SCOTTISH LAND COMMISSION
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Natural capital, carbon offsetting and land use

A discussion paper

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LAND LINES
A series of independent discussion papers on land reform issues

Background to the ‘Land Lines’ discussion papers

The Scottish Land Commission has commissioned a series of independent discussion papers on key land reform issues. These papers are intended to stimulate public debate and to inform the Commission’s longer term programme of work.

The opinions expressed, and any errors, in the papers are those of the author and do not necessarily reflect those of the Commission.

About the Author

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1. Introduction

Scotland's natural capital has suffered, as has much of Europe's, from the impacts of the intensification of agriculture. But Scotland, as an economy overwhelmingly dependent on its natural capital, has its own particular long history of decline: the loss of the great native pine forests; the clearances and the sheep; the great deer and grouse shooting estates; the conifer plantations; and the use of pesticides and fertilisers on the arable lands to the east. To these pressures on the land, the modern ones include the development of marine aquaculture.

The results have been the depopulation of the Highlands, the great wet desert that Fraser Darling described in the 1950s, and the loss of invertebrates, plant biodiversity as well as fish, birds and mammals in both the land and marine environments. Scotland's natural capital is a fraction of what it once was.

Scotland has also used up a lot of its non-renewable natural capital, depleting its oil and gas reserves, its peat and its coal deposits.

That this is not sustainable is at least widely understood. To the years of patient monitoring by conservation groups of biodiversity declines have now been added the concerns and impacts of climate change.

Scotland can do much better. It can turn this long history of decline around, and it needs to do so urgently – in particular, to meet its climate and biodiversity targets. It still has great assets, and lots of economic opportunities to enhance them.

Turning these opportunities into practical environmental and economic gains requires a combination of strong state action and private incentives and supporting private markets.

This could be a great Scottish success, or it could, if done badly, be a disaster. The current overwhelming focus on carbon and carbon offsets is where many of these opportunities and also the risks arise, and, for that reason, this paper concentrates on this dimension of natural capital approaches and policies.

2. Natural capital, systems and public goods

Natural capital is all the capital assets that nature provides us for free. Planet earth is a wonderful cornucopia of resources which have been bequeathed to us. There are two sorts. Renewable natural capital is what nature keeps on giving us for free as long as it is not depleted below minimum thresholds. Fish are classic renewable natural capital: they go on reproducing so that in effect they can be consumed for ever, as long as they are not overfished to the point where they cannot sustain their breeding populations. Scotland has brought quite a lot of its renewable natural capital to the brink so that some risk becoming non-renewable.

Non-renewable natural capital assets are those that can be used only once. The North Sea oil and gas are non-renewable natural capitals which cannot be reproduced by nature except over geological time. The Scottish economy has been heavily reliant on the non-renewable natural assets. Indeed, it was built upon them.

In a sustainable economy, natural capital is passed down through the generations, as a set of assets properly maintained. For renewable natural capital, there can be no depreciation, only capital maintenance, so that they are assets-in-perpetuity. Where that capital maintenance is not carried out, the risk is not only that the current generation is cheating on the next, but, in the event that a renewable becomes non-renewable, it is cheating on the inheritance of *all* future Scottish generations.

The absence of proper national and company accounting for the capital maintenance of these assets-in-perpetuity is a serious gap in both the pursuit of sustainability and an evaluation of the performance of the economy net of capital maintenance. Not to fully carry out capital maintenance is capital consumption.

In the case of non-renewables, since they can be consumed only once, there needs to be compensation for the fact that they are not available to future generations. In the North Sea oil and gas example, there should be a sovereign wealth fund, of the sort deployed in Norway, to do this intergenerational compensation. Otherwise, the current generation is again cheating, overconsuming at the expense of future generations.

The absence of these accounts for both renewable and non-renewable natural capital for the Scottish economy as a whole means that the reported economic performance may be less than it seems. In their absence, it is not possible for government to claim that it is pursuing a sustainable economy. It is also not getting the full benefits of a sustained natural capital asset base.

The great natural capital assets come in *systems* – river and catchment *systems*, upland *systems*, marine *systems*, and urban *systems*, just as physical capital infrastructure does (energy network, water, communications and transport systems). These systems are not merely the sum of their parts. What happens in the headwaters of the great water catchment of the Tay impacts all the way down to Dundee and beyond. Having excess herds of deer in the uplands damages the whole ecosystem not just of the Highlands, but through the interconnectivity – notably through the river systems of the Lowlands.

These systems have multiple natural capitals embedded in them, and they interact. It is not biodiversity *or* carbon *or* air quality in silos; they *all* need to be considered jointly. This has an important implication. Piecemeal improvements without regard to where they fit into the wider ecosystems are likely to be inefficient and sometimes may even have perverse impacts on the ecosystems as a whole. There is no escape from the need to take a holistic systems approach to land and land management.

Public goods arise when private property rights are deficient. This matters when thinking about the role and limits of markets and private choices. A private good is excludable and rival. If you have it, I don't. You can exclude me, and if you consume it, I can't.

Pollution arises where your activities impose costs on me (they are not excluded) and you do not pay for the damage the pollution causes. These are externalities. The remedy is to make polluters pay.

Public goods have the neat and wonderful property that we can all enjoy them simultaneously. They are both non-rival and non-excludable – externalities that are also non-rival. Your consumption does not stop me consuming them at the same time. In technical terms, the marginal cost of each additional bit of consumption is zero. And if it is zero, then the social good is maximised if as many people as possible have the benefits.

Much of Scotland's lands are public goods par excellence. That is why the right to roam, finally achieved in the 2003 Land Reform Act, is not only a matter of equal rights of access for all citizens but is economically efficient too. Exclusion from lands – from the great outdoors – reduces the number of people who benefit, and hence lowers the total social good. But to get the greatest benefits from roaming across Scotland, the land needs to be in good heart to provide this public good. It is not just about the economic efficiency of being able to access the countryside. These public goods benefits increase with enhanced natural capital. Improvements can be enjoyed by many people, and it is the *aggregate* of these benefits that makes public goods so valuable in economic terms.

Pure private enterprise will not preserve natural capital. It will be over-exploited and capital maintenance will be insufficient to repair the damage. The reason is simple and goes to the heart of the definition of public goods. They are non-rival and non-excludable. Private owners cannot extract the economic rents.

A current example is the development of private "rewilding projects" across the Highlands. The private owners have in effect been creating safari parks and can capture the economic rents of their investments only if they can charge customers for access and if they can rent out their holiday accommodation. Their problem is that with the right to roam, anyone can enjoy their land anyway, and even camp on it. The owners have to rely on there not being good practical public access for the roamers. Inadequate public transport, and the lack of local amenities, shops and cheaper accommodation, make the estates in practice excludable – because many citizens cannot afford to have access. Some safari guests might actually value others not having access so they can enjoy the new "wild" that has been created. Their utility depends positively on excluding others' utility. The point here is one of economic efficiency: if the marginal cost of another person enjoying the land (non-rivalry) is zero, the greatest good for the greatest number comes from allowing widespread access and supporting local community provisions. Overcrowding, where the marginal cost becomes positive, changes the calculation. This may be a problem at peak times in parts of Loch Lomond and the Trossachs National Park, but it is unlikely to apply to most of the Highlands.

The problem with free access is that nobody has the incentive to protect and enhance natural capital. Everyone can harvest and consume natural capital. That is indeed what has happened: the herring and other fish stock have been greatly diminished as the herring fleets and their trawlers overfished; the sheep overgrazed the land and exposed

and depleted the peat bogs; commercial forestry took the land for dense plantations and neglected the biodiversity; and modern intensive chemical farming damaged the soils and polluted the rivers and the marine habitats.

It is a story repeated across the UK and in Europe and the US, and now in China too. Though it is easy to say that it is all the fault of fishers, farmers and estate owners, this neglects the obvious point: private business responds to the incentives they face. When it comes to public goods, it is the public bit that counts. When it comes to externalities if polluters do not pay, they will over-pollute, faced with a pollution cost of zero. The missing ingredients are making polluters pay for the pollution they cause, and for the state to provide the great public goods.

The (analytically) easy bit is the pollution. An efficient market internalises all the externalities, and hence incorporates the costs of pollution within the markets. That means that the pollution from burning coal and peat, from fertilisers and pesticides, from acidification caused by dense conifer forests, all need to have a price. If they do not, there will be excessive pollution. In some cases, pollution should be zero – here the damage is so great – but mostly it should be paid for and hence output will be lower. There would have been a lot fewer sheep, a lot fewer deer in the sporting estates, a lot less heather burning, more targeted and frugal application of fertiliser and pesticides, and so on. It is the job of the state to impose pollution prices. Markets will not do this. The state adjusts the prices to reflect the externalities, and then the private companies and citizens internalise these pollution costs and change their behaviours accordingly. A carbon tax is an obvious example.

When it comes to the stocks of natural capital, the public goods, depletion has been excessive because there is no requirement, nor indeed any private incentives, to do the necessary capital maintenance. As with mending the potholes in the roads, failure to do so leads to the assets themselves cracking up. This is, in effect, a public duty of care. Depleting renewable natural capital should be allowed only if there is a net environmental gain, the thresholds above which the renewable can sustain itself are respected, and only if the damage is in some significant wider public interest. Again, the role of the state is to ensure that public goods are properly capitally maintained. The private sector can do the maintaining, but it is the state that decides and directs what should be done.

3. Carbon

Carbon enters the discussion because a balanced atmosphere is a public good and climate change is a public bad: no one can be excluded from the consequences of an increase in the carbon concentration in the atmosphere. It is this concentration that creates and enhances the greenhouse effect and thereby causes climate change. The emissions themselves are negative externalities, and sequestrations are positive externalities. It does not matter from the perspective of the stock of carbon in the atmosphere where these emissions and sequestrations take place.

The Climate Change Act 2008 and the 2019 amendment commit the UK to reducing its territorial carbon emissions to net zero by 2050, and the nations have all taken their own paths, with Scotland being more ambitious.

Territorial carbon production is a flow which is not equivalent to carbon consumption. It is not the same as a country and its citizens' carbon footprint, and reducing territorial emissions to net zero will not stop causing climate change. A de-industrialising country (like Scotland) can meet net zero whilst not stopping causing climate change. Indeed, it can make it worse if it swaps home production for imports and those imports come from countries that are more carbon-polluting. For the UK as a whole, the economy is now 80% services, and the really big pollution sources – petrochemicals, aluminium, fertilisers, cement and steel – are largely imported, and often manufactured using coal-powered generation.

At the global level, the concentration of carbon in the atmosphere has been rising at around 2 parts per million every single year since 1990, without a break for even the great financial crash of 2007-08 or the coronavirus lockdowns. Nothing has yet been achieved to interrupt the relentless march of the concentration of carbon in the atmosphere. Scotland, like all the developed countries, continues to import carbon-intensive products without a border carbon adjustment, flattering itself that it is fighting climate change, whilst all the while playing its part in maintaining the global energy mix, which is 80% dependent on oil, gas and coal, as it was in 1970.

In this context, there is scope to make a positive contribution, and in Scotland this has a big land use dimension. With BREXIT, each of the nations is having to reinvent its own agricultural and environmental legislation. Though there are differences between the approaches, all have public money for public goods at the heart of their agricultural reforms, and all are looking to protect and enhance biodiversity, improve air and water quality, and provide greater mental and physical health benefits from natural capital.

Though these other aspects are important, in all the nations carbon is being prioritised. In Scotland there is a dash for both renewables and for carbon offsetting through tree planting and peat restoration.

The development of markets for carbon assumes that this public good can be transposed into a private one, and hence a private property right can be created, legally defined, and traded.

It is immediately obvious that this full privatisation is not just impractical but undesirable. The value of carbon is determined not in pure private markets, but in state-driven contexts. The state defines the target, and then the permitted carbon budgets. The private carbon market is essentially a contracted-out exercise in delivering the public goods. It is not the delivery of private goods.

To do this the state "pretends" that carbon is excludable and rival, not public and hence non-rival and non-excludable. It "pretends" that a person or company can "own" a tonne of carbon, from which others can be excluded; and that if this person or company "consumes" the tonne of carbon, others cannot.

This is a fiction, which may or may not be useful. “Owning” here really means meeting a state-defined or voluntary obligation; and exclusion and rivalry are defined in terms of the fulfilment of that obligation. The state may define a target like net zero, and then demonstrate at the national level that it has fulfilled its nationally determined contribution (NDC) by using carbon property rights to meet this, which in turn means that companies and individuals fulfil their part of the exercise by paying a price to pollute. A polluting company “buys” a tonne of carbon, and hence can emit a tonne of carbon. This is not a specific tonne – it is just a unit of account.

It does not help if the target set by governments and companies in their own net zero contribution is badly linked to the overall objective, which is to maintain the public good of a given stable concentration of carbon in the atmosphere. Since a territorial carbon production target, like that adopted in Scotland, does not necessarily mean that, in meeting this definition of net zero Scotland does not stop causing climate change. Indeed it could even be perverse. Closing the Grangemouth petrochemical works would reduce carbon territorial emissions in Scotland, but if its production were replaced by imports from, say, China, it could actually increase the carbon concentration in the atmosphere. The Scottish Government has therefore not defined a sustainable carbon target, to which values of notional carbon tonnes are accredited.

4. Sequestration and offsets

Carbon concentrations in the atmosphere are *net* of emissions *and* sequestrations. The natural world sequestrates carbon from the atmosphere, notably through vegetation and the marine carbon sinks. This sequestrated carbon becomes assets as stores of carbon – in the soils, the trees, the marine seabed and the oceans more generally. Scotland has a lot of carbon natural capital, such as that stored in some of the greatest peat bogs in the world. They are and should be treated as both non-renewable natural capital when extracted, and gradually renewable natural capital when allowed to gradually add more materials.

There are three related requirements in respect of these sequestrated carbon assets: peat and trees should not be extracted and burnt or depleted for horticultural uses or power generation as though they are purely non-renewable natural capital; they should be capital-maintained; and they should be enhanced as part of the attempts to mitigate climate change.

The confusion in the carbon offsets discussion arises in a number of ways. In any serious climate change policy, there should be measures *both* to reduce emissions and to increase sequestration. One is not simply a substitute for another. There should be capital maintenance of these stocks – they should not be allowed to depreciate. Offsets that facilitate greater emissions are undesirable in any credible climate change policy. Protecting existing stocks of carbon, such as in peat, is not an offset for greater emissions.

These observations are critical to understanding what is currently going on in the “offset market”. The reason that companies are allowed to exchange their emissions for carbon offsets is because of the way in which the territorial carbon production

target is defined. The reason why companies are allowed to offset emissions by, for example, protecting peat bogs that would otherwise erode is because government is not prepared to pay for these public goods. The first is a failure to face up to Scotland's true carbon footprint; the second is a failure to sort out public expenditure in a sustainable economy.

These failures are not unique to the Scottish Government, but they would be fully and properly exposed if Scotland had proper national and company accounting rules in place, and a serious net zero carbon consumption target. It has neither – in common with the rest of the UK, the EU and the US. China, Russia and India, as the other three big carbon players, also have no such framework.

In a second-best world, there may be no other politically feasible ways of protecting the peat and the soils, getting trees planted, and otherwise addressing the climate agenda. Instead the second best is to look to private incentives to provide the public goods. In doing this, there are three core steps: to work out how to value a carbon offset; to ensure that there are no capital maintenance losses to other natural capitals, such as biodiversity and water; and to prevent social capital consumption.

5. How to calculate carbon values

Setting aside the serious criticisms of offsetting discussed above, how exactly should a carbon offset be measured and valued?

An offset represents an enhancement to the stock of carbon natural capital. This requires a baseline assessment. It is not an ideal or optimal baseline: we are where we are, and the question is whether there is a legitimate additional sequestration to be made. There is no prospect of getting back to the pre-Industrial Revolution baseline.

Fortunately, it is increasingly easy to do such baseline assessments in the world of digital and satellite imaging to quite fine resolutions. Just because the baseline is not perfect, and some approximation and proxies need to be employed, should not deter us from getting a good rough estimate.

A problem for baselining is that the incentives of those doing the baselines are not necessarily neutral. If the offset has a tradeable value, it helps to claim that the baseline is worse than it might be, and the gain would therefore be correspondingly greater and more valuable. Worse, there is the perverse incentive to treat the baseline as a variable, and weaken it in advance of measurement.

An example of this perverse incentive can already be seen in the case of net biodiversity gains. Suppose that a builder wants to acquire a greenfield site for housing. The value of the land will be reduced if it has lots of biodiversity on it, since the costs of making a net gain compensation will lead to a reduced capital value of the land. Therefore if the seller (or the housebuilder as part of its landbank of previously acquired land) glyphosates the land repeatedly and generally degrades it, the costs are lower of net biodiversity gain (because the baseline is now awful) and hence the capital value of the land rises.

This is a very serious problem in respect of soil-based carbon offsets, and indeed the worse the state of the soils and the lower the carbon content because of agriculturally intensive activities, the greater the scope for gaining value from offsets. Whether farmers who have degraded the soils should be rewarded through carbon offsets for their past practices raises serious ethical questions, particularly where they have not paid for the pollution caused in the process of degrading and emitting more carbon.

The baseline cannot therefore be left to the private parties and, to the extent that it is, this is a major flaw in the "voluntary" carbon markets. The buyer simply cares about demonstrating that carbon has been sequestrated. The seller wants to sell as many offsets as possible. Both therefore have an incentive to degrade the baseline before the transaction.

Once a baseline is in place, the next step is to consider the capital maintenance before the offset as an enhancement is applied. If the purchaser of the offset wants to avoid paying for the pollution its emissions would otherwise have made, then it is symmetrical to require the seller of the offset to pay for any emissions they are causing. From the climate change perspective, if a landowner lets the site decline for the baselines, and hence makes net emissions, they should pay the symmetrical price as the purchaser of the emission reductions.

This means that the gains against the baseline that form the offset must be net of capital maintenance. This becomes extremely important where there are land use changes. For example, in converting, say, open hills, mountainsides and farmland to forestation, it may be that carbon that otherwise would not have been emitted is in fact lost.

The capital maintenance brings the calculation to the counterfactual. What might otherwise have happened to the land had, for example, trees not been planted? Might it in any event have grown natural vegetation? The "rewilding" exercises in Scotland, often at the direction of private owners with multiple motivations, might have happened anyway. Should they be paid for what they want to do anyway? It can be an offset only if the carbon sequestration would not have happened anyway.

Once the counterfactual issue is introduced there are multiple scenarios for any piece of land. Land use is contested because it has multiple and sometimes conflicting uses, and not only in carbon terms.

Supposing now there is a baseline that has not been "doctored" to make the offsets look greater than they should be, and suppose the baselines have been tested against plausible counterfactuals. The next step is to identify changes to land (or marine) use that are genuine *additional* enhancements to carbon sequestration.

There may be many ways to make these enhancements. For ease of exposition of the valuation issues, let's assume the enhancement here is tree planting. Planting a new forest is a capital- and labour-intensive activity, and may have lots of carbon emissions associated with it. These emissions should be subtracted from the offset. Once the trees have been raised and planted out, and the soils have been disturbed, there is a lot of capital maintenance of these new renewable natural capital assets. In Scotland there are lots of deer (too many). They like eating saplings, and so they

either have to be shot (and repeatedly shot as more deer arrive) or the new forest has to be fenced. Fences have to be maintained. Deer are good at breaking in. Then there are squirrels and voles, which tackle the bark. There will need to be a constant spend on “pest” control, probably with associated carbon emissions from vehicles and equipment use.

Next come the problems of the Scottish weather. Droughts may slow down growth or kill young trees. Floods can do damage too. Fires destroy trees and especially saplings. There can be storms (like Storm Arwen) that blow the trees down. There is a whole battalion of pests and diseases that attack trees, and planting lots of the same species in one place enhances the risks.

All of this needs to be taken into account when valuing the offset, and before applying conventional project appraisal techniques. Yet even if we know the full costs of the tree planting and maintenance, and even if we have a very good estimate (and a validation methodology and process), there remains the problem of the discount rate. Trees are poor conventional investments, which have almost always required state support and subsidies when large-scale forestry takes place. This is because it takes years – indeed decades – between the outlay of the original costs, and then the yield of the timber or carbon in the offsetting case. In the meantime, the land yields little or nothing. Even at a very low cost of capital (as if the risks identified above did not arise) over say 25 years, a discount rate undermines the economics of the project. The price today of the offset should be correspondingly low – indeed, on any reasonable assumption about the cost of capital, close to zero (or even less than zero once account has been taken of the cost of planting and capital maintenance). It has taken large-scale tax breaks in the past to get private forestry into the game.

Finally, to complicate things yet further, there is the question of what happens at the end of life for the trees in our example. The carbon has been locked up in the tree trunk. It will take heavy machinery to fell and remove (creating more carbon emissions) and then this new bit of natural capital needs to be protected and maintained. It cannot, for example, go into wood pellets and be burnt, returning the carbon to the atmosphere and producing PM2.5 emissions too. There can be no case for burning the offsetting wood as pellets.

It could go into timber as part of timber buildings, but all the machinery and activities to get from the forest to, say, the beam inside a building at some other location and all the associated engineering works would need to have their associated carbon emissions subtracted from the offset value. Probably the best would be to simply leave the tree where it is, though the land would no longer be sequestering as much carbon as the tree ages. For example, rebuilding Scotland’s great Caledonian forest should be a permanent activity.

Once these calculations have all been made, the scope for offsetting emissions (and emissions that should in any event have been abated) looks a lot narrower than some advocates and vested interests have indicated, and distinct and separate from a policy of rebuilding Scotland’s natural forests. Yet this is not the end of the calculation. We need to take account also of the impacts of offset investments on other natural capitals.

6. The other natural capitals

Much discussion of climate change treats carbon as the primary environmental concern, and frequently this dominance leads to a downgrading of other environmental and social issues, and sometimes the argument that other natural capital needs to be sacrificed to meet the net zero targets. Birds, landscapes and biodiversity can be seen by some to be necessary sacrifices in the name of the greater good of addressing climate change with windfarms. “Renewable” hydro dams disrupt the natural flow of rivers and their mobile biodiversity.

That there can be trade-offs means that there is a strong case for looking for examples where increasing carbon sequestration also improves other natural capitals, and to consider how to *jointly* maximise both carbon sequestration and, for example, biodiversity gain, mental and physical health benefits, and river water quality.

The first example of co-benefits arises in soils. Most biodiversity is beneath our feet in the soils and so is most carbon (perhaps four times as much as in the atmosphere). It turns out that more carbon often means more biodiversity in soils. A rich and diverse permanent pasture stores a lot of carbon and has much more biodiversity than an intensive cereal production field. More carbon means more earthworms, more fungi and a host more invertebrates. Increasing carbon sequestration in soils by changing farming practice is a win-win, provided it is not associated with heavier chemical applications, as, for example, in the multiple applications of glyphosate to support “no till” by not ploughing.

When it comes to trees, it is more complicated. Dense conifer woods tend to yield carbon sequestration faster. Best for sequestration is probably eucalyptus trees. This would be a disaster for biodiversity and probably water quality. Dense conifer woodlands tend not to be people-friendly and do not yield the mental and physical health benefits. Once planted, they tend to displace the local population, with all the social consequences that follow. Mixed woodland – especially mixes of Scots pine and broadleaf deciduous trees – have a lot better biodiversity, but they grow more slowly and therefore run into the discount rate problem discussed above, as well as the carbon offset volume limitations per land area.

The way to handle the other natural capitals is to do a multiple natural capital baseline at the outset and go through the steps above in respect of capital maintenance and counterfactuals for each of the natural capitals, and to calculate the net benefits of all the natural capital enhancements of the land use change. The constraint is that renewable natural capital assets should be not allowed to depreciate: the carbon offset needs to be net of capital maintenance for *all* the other natural capitals.

7. Conclusions – back to the land use questions

The above considerations should sound alarm bells about the rush to switch to carbon offsets and especially private landowners selling to private companies, and about investment institutions engaging in a carbon offset-driven land grab in Scotland. More haste without a proper framework in place may lead to less speed in addressing climate change. There could be a lot of collateral damage, and with it reputational damage for the offset buyers.

Recall above the point that we are talking about *multiple* natural capitals in environmental *systems*. These public goods cannot be adequately addressed in a purely private fashion, and that raises a significant question for Scotland and its government. Land use cannot be left purely to the private sector. Government needs to define the rules, and it cannot avoid being involved in land use change in Scotland. There needs to be land use planning for the natural capital systems. The trade-offs between nature, net zero and food production have an obvious political dimension.

With a land use plan in place, and with credible baselines for all the natural capitals, there is a place for private contracts for carbon offsets, but it is bound to be limited. It is not an excuse for not making emissions reductions and, as the calculations above demonstrate, the value of the offsets is likely to be quite small.

What is currently going on in the “wild west” of offsetting, and with the rapid and major land use changes taking place, and the land grab of financial and corporate interests, alongside those of rich private individuals, is unlikely to be optimal from the public good perspective or from the interests of the Scottish people. There will likely be “train crashes” as examples of greenwashing come to light and some of the purchasers of offsets witness the reputational risk that they may be exposed to. Protecting Scotland’s peat is a matter of national and global significance, and relying on offset monies to address capital maintenance rather than enhancement points to the failures of Scotland to address these issues directly. Enhancing the soils is a great project, but must not be at the expense of first degrading the baselines to make the enhancements look greater. More forests can add greatly to the benefit of Scotland, if they rebuild parts of the great Caledonian forest, add broadleaf trees to riverbanks and support agri-forestry schemes. There are gains to be had – and serious risks too.

The future of the Scottish economy depends on all its capitals, natural, human, social and physical. Bequeathing to the next generation a set of assets at least as good as the current generation inherited would leave future citizens with the capabilities to choose how to live their lives. In Scotland’s case, the natural capitals figure strongly in this inheritance, and they also form a major part of the economic opportunities now. Maintaining and enhancing natural capital builds up a healthy population, and provides the necessary inputs to a sustainable tourism, a sustainable agriculture, and sustainable fisheries and aquaculture. Good natural capital brings in a smarter and more capable workforce and underpins the new technology companies – the ones that find Seattle, Vancouver and Silicon Valley such great places to work, as distance disappears with modern fibre communications. Many of the old economic disadvantages of the remote communities in Scotland are disappearing.

Rebuilding vibrant communities throughout Scotland, around great natural capital, should help to maintain and enhance social capital. It would be a tragedy if instead a rush for carbon offsets considered in isolation from the other natural capitals resulted in another clearance – this time with local people displaced for carbon harvests in dense single-species forests, following on from the displacement by sheep. The question the offset traders are interested in is how to maximise the carbon yield per hectare. The Scottish people should be more interested in the question of how to maximise the natural capital assets per ecosystem, including but not limited to carbon.

There is no escape from the public goods dimensions of Scotland's natural capital, and from the need for polluters to pay for emissions and other environmental damage. Ignoring the public goods dimensions and failing to make polluters pay is not sustainable. Therefore it will not be sustained. Inadequate and poorly maintained public goods and excess pollution are also economically inefficient. They make Scotland poorer as a result. The opportunities to do much better are multiple, thereby making Scotland's citizens much better off (when measured properly) and most importantly ensuring a bright future for future generations.