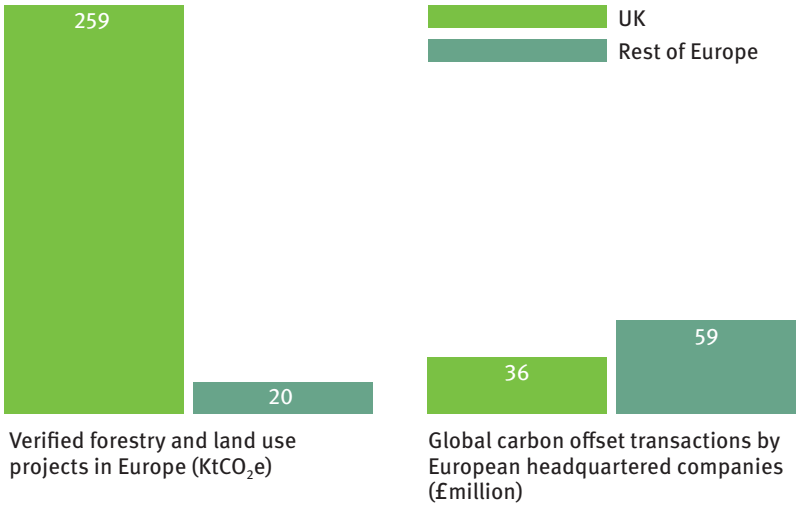
2. The UK is a major trader in the voluntary carbon offset market

Businesses can buy and sell carbon credits to meet compliance or voluntary obligations to reduce their contributions to climate change.

Although voluntary carbon markets are currently small in total carbon terms, firms with UK headquarters account for a significant portion of the

buyers and sellers in Europe.[15] Companies buy credits to show investors, customers and the public their commitment to reducing climate change and to offset reported emissions which are currently difficult or impossible to eliminate. And, in a marketplace where land based emissions projects are quite hard to deliver, the UK has generated 93 per cent of the verified forestry and land use projects in Europe.

The UK leads Europe in voluntary carbon offset markets[16]



3. Robust regulation

Markets for environmental improvement need robust regulation. Private investors need to know that activities they are paying for are 'additional' and would not have happened as a result of existing regulation, policy or public support, and that they are not causing environmental destruction elsewhere. For example, in England, replanting and maintaining trees is usually a condition of felling licences. Therefore, this replanting does not qualify for carbon credits, giving buyers of carbon credits generated in the UK the confidence that they are investing in genuinely new woodland.

The UK has also developed its own Peatland and Woodland Carbon Codes to drive market development. These voluntary standards set out the best practice requirements for quantification of a project's climate benefits. Applying this standard and gaining validation from an independent body assures buyers about the verifiable units a project can generate and when.

2
Selling climate solutions through a Natural Infrastructure Scheme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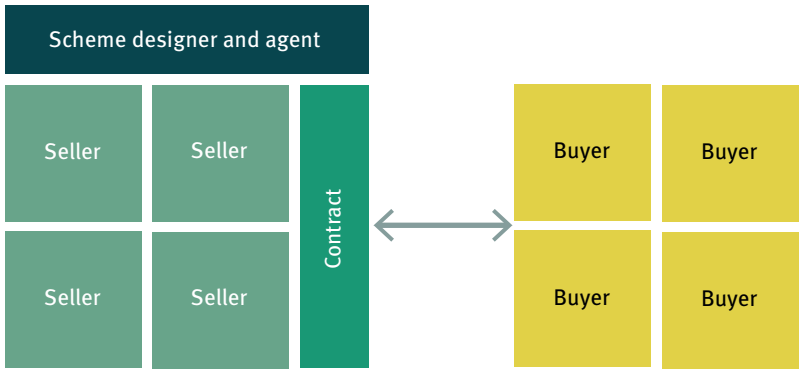
"Carbon emissions reductions and sequestration are a common side effect of many land management changes that also deliver better water quality and flood prevention."

The NIS is a mechanism that uses private contracts to deliver area-based natural capital improvements. We first proposed it as a way to deliver 'slow, clean water' in places where consortia of farmers and land managers could reduce flood risks or improve water quality by changing the management of their land. Funding comes from downstream beneficiaries who can save money and reduce their risk exposure by investing in the scheme.

We envisaged that the scheme could also apply to other ecosystem services. Private buyers of biodiversity, carbon and potentially even recreational access, could use it as a way to invest in land use and management changes.

Carbon markets are particularly interesting from a NIS perspective because carbon emissions reduction and sequestration are a common side effect of many land use and management changes that also deliver improved water quality, flood prevention, improved soil health and biodiversity. Therefore, a route for private investment in land based projects with marketable climate change mitigation benefits is likely to be relevant to a wide range of environmental restoration projects that a NIS could deliver.

The NIS model: a consortium of land managers sells a service to multiple beneficiaries[17]



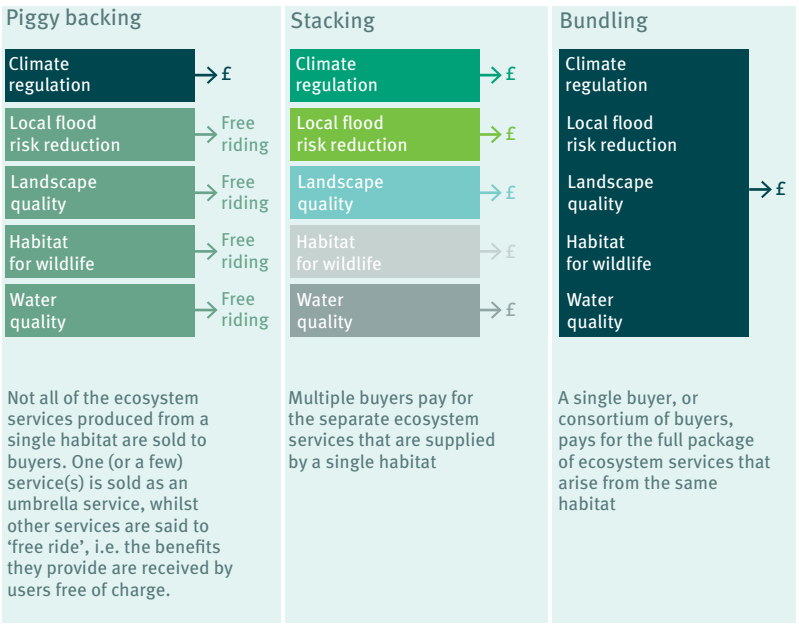
Different ways to sell ecosystem services

As shown opposite, benefits from land based projects can be packaged and sold in different ways. In 'piggy backing' a single benefit is paid for and co-benefits are effectively delivered for free. In 'bundling' a single buyer or consortium of buyers pays for a range of benefits. And, in 'stacking', the benefits from the same activity are sold separately to a number of different buyers. Most existing payment schemes use the piggy backing or bundling approaches, or a combination of the two. Examples of stacking are extremely rare.

The NIS effectively bundles flood and water quality, allowing the habitat and carbon benefits to piggy back. For selling carbon credits, bundling is less relevant because, unlike flood prevention and water quality, carbon

reduction could be delivered anywhere and there will be few single customers who will want to buy all three services from one project. However, piggy backing and stacking are useful to explore. With piggy backing, buyers could source carbon credits which also deliver significant co-benefits. In stacking, sellers could combine payments from multiple customers with different needs to make a project viable. In both cases, private investment supports an increase in the overall environmental value and number of projects delivered.

Different ways of packaging payments for ecosystem services[18]



Two ways a NIS could be used:

1. Only selling carbon credits: In this case the principle benefit contracted would be carbon emissions reduction and sequestration. A geographically clustered set of land managers would jointly develop, deliver and monitor a project, reducing their transaction costs. It would then be marketed to buyers who want to support identifiable UK based schemes with good reputations and significant co-benefits, rather than disparate projects across the country selected purely on cost.

2. Selling carbon credits as one of the stackable benefits: the services of climate change mitigation, flood mitigation and improved water quality are sold separately in circumstances where none would be sufficient on their own to make a project viable. A NIS reaches its funding threshold by selling these benefits to a combination of local, direct beneficiaries and to buyers of carbon credits around the country who are part of voluntary or compulsory schemes.

Challenges for carbon markets

The challenge for carbon markets is to find ways to ensure the activities they support and credits they generate are truly additional, that the estimation or measurement of the credit is robust and that the change is permanent.

"Proving that a project is 'additional' is fundamental to the effectiveness of the carbon credit market."

The history here is not good. It is estimated that 85 per cent of the projects undertaken through the Clean Development Mechanism (CDM), established under the Kyoto Protocol, would have been delivered anyway, or the scale of climate change mitigation they have achieved has been overestimated.[19] This has undermined the environmental integrity of the credits issued and subsequently depressed carbon prices.

These flaws mean very few countries intend to use international credits to achieve their climate change mitigation pledges, increasing the importance of new domestic sources of carbon credits and credible systems that prove their impact.

Defining 'additionality' [20]

Proving that a project is 'additional', ie that it is above the regulatory baseline and would not have been delivered without extra funding, is fundamental to the effectiveness of the carbon credit market.

Increasingly, assessments are based on protocols using standardised information, rather than relying on information supplied by projects. National and regional assessment on the viability of various measures, can take into account non-financial barriers and the extent of novel or innovative practices, so whole classes of activity can be designated as additional.

The main tests for additionality, whether evaluated at the project or programme level are:

- **Emissions additionality:** This is when a project reduces emissions, even if, like industrial efficiency, it was already profitable but faced other barriers to take up, such as information, risk or upfront financial constraints.

- **Financial additionality:** This is when a project would not reach the required rate of return without a carbon credit. The UK's Peatland Code and Woodland Carbon Code require 15 per cent of project costs to be covered by carbon funding. Weaker tests rely solely on information provided by the recipient. Stronger tests include standardised information.

- **Technological additionality:** This is when a project leads to faster uptake of a technology than would have otherwise occurred. The US regional greenhouse gas protocol considers technologies with less than five per cent penetration to be additional if there are no laws and regulations that would otherwise drive their take up.

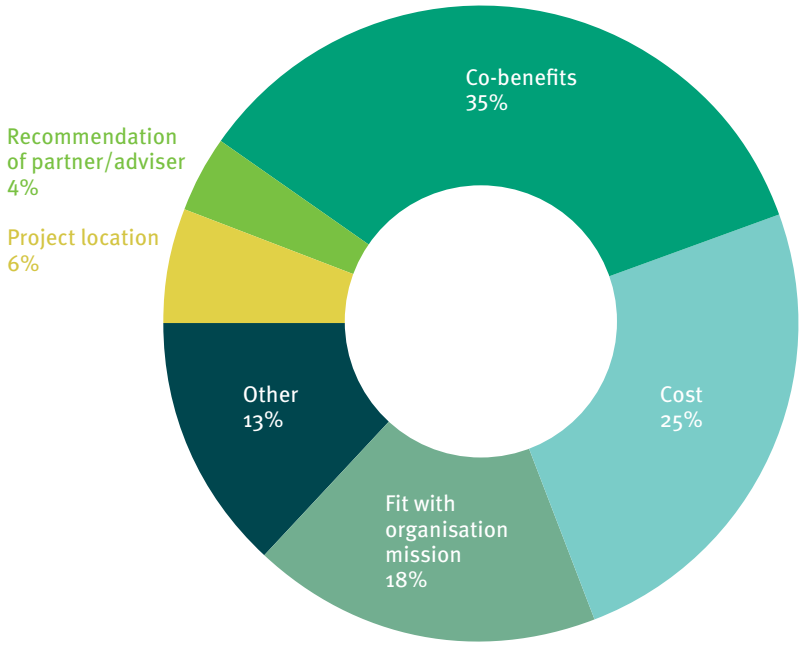
The development of the ELM system, which will require an assessment of the public money available to support each category of public good, is an ideal opportunity to establish a test or assessment of the additionality of private investment in carbon and other offsets. This is best done at the regional level, to take into account local need for particular ecosystem services and the varying cost of delivering them in each part of the country. An additionality protocol could include a test for emissions, financial and technological additionality, and would have to be updated periodically to take account of changing costs and developments in mainstream practice.

How carbon credit markets work

Voluntary carbon credit markets currently use a bundling or piggy backing approach. According to a survey of voluntary carbon credit companies, the primary reason for purchasing credits is to achieve emission reduction targets, with other reasons being valuing the ability to show climate leadership, pursue a climate driven mission or engage customers and clients.[21]

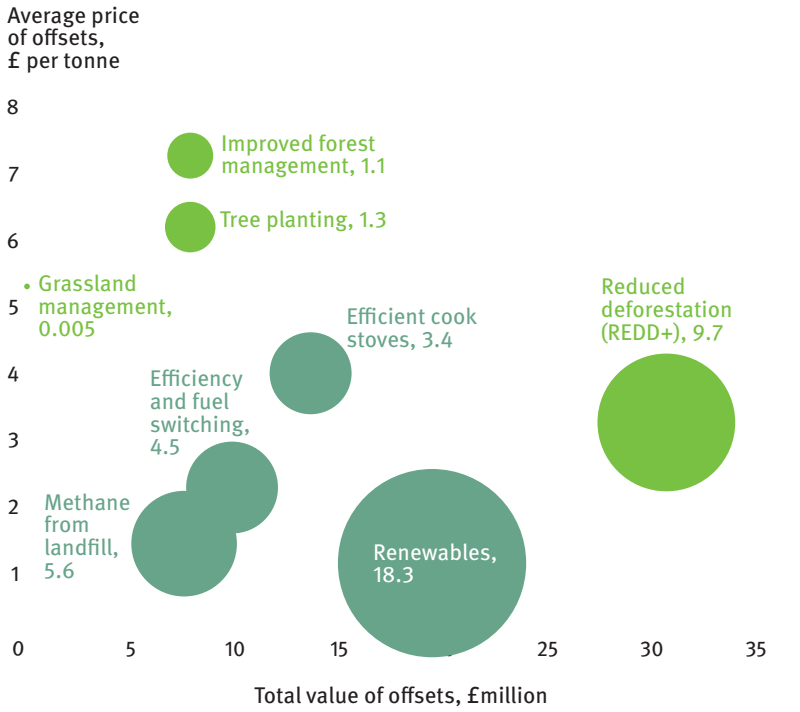
While price is important, many buyers of carbon credits also take into account the type of project, location and other benefits for the environment and community when choosing land based credits, often paying a premium where other benefits can be quantified and verified (see below).[22]

Primary reasons for choosing particular carbon offsets[23]



While land based credits can command a higher price in voluntary carbon markets (see below), in markets driven by regulation and compliance obligations, price is likely to be a more important factor when choosing credits. For example, in 2016, renewables accounted for the largest share of global voluntary carbon credits. They were also some of the cheapest at an average £1.05 per tonne CO_2e. While forestry and land use projects were the second most popular choice, 80 per cent of the credits sold in this category were from reduced deforestation and forest degradation (REDD+), with only 11 per cent for planting new trees.[24]

Comparison of global offset activities 2016 ($MtCO_2e$)[25]



Carbon credit prices

As shown above, global average prices for carbon credits vary between different offset project types. For tree planting, the global average price is about £6 per tonne of CO_2e. However, prices can vary widely, with some forestry projects attracting prices up to £60.[26] In the UK, woodland planting projects may typically attract prices between £3-£9 per tonne CO_2e, paid upfront to the landowner by a project developer.[27] In this report, we use £9 per tonne CO_2e as an indicative price to test the viability of different natural climate solutions.

Providing stackable benefits with a NIS

We have discussed how some buyers of carbon credits may be willing to pay a premium for projects that offer other benefits. Land based carbon projects primarily funded for their climate change mitigation benefits could be delivered through a NIS in some cases, with other benefits piggy backing. On page 28, we discuss how a NIS could make those projects possible. However, here we focus on the opportunity for projects that sell stackable benefits.

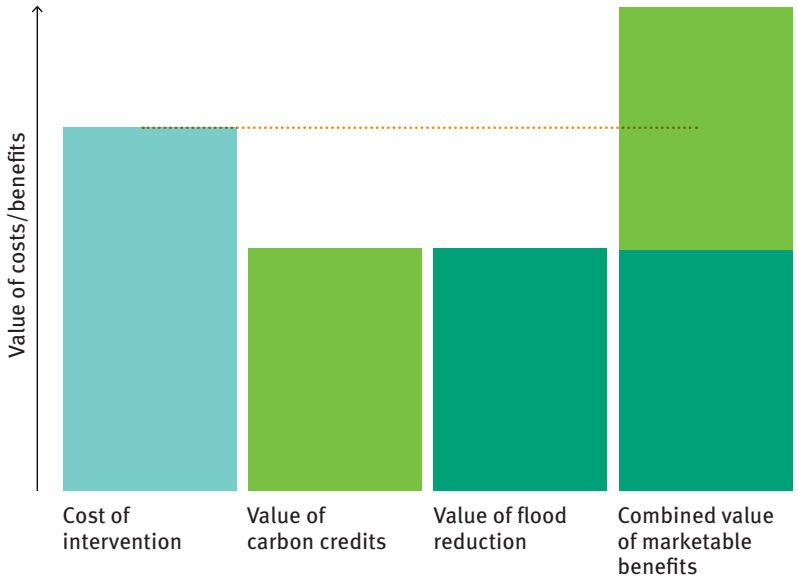
"Selling water quality or flood mitigation and carbon credits as separate benefits is likely to lead to greater funding overall for most projects."

In previous studies, we have shown how an agreement between multiple farmers and multiple beneficiaries to prevent flooding and improve water quality could work based on avoided costs. Including buyers of additional ecosystem service benefits, such as climate change mitigation, could benefit the environment by increasing both the quantity of viable projects and the environmental value of interventions.

1. More viable projects

As mentioned above, some companies may be prepared to pay more for carbon credits that have additional benefits such as biodiversity or flood resilience. But, if these co-benefits are not their primary interest, they will not value them as highly as a company paying to avoid the immediate and real costs of flooding in their locality. Therefore, selling improved water quality or flood mitigation and carbon credits as separate benefits is likely to lead to greater funding overall for most projects. As shown in the figure below, this should make more projects viable, increasing the rate and extent of environmental recovery.

How 'stacking' can make more projects viable



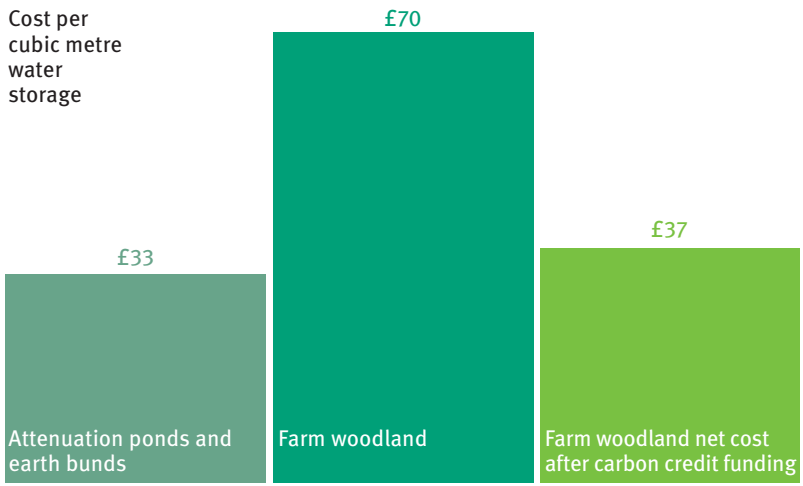
2. More valuable interventions

A NIS project purely focused on reducing flooding might choose bunds and attenuation ponds as the most cost effective means to store and break up the flow of water. However, if the project was also able to sell carbon credits, it might choose different interventions with higher value for the environment overall, such as woodland planting or peat restoration.

"If a project was also able to sell carbon credits, it might choose interventions with higher environmental value."

Using indicative costs and details of water storage capacity, the chart below shows how farm woodland could be less cost effective as a flood management measure than attenuation ponds and bunds. However, when carbon credit funding is added, the net cost of farm woodland is reduced to a similar level of cost as attenuation ponds and bunds, making it a more competitive choice. The cost and efficacy of natural flood management measures varies greatly and is highly location specific, but these indicative costs show how the addition of carbon credit funding could change the choice of intervention.

Costs of water holding capacity compared[28]



While woodland is not always appropriate, in many circumstances it would provide higher environmental value than attenuation ponds and earth bunds (see below).

Environmental benefits of interventions compared

	Attenuation ponds and bunds	Woodland
Biodiversity	✓	✓
Soil quality	✓	✓
Carbon reduction	✗	✓
Air quality	✗	✓

3.
Scaling up environmental projects with carbon credits

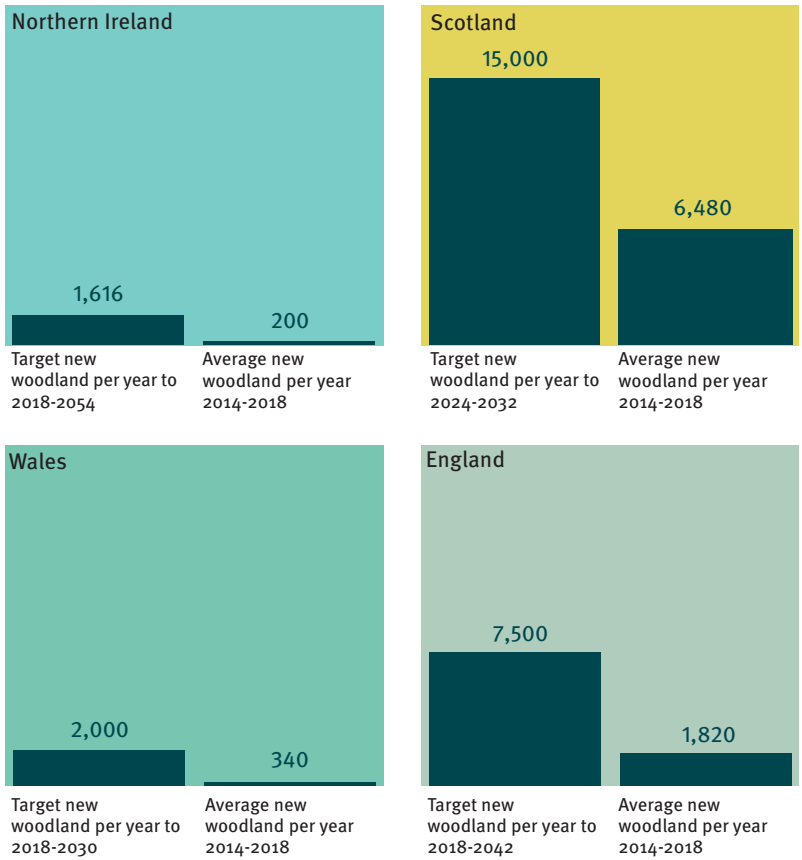
We examine carbon reduction activities from land use in three broad categories: peatland restoration, agriculture and forestry, focusing on those measures which are most significant to the UK and which are unlikely to be carried out at scale without additional support or incentives.

We concentrate on mitigation measures where there are proven methodologies for verifying the carbon impact; and where there are additional environmental benefits, particularly flood prevention and improved water quality. For these measures, the addition of carbon credits would help to scale up or increase the number of projects.

Increasing woodland

To meet UK and devolved government targets for increasing woodland to tackle climate change, around 24,100 hectares of new woodland needs to be planted per year over the next decade and beyond (see chart below for specific targets), rising to 26,100 hectares per year from 2024. Only 9,000 hectares of new woodland was planted in 2018.[29]

New woodland planting targets compared to current planting rates (hectares)[30]



New woodland may have multiple marketable benefits including commercial activities, such as timber production and game shoots, carbon sequestration and flood risk reduction.[31] However, because converting farmland to woodland is a permanent change of land use and can reduce the value of land, it is a risk for farmers and land managers who may need greater incentives to make the change.[32,33]

"Converting farmland to woodland is a risk for farmers and land managers who may need greater incentives to make the change."

Woodland planting will have to become a more attractive prospect for farmers and land managers to meet the government's tree planting targets. Combining carbon credits with another source, such as flood risk reduction funding, could help to make it more attractive and increase planting rates.

The Woodland Carbon Code

To boost woodland creation in the UK, the government created the Woodland Carbon Code to provide a verifiable standard to help UK based businesses to invest in woodland creation in return for carbon credits.

Where government grants and commercial benefit are not sufficient to make a project viable or attractive compared to other land uses, carbon credits are registered under the code and sold to UK businesses that want to offset their emissions and achieve sustainability goals.

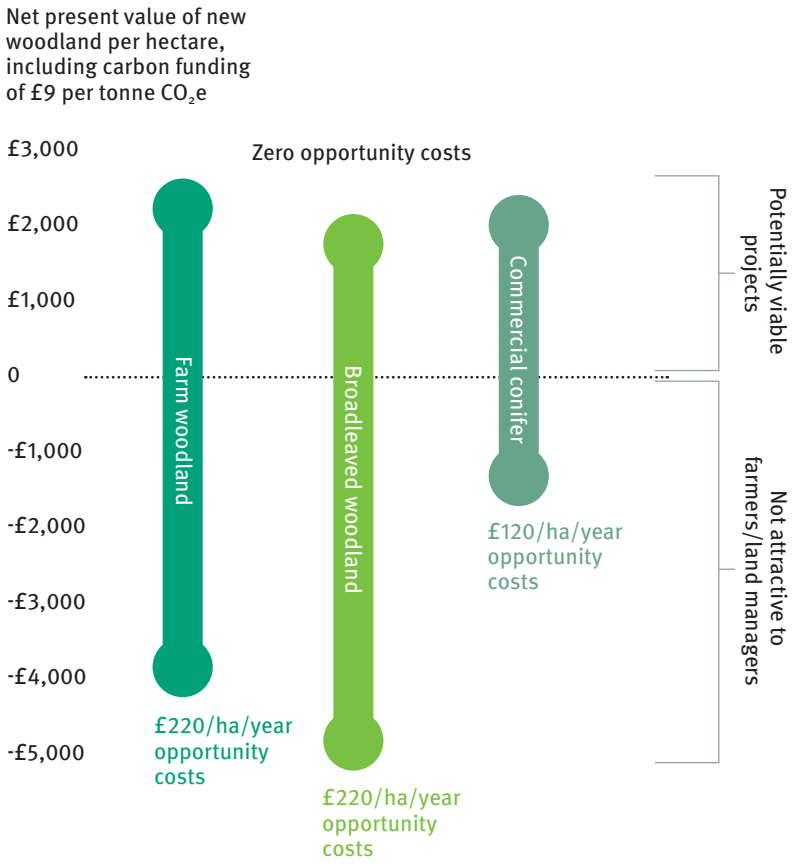
By 2018, 5,257 hectares of new woodland had been planted under the code, with a further 10,868 hectares of projects registered. The ability to register and sell carbon credits has led to more woodland planting in the UK, but the overall impact has been limited by relatively weak demand in the current voluntary carbon market. So far, about eight per cent of the new woodland planted since the code was established has used carbon credit funding.[34]

The government has pledged to buy up to £50 million of Woodland Carbon Code credits over the next thirty years. At average global voluntary carbon prices, this could support the creation of up to around 17,000 hectares of additional woodland.[35]

The graph below shows the net present value per hectare of planting three different types of woodland (see annex 1). This takes into account the cost of planting and maintaining the woodland compared to the income that could be expected from government grants, commercial income, such as selling timber, and funding for carbon credits at £9 per tonne CO_2e. On some land, where opportunity costs are very low, all woodland types could be attractive to farmers and land managers if carbon funding is included. However, due to loss of income from farming, many potential woodland projects will not be an attractive prospect unless other sources of income are available. This is especially the case for farm woodland and broadleaved woodland managed for biodiversity. If additional income could also be received for the land use change, for example as part of a natural flood

management scheme, planting woodlands could become a more viable option on more land, helping to achieve the big increases in tree planting rates required to meet government targets.

Many potential woodland projects will not be attractive to farmers and land managers when opportunity costs are taken into account[36]



Different mixes of trees and different management regimes will deliver different commercial, environmental and social value. For example, conifer plantations managed for timber have a higher commercial value, but lower value for carbon sequestration, habitat creation and recreation. The ability to access multiple income instreams could also make more environmentally valuable woodland types more viable.

Peatland restoration

'Gully blocking' to restore peat

"While peat bogs in their natural state are a perpetual carbon sink, degraded peat is a net emitter of greenhouse gases."

Peatland covers an estimated 12 per cent of the UK and stores 20 times as much carbon as the UK's forests.[37] It provides valuable services to businesses and society, including biodiversity, helping to manage flood risk and improve water quality, as well as storing carbon. However, 80 per cent of UK peatlands are in a damaged or deteriorating state, often due to drainage for agriculture, shooting or forestry.[38]

The Committee on Climate Change estimates that 55-70 per cent of peat (0.7-1.1 million hectares) needs to be restored by 2050 to meet climate change targets.

While peat bogs in their natural state are a perpetual carbon sink, taking carbon from the atmosphere and storing it in plant remains, degraded peat is a net emitter of greenhouse gases. It is estimated that actively eroding peat emits 23.84 tonnes of CO_2e per hectare per year; this is more than three times the average yearly emissions of a person in the UK.[39,40] Drainage can also lead to sediment pollution and reduced water storage capacity.

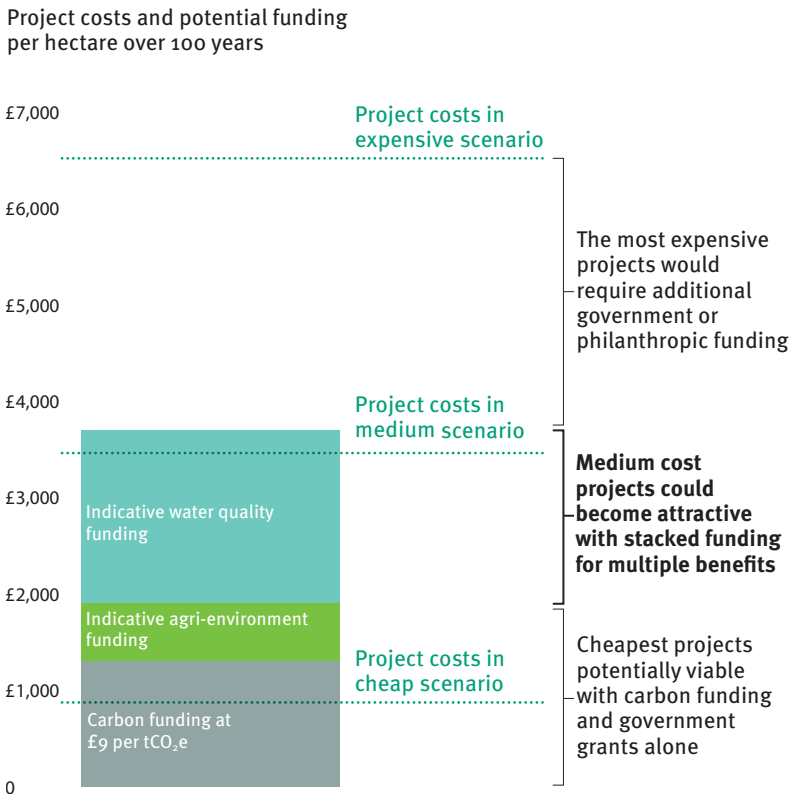
Costs of peat restoration vary widely between projects, depending on the specific condition of the peat and the accessibility of the site. Unlike woodland, there is no clear commercial revenue stream for restored peat, so new funding is needed to make maintaining peatland an attractive prospect for farmers and land managers.

For example, farmers and land managers can create and sell carbon credits from their peatland restoration projects carried out to the Peatland Code standard. This launched in 2015 and one project has been validated so far with three other projects in development. In addition, peat restoration can have water quality and flood alleviation benefits and some water companies already invest in peat restoration. Some philanthropic or government grants and agri-environment payments may also be available for these projects.

To show how stacking benefits, including carbon credits, could increase peatland restoration we have looked at three theoretical projects with varying costs, depending on the extent of restoration activities.

With carbon funding and government agri-environment payments alone (grey and green respectively in the graph below), only the cheapest restoration projects will be attractive to farmers and land managers. However, if additional funding were available to them, for example for water quality benefits (blue), more projects in the medium cost scenario would become attractive. The most expensive peat restoration projects are likely to rely on additional government or philanthropic grants.

Restoration costs compared to potential funding for a 100 year peat restoration project (£ per hectare)[41]



Changing agricultural practices

Changing the way land is used and soils are managed is an important source of potential carbon reductions, estimated to account for around 89 per cent of the global potential for cutting emissions from agriculture.[42] But there are challenges in bringing about these changes and measuring their impacts. Changes made often affect more than one type of greenhouse gas emission so the combined net effect has to be considered.[43] Soil carbon sequestration from changing arable to grass or switching to agroforestry takes some time to accrue and is only fixed as long as the practice is maintained, whereas changes to crop management reduces emissions immediately and every year. In both cases, the effects are highly variable and the costs, or potential profits, depend on current margins and whether new low carbon measures are integrated profitably into the wider farm business.

The Committee on Climate Change has highlighted that changes to the climate could result in the UK developing a comparative advantage over food producing regions at lower latitudes, increasing the importance of the UK as a food producing nation.[44] This will increase the imperative for the UK to develop low carbon farming practices. The value to agricultural production of increasing organic matter and the natural fertility of the soil are becoming much more widely understood, but additional incentives are still needed to motivate farmers to invest in new practices.

The policy framework for the ELM system could support low carbon farming because it produces public goods – climate change mitigation and carbon sequestration – through practices that would not otherwise be viable. The ELM should also set a threshold for the extent of carbon benefits it expects from regulation and payment for public goods. This will enable assessment of which additional activities could generate carbon credits and be attractive to private investors.

Despite increasing public policy interest in low carbon agriculture there is, as yet, no farming and soil carbon code in the UK equivalent to those for woodland and peatland. This is a major barrier to market development. Understanding of land based measures to cut carbon is still evolving and it will take time for the full range of potential measures to be included in a code. However, government support to develop a standard assessment of the impact of the most well evidenced measures would help farmers and investors take early action to start delivering improvements now.

The NIS can be used for measures that improve soil quality and increase levels of vegetation, ie the natural infrastructure which delivers carbon and other co-benefits.[45] Because we are examining the role of private investment, we have focused on those agricultural measures not expected to be required by regulation or sufficiently incentivised by policy.[46]

"Despite increasing public policy interest in low carbon agriculture, there is no farming and soil carbon code in the UK equivalent to those for woodland and peatland."

There are five types of land management that have the most potential for large scale carbon reduction in the UK but which require significant change to a farm's business model, upfront investment or which are otherwise not commercially viable in the short term.

Sharing the transactional, monitoring and evaluation costs of low carbon agricultural practices via a NIS mechanism would enable more of these projects to reach the threshold for delivery.

Five low carbon agricultural practices:

1. Growing legumes in rotation: biologically fixing nitrogen in the soil with legumes could increase a farmer's gross margins by reducing the need for fertiliser. However, low legume prices, the constraint this subsidiary crop imposes on when the main crop can be planted, along with the need for new equipment means adoption tends to be very low.

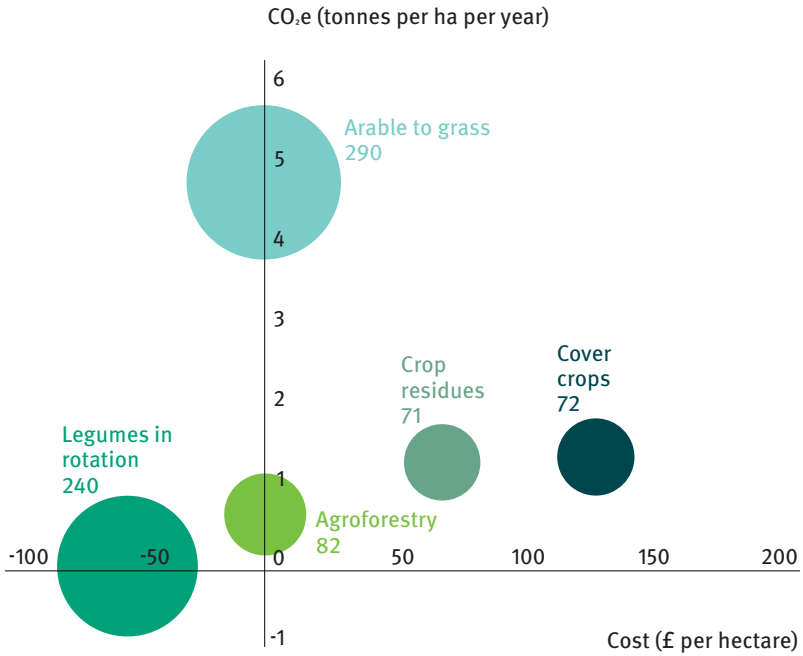
2. Converting arable to grass, with no additional livestock: this permanently reduces production but, on marginal land, it may not reduce profits. Carbon reduction, biodiversity and improved water quality benefits would need to be rewarded well to motivate farmers to convert their higher grade land.

3. Agroforestry: this could have a positive effect on productivity and deliver further carbon reductions than shown in the graph above , depending on the use of the biomass generated, but the need to adopt different farming techniques currently hinders adoption.

4. Leaving crop residues on the surface: this increases soil carbon but loses income from straw or leads to additional fodder costs.

5. Planting cover crops: these sequester carbon and reduce N_2O emissions. It is possible they could generate a profit with the right crop, yield and no new equipment required, but generally they are a net cost.

Cost and carbon reduction potential of different agricultural changes (Bubbles represent total potential per year in $KtCO_2e$)



A full description and assessment of each measure is set out in Annex 3

Most of these agricultural practices deliver relatively low carbon reductions per hectare, which means it is unlikely that the ability to sell carbon credits will encourage their uptake alone. For example, leaving crops on the surface or planting cover crops would require a very high carbon price of £66-£107 per tonne, if it were funded by carbon credits alone.

However, all of these measures also provide co-benefits. If they were able to access payments for their biodiversity, flood mitigation and water quality benefits for example, they may be fundable via a NIS project selling stackable benefits.

Converting arable to grass is the only measure where carbon funding alone, ie the piggy backing funding model, might be feasible. If the average cereal farm of 208 hectares converted half of its land to pasture for a carbon price of £9 per tonne, the farmer could earn around £4,500 per year from carbon credits. The extent to which that would compensate for income from cereals would depend on the margins earned from the land converted. The return to the average UK farm from cereal was £1,600 in 2017-18, and in the previous five years cereal farming made a loss, so there are likely to be a number of farms that could take some land out of production without negative impacts on their margin.[47]

There will be a range of project costs for each measure, and the carbon prices required to encourage uptake will reflect how costly the project is overall and how risky or beneficial it is for the individual farm business concerned. Costs and risks are likely to reduce over time as more and more farmers adopt new practices and learn how to integrate them into their businesses.

"In Australia, farmers can generate Australian Carbon Credit Units through an approved method and then trade credits in voluntary and compliance markets"

The additionality assessment for those projects which could be profitable or, at least cost neutral, should be based on technological additionality, making them time limited. This would allow early adopters to cover the costs of making the change while the practice is still novel and risky. But, as practices become more mainstream they should no longer be considered additional.

Australian Carbon Farming Initiative

Australia's Carbon Farming Initiative is the world's first national scheme to regulate the generation and trade of carbon credits from farming and forestry. Landowners can generate Australian Carbon Credit Units (ACCU) through an approved method and then trade credits in voluntary and compliance markets.

Farmers gain credits for implementing specific management actions: nutrient management, soil acidity management, new irrigation, pasture renovation, stubble retention and conversion to pasture.[48] Farmers must be able to show that the management actions are markedly different from their land management over the previous ten years.

A new soil carbon methodology came into force in December 2018. It is designed to increase uptake of carbon farming by expanding the range of farming systems that can participate in the scheme and by allowing new and cheaper measurement techniques.

Some steps have been taken towards enabling farmers to take advantage of carbon credits in other countries. For example, in New Zealand, the inclusion of agriculture on the country's emissions trading scheme is planned by the current government, pending review. California's cap and trade system allows purchase of offsets from projects based in the USA and is developing a protocol to reduce emissions from rice growing.[49]

4
How a NIS can enable project delivery

Attracting more investment in environmental restoration projects, to supplement government spending, will be vital to achieve the ambitious goals of the 25 year environment plan and to enable land managers to switch to low carbon business practices.

If a carbon credit scheme is well managed and rigorous in its measurement of additionality, the NIS it funds will deliver environment benefits that would not have otherwise been realised.

Buying and selling carbon through a NIS offers the following benefits:

It brings together local and non-local buyers: many of the measures that slow and hold water in the catchment, such as tree planting, soil management and wetland creation also have carbon benefits. If stacking flood mitigation, water quality and carbon reduction is necessary to make a project viable, it can only happen by identifying the local beneficiaries for flood and water first and adding the carbon credit buyers afterwards. A geographically disparate set of carbon reduction projects cannot be made viable by adding flood reduction or water quality benefits because their cumulative effect will not be sufficient to benefit local customers.

"If a carbon credit scheme is well managed and rigorous, the NIS it funds will deliver environment benefits that would not have otherwise been realised."

It reduces the transaction costs of trading carbon credits: projects that are co-located and use the same measures can lower their transaction costs and the price they need for their carbon credits by pooling the measurement, reporting and verification costs.[50] These costs are a particular barrier for a farming sector which is dominated by small businesses.

It allows sellers to manage variation in delivery: as natural systems mitigate and store carbon at different rates, variability of carbon reduction makes accessing the carbon market a relatively difficult prospect for farmers. By bringing a number of projects together, farmers can sell a higher aggregate effect than they would be able to sell alone. This is because natural variation in each project can be balanced out when the whole scheme is assured together.

Increases the reputational value of the project: as well as the increased environmental quality that comes from stacking benefits, there is also value in concentrating environmental delivery in neighbouring areas. Biodiversity and habitat improvements are multiplied by having a number of projects close together. This is an important consideration for buyers of high quality offsets, where co-benefits piggy back on the primary carbon purchase; value is further enhanced by the ability to identify and report to buyers on a larger scale project.

Complementing 'public money for public goods' payments

Details about the new ELM system in England are still being developed, with a large scale pilot planned for 2021-24 and full implementation intended from 2025. We know that Defra is keen to explore how public money can use market mechanisms and make space for private investment where appropriate.

"A NIS could have a role as a catalyst driving innovation at the margins of what is currently possible."

One of the projects in the tests and trials phase is expected to focus on developing a NIS for flood mitigation and water quality in Cumbria. But how can private money support the delivery of the same public goods that Defra also wants to support? The answer is through good assessment of additionality.

The ELM system will do three things: set a minimum regulatory requirement for land management and agriculture; make the measuring and reporting of public goods a core requirement for farmers and land managers; and fund projects that deliver public goods.

Provided that funding is maintained or increased, the commitment to pay for environmental public goods should enable a significant change in what farmers choose to deliver, providing environmental services alongside, and at the same time as, producing food, particularly encouraging the adoption of lower carbon and nature friendly modes of production.

Once the ELM system is up and running, the interventions that are easiest and cheapest to deliver will come forward for funding first; there is a threshold where projects will not have sufficient incentives to make them deliverable. This is where a NIS could have a role, as a catalyst driving innovation at the margins of what is currently possible. What is considered additional will change over time, because innovation and new practices are likely to lead to changes in what is considered best practice over time.

Defra should use the tests and trials phase to explore how ELM funding for public goods can allow for a relatively simple test for additionality, so private funding can be levered alongside public money where possible. For example, a regional assessment of priority public goods in a particular area could also identify measures that would be covered by ELM payments, and those that should be considered eligible for carbon credits because they would otherwise not be viable. This assessment would have to be periodically reviewed and updated as some types of activity could enter the mainstream and become less costly.

As with the Woodland Carbon Fund, it would be helpful to establish a general principle about how public and private money could be used together to support land based projects. An intervention not viable with ELM payments alone should be able to assemble a case for additional private funding, to help it reach viability. It should also be possible that, in some schemes, the government could operate as a 'buyer' alongside private sector interests, each purchasing different benefits.

The problem of international carbon credits

Constructing a private-public joint funding arrangement will be simpler when only domestic carbon credit purchasers are involved. Including international carbon credits in the mix is significantly more complicated because of their impact on UK carbon emission accounts.

If land based schemes in the UK generate credits that are then sold to buyers in another country or into international carbon schemes, eg for aviation and shipping, they have to be excluded from the UK's emissions reduction target reporting. This is because the carbon credit has to be allocated to the country that purchased it, and would be double-counted if the UK accounts also reported the resulting emission reductions from the activity.

"It would be unfair to deny UK projects access to funds from international carbon credit schemes if policy and funding was not available in the UK."

As such, the opportunity for UK based projects to sell into international credit schemes like CORSIA (see page six) would have to be closely managed. Whether international or domestic, the only carbon credits eligible for sale would have to be those generated by a project the UK government had assessed as undeliverable without additional support. It would be unfair to deny UK projects access to funds from international carbon credit schemes if policy and funding was not available in the UK. But the UK government may not want to give up this potential source of UK agriculture and land use emission reductions, as it may want to include them in future domestic carbon reduction policy.

The UK is likely to be a relatively expensive source of land based carbon credits, due to the scope of activities possible, so there may not be a flood of interested international buyers. The most likely international buyers would be UK based aviation and shipping operators, who, for reputational reasons, may want to buy some high quality credits generated at home to meet their obligations.

The challenge for the UK government is therefore to develop policy and domestic schemes quickly enough to avoid UK carbon credits being lost to the international market. Progress on the government's commitment to develop domestic frameworks for carbon credits, in which land based schemes would be eligible, would be the best way to prevent land managers requesting to sell their land based credits internationally.

5
Our recommendations

The NIS concept was an idea to enable markets for flood prevention and improved water quality, by encouraging investment in land management measures that slow and hold waters in a catchment. But the long term and geographically concentrated nature of these schemes also makes them well suited as a means to stimulate investment in land based carbon reduction projects. By offering carbon credits, they could increase the quantity and quality of land based ecosystem service projects in the UK.

Mitigating and sequestering carbon from forestry, land use and agriculture is an increasing political priority for the UK in its efforts to meet ever more stringent carbon targets. The NIS can be used to lower emissions from the land, while creating new income streams from managing woodlands, peatlands and changing agricultural practices.

To start making the most of this opportunity, the UK will need to strengthen the domestic market for carbon credits from land based projects.

We recommend the following:

Increase private sector demand for land based carbon credits

While the government has committed to buy up to £50 million of woodland carbon credits, private demand for them is limited. The Clean Growth Strategy commits to developing "a stronger and more attractive domestic carbon offset market". The government has introduced new regulations requiring large companies to report their emissions, but it is unclear to what extent, if at all, this will drive demand for domestic carbon credits. The government should introduce new measures to boost the market for UK land based carbon credits. To achieve this, the Department for Business, Energy and Industrial Strategy should:

- conduct a systematic review of options for boosting domestic demand for land based carbon credits; these could include an emissions trading scheme for the agriculture and land use sector or new requirements or incentives for sectors which fall outside the existing emissions trading scheme to reduce their emissions and invest in carbon credits.

Fund a new Farming and Soil Carbon Code

While the UK now has carbon credit codes for woodland creation and peat restoration, there is no equivalent code or protocol in the UK for generating carbon credits from changed farm management practices. Australia has a scheme that helps farmers create and sell carbon credits, and other countries such as New Zealand and the USA have taken steps towards this. Learning from these examples, the Department for Environment Food and Rural Affairs (Defra) should:

- provide a strategic framework for farmers and land managers to generate carbon credits in the forthcoming emissions reduction plan for

agriculture; this will help develop the market and give confidence to farmers, land managers and potential credit buyers;

- work with farmers and businesses to develop a Farming and Soil Carbon Code, tailored to the UK farming context; as with the Woodland Carbon Code, this should give private buyers confidence in the permanence and additionality of the credits, while simultaneously providing a robust measure for 'public money for public goods' payments for carbon on farms.

Demonstrate the ability of environmental projects with multiple benefits to lever in private investment

Environmental projects often have more than one benefit, simultaneously providing services like climate change mitigation, flood regulation, improved soil and water quality, biodiversity etc. We have described how the ability to sell more than one benefit from a single project would boost the quantity and quality of environmental restoration it delivers. Under the new ELM system, public money will be supporting public goods and it must do so in a way that promotes projects with multiple benefits and allows additional private investment to be accessed. Defra should:

- use the tests and trials for the new ELM system to show how the government could be included as a 'buyer' in schemes such as the NIS, alongside private sector buyers;

- publish clear guidelines on how, when and where private funding can be used to complement the new public payments system.

Annex 1 Indicative woodland planting scenarios

Assumptions and sources

	Unit	Farm woodland Northern England	Broadleaf for game and biodiversity Wales	Upland conifer for timber Scotland	Discounted?
Opportunity cost[51]	£/ha/year	220	220	120	Yes
Net present value of woodland excluding opportunity costs[52]	£/ha	-1,500	-900	1,000	na
Net greenhouse gas emissions reduction 100 years[53]	tCO2e/ ha	450	330	130	na
Discount rate	percent	3	3	3	na
Carbon credit price	£/tCO2e	9	9	9	No
Woodland mix[54]		Sycamore/ alder/ birch (65%), Douglas fir (25%), open space (10%)	Sycamore/ birch (45%), oak (45%), open space (10%)	Sitka spruce (90%), open space (10%)	

Annex 2 Indicative peatland restoration scenarios

Our three scenarios:

Low restoration costs: the cheapest estimate of capital costs for peatland restoration, with basic project costs, £10 per hectare per year incentive to farmer or landowner, and no opportunity costs

Medium restoration costs: 'rule of thumb' capital costs of £1,000 per hectare, average project costs, £10 per hectare per year incentive to farmer or landowner, and mid-level opportunity costs (£50 per hectare per year)

High restoration costs: More expensive capital costs (eg re-vegetation and hag-reprofiling), average project costs, £10 per hectare per year incentive to farmer or landowner, and relatively high opportunity costs (£100 per hectare per year)

Assumptions and sources

	Unit	Low restoration costs	Medium restoration costs	High restoration costs	Discounted?
Opportunity cost[55]	£/ha/year	0	50	100	Yes
Incentive[56]	£/ha/year	10	10	10	Yes
Monitoring, maintenance, co-ordination and accreditation 100 years[57]	£/ha/year	11	20	20	Yes
Capital costs[58]	£/ha	300	1,000	2,495	No
Site assessment and planning[59]	£/ha	26	31	31	No
Net greenhouse gas emissions reduction 100 years[60]	tCO_2e/ ha	153	169	202	na
Present value of water quality benefits over 25 years[61]	£/ha	£1769	£1769	£1769	na
Discount rate	percent	3	3	3	na
Carbon credit price	£/tCO_2e	9	9	9	No

Annex 3: Agricultural mitigation measures[62]

	Description	Costs	Effectiveness per hectare	Total potential impact in UK[63]	Uptake without additional incentives	Co-benefits
Measure		£/ha	tCO_2e/hc/ year	k t CO_2e /year	%	
Conversion arable to grass	Carbon reduction effect of permanent grassland with no additional livestock which sequesters soil carbon for 30-50 years before reaching equilibrium	UK cereal farms make little or no returns from agriculture. Therefore, on marginal land, it will not necessarily reduce overall margins[64]	4.75	290	1%	Reduced risk of soil erosion Reductions in nitrate leaching and phosphorus loss to watercourses Increased biodiversity of the soil, habitats and species of the grassland
Agroforestry	Increase in soil carbon from integrating trees into crop or livestock systems[65]	Could increase or decrease gross margin after initial investment depending on productivity effect on crops and grasslands.	0.52	82	1%	Improved soil moisture and efficient water use Reduced soil erosion Improved biodiversity and pest control Wind breaks and shade
Leaving crop residues on the surface	Increase soil carbon content	Income loss associated with reduced sales of straw or additional cost of fodder of £77/ha in the UK	1.16	71	1%	Reduced soil erosion Improved soil moisture Improved soil biodiversity
Catch and cover crops	Reducing bare soil sequesters soil carbon and reduces N_2O emissions	Costs depends on crop type, yield and equipment required measure could increase or decrease gross margins, on average short term cost £126/ ha	1.18	72	10%	Improved soil nutrient content Reduced wind and water erosion Reduced nutrient and sediment run off
Legumes in rotation	Reducing the need for nitrogen fertilizers by including more biological nitrogen fixing crops in a high productivity arable or grass rotation.	Fertilizer savings could increase gross margins by £58/ha, if fixing crop is profitable and doesn't require new equipment	0.02	240	5%	Reduced nitrate leaching Biodiversity, especially insect pollinators Diversity of habitat on arable farms

Endnotes

[1] In this report when we refer to 'carbon reduction' we mean projects which either reduce greenhouse gas emissions, or sequester carbon, or both, such as tree planting, peat restoration, or changes to land management to increase soil carbon. These types of interventions are often called 'natural climate solutions'. We use 'carbon' as a catch-all term to refer to all greenhouse gases, except where a specific reference is made, eg 'soil carbon'.

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[4] D Benton, November 2018, *How the UK can stop contributing to climate change*, Green Alliance

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[16] Based on data from K Hamrick and L Brutto, 2017, *State of European Markets 2017: voluntary carbon* Original figures in EUR, converted to GBP using yearly average exchange rate to 31 March 2016, www.gov.uk/government/uploads/system/uploads/attachment_data/file/518917/average_spot_rates_310316.csv/preview

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[19] M Cames, et al, March 2016, *How additional is the Clean Development Mechanism?*

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[21] K Hamrick and M Gallant, 2017, *Unlocking Potential: state of the voluntary carbon markets 2017: buyers analysis,* Ecosystem Marketplace

[22] Centre for Environmental Policy, 2014, *Quantification and evaluation of the voluntary market's co-benefits*

[23] Preference weighted by volume of purchases globally. K Hamrick and M Gallant, 2017, *Unlocking potential: state of the voluntary carbon markets 2017: buyers analysis,* Ecosystem Marketplace

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[45] There are a great many measures for agricultural emissions reduction, including, a number addressing cattle and sheep health, feed additives and anaerobic digestion which should be supported but are focus on livestock not the land and so are not relevant to a NIS

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[63] Median scenario

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[65] Additional effects of sequestration in trees have not been included because they are variable and dependent on the use of the biomass generated

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