Recommendations for development of a UK domestic Saltmarsh Code

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Acronyms

BEIS	Department for Business, Energy & Industrial Strategy
BNG	Biodiversity Net Gain
BNIF	Big Nature Impact Fund
BSI	British Standards Institution
BUDS	Beneficial Use of Dredged Sediment
Defra	Department for Environment, Food and Rural Affairs
EF / EFs	Emission Factor / Emission Factors
GHG / GHGs	Greenhouse Gas / Greenhouse Gases
GWP	Global Warming Potential
ICROA	International Carbon Reduction and Offset Alliance
ICVCM	Integrity Council for the Voluntary Carbon Market
LOI	Loss on Ignition
LULUCF	Land Use, Land Use Change and Forestry
MRV	Monitoring, Reporting and Verification
NEIRF	Natural Environment Investment Readiness Fund
NFRM	Natural Flood Risk Management
PIU	Pending Issuance Unit
RTE	Regulated Tidal Exchange
SER	Society for Ecological Restoration
SOC	Soil Organic Carbon
SRUC	Scotland's Rural College
UKAS	United Kingdom Accreditation Service
UK BCEP	UK Blue Carbon Evidence Partnership
UK GHGI	UK Greenhouse Gas Inventory
VCMI	Voluntary Carbon Markets Integrity Initiative
VCS	Verified Carbon Standard
VVB / VVBs	Validation and Verification Body / Validation and Verification Bodies
WWF	World Wide Fund for Nature

Summary

This report provides detailed recommendations for the development of a UK domestic Saltmarsh Code. It is one of two final reports from the initial phase of the Saltmarsh Code project – the overall aim being to provide a Saltmarsh Code for use within the voluntary carbon market in the UK, thus providing the opportunity to generate incomes from carbon credits to support the delivery of accelerated saltmarsh restoration. Here we describe recent developments in the UK voluntary carbon market (to provide background to the space in which the Code would operate) and give detailed thought to key elements such as eligibility, additionality, permanence, and leakage.

As part of this initial phase, we have also reported on the feasibility of using Verified Carbon Standard (VCS) VM0033 Methodology for Tidal Wetlands and Seagrass Restoration, v2.0 (see accompanying Feasibility study of VCS VM0033 report (Burden et al., 2023) in a UK context. However, we conclude development of a domestic code is the best approach with the key benefits being:

- Alignment of key aspects with the other UK domestic codes (e.g., Woodland Carbon Code and Peatland Code), to ensure a comparative level of rigour, and consistency within the market.
- Ability to design the Saltmarsh Code to the specific UK context, resulting in a more straightforward, easy to follow process, with lower validation and verification costs.
- Greater flexibility to update the Saltmarsh Code when new evidence becomes available

We recognise the need for more research to facilitate the development of the UK Saltmarsh Code. The quantitative empirical evidence behind carbon accumulation and sequestration rates remains scarce and needs to be improved. This is especially true for restoration sites and their development over longer timescales, as well as identifying drivers that control net rates over time. Identification of predictor variables (or ‘proxies’) to estimate or model carbon gain or loss in restoration sites would also decrease the cost of monitoring, reporting, and verification (MRV), a key commercial consideration for financial viability of the emergent UK Saltmarsh Code.

1. Introduction

The Saltmarsh Code project, started in 2021, aims to develop a UK domestic Saltmarsh Code to be available for projects in the UK, providing the opportunity to generate incomes from carbon credits to support the delivery of accelerated saltmarsh restoration. The goal is to create a rigorous and scientifically based voluntary certification standard, to be adopted within the voluntary carbon market, enabling saltmarsh carbon to be marketed and traded as carbon offsets, whilst providing assurances to buyers that the climate benefits being sold are real, quantifiable, additional, and permanent. The Saltmarsh Code will promote new habitat creation that would not otherwise be taking place. If designed so only UK companies – or UK arms of international companies – can invest, this additional restoration will contribute to the UK net-zero targets, providing more space for saltmarshes to trap and store carbon dioxide from the atmosphere – a nature-based solution to climate change mitigation.

The initial phase of the Saltmarsh Code project has been funded by the Natural Environment Investment Readiness Fund (NEIRF), an initiative designed by the Department for Environment, Food and Rural Affairs (Defra), the Environment Agency, and Natural England which aims to stimulate private investment to improve and safeguard our natural environment. The fund is developing innovative nature projects that provide both environmental benefits and can attract private investment, helping them get ready for investment and therefore creating a pipeline between projects and the private sector. This initial 1-year project is the start of developing an operational saltmarsh code, with a focus on restoration of habitat through managed realignment (MR) – the deliberate breaching of coastal defences and subsequent tidal inundation to restore intertidal habitat to low lying coastal areas. This is the predominant method of saltmarsh restoration in the UK. It is a collaborative project between 9 organisations, led by the UK Centre for Ecology & Hydrology (UKCEH). The diverse team includes scientific, conservation delivery, and investment finance experts across the charity, finance, and academic sectors.

The objectives of this project were to:

1. Evaluate the current evidence about carbon sequestration rates in UK (or equivalent biogeographic zone) saltmarshes. This included reviewing what factors control and potentially predict carbon and greenhouse gas (GHG) fluxes, how sequestration and/or accumulation rates differ over time between

restored and natural saltmarsh, and identify current common methods for monitoring saltmarsh carbon and GHG fluxes (Mason et al., 2022).
2. Review and analyse other international codes, standards, and protocols to gather information on how key elements of a code have been addressed for coastal habitats. Whilst analysing a subset of these codes in more detail, the VCS VM0033 Methodology for Tidal Wetland and Seagrass Restoration, v2.0 was identified as potentially useable in a UK context.
3. Analyse the implications of VM0033 vs. a UK code by:
    a) Assessing the applicability of key elements within VM0033 to a UK context.
    b) Assessing the project related validation- and verification-related costs of VM0033 vs a UK code based on existing domestic codes, i.e., Peatland Code and Woodland Carbon Code.

    Our full analysis of VM0033 is within the accompanying report: Feasibility study of VCS VM0033 for use with restoration of UK saltmarsh habitat (Burden et al., 2023).
4. Develop illustrative investment cases for two sites to understand the business case for saltmarsh restoration using voluntary carbon unit generation as a revenue stream.
5. Provide recommendations for moving forward with the development of a UK domestic Saltmarsh Code – this report.

This report provides recommendations for developing a UK domestic Saltmarsh Code. We give an overview of the benefits of saltmarsh restoration and restoration effort in the UK to date, and summarise the growing interest in blue carbon. We summarise the need for a UK code and describe recent developments in the UK voluntary carbon market. We then give detailed recommendations for key elements for the development of a UK Saltmarsh Code. We draw on best practise lessons from each of the saltmarsh codes we reviewed (in particular VM0033), other carbon codes where relevant (notably the Woodland Carbon Code and Peatland Code, to ensure broad alignment with the two main existing carbon markets in the UK), and the NEIRF funded minimum requirements for a soil carbon code (to increase the likelihood that our recommendations for a UK Saltmarsh Code would be consistent with any future British Standards Institution (BSI) standard for saltmarsh carbon codes). We then outline further considerations needed for development of MRV procedures and protocols for the Saltmarsh Code, including a summary of two evidence reviews (Mason et al., 2022, and Mason et al., in prep). Key commercial considerations are also then discussed.

1.1 Benefits of saltmarsh restoration and the growing interest in Blue Carbon

Saltmarsh in the UK covers about 45,000 ha, with the five largest sites (Wash, Inner Solway, Morecambe Bay, Burry Estuary, Dee Estuary) accounting for one-third of the UK total. Prior to the 1980s, major losses of Saltmarsh occurred due to widespread, large-scale reclamation of land for agriculture or development. In the Wash, 3,000 ha of marsh were reclaimed in the 20th Century alone (Doody, 2008). Currently, major losses in saltmarsh extent are occurring in the south and south-east of England.

Despite the long history of land claim and degradation there has been a fundamental shift in how people view and value saltmarshes. No longer are they viewed as wastelands, best drained, impounded and used for agriculture. Saltmarshes are now valued in their own right and for the goods and benefits they provide to people (Ecosystem Services - ES). In the UK the change in attitude and policy began in the late 1980's when land claim was regarded as environmentally damaging, later re-enforced at the 1992 Rio Earth Summit where the Convention of Biological Diversity (United Nations 1992) was adopted as an international legal instrument by 196 nations including the UK.

Restoration of saltmarsh, to mitigate historical and ongoing losses, has been gathering momentum since the early 1990s, mostly via MR. Multiple monitoring programmes have shown that the landward realignment of coastal defences will quickly produce intertidal mudflats on low-lying agricultural land which are colonised by saltmarsh plants and invertebrates. This is possible with minimal pre-treatment and management by allowing tidal ingress through coastal defences, either by single or multiple breaches, on occasion by the removal of entire banks. By 2018, 50 managed realignment schemes had been completed in the UK, creating almost 2500ha of habitat, of which 72% can be classified as intertidal in nature (ABPmer, 2017). In addition, 24 regulated tidal exchange projects have been completed, creating a further 300ha of coastal habitat, as well as 18 restoration projects involving sediment recharge through the beneficial use of sediment routinely dredged from ports and harbours (ABPmer Online Marine Registry, 2014). From the mid-2000s, schemes began to increase significantly in size. The three recent projects at Medmerry, Steart and Wallasea Island have created over 1,000ha of habitat alone, almost 40% of the total area of habitat that has been restored in the past three decades (Hudson et al 2021).

There is an ambition across all four devolved nations of the UK to accelerate saltmarsh restoration in recognition of the goods and benefits the habitat provides and to meet ambitious targets to address the challenges of biodiversity loss and climate change through national and international policy and initiatives. In March 2019, the United Nations (UN) General Assembly (New York) declared 2021–2030 the "UN Decade on Ecosystem Restoration." This call to action has the purpose of recognizing the need to massively accelerate global restoration of degraded ecosystems, to fight the climate crisis, enhance food security, provide clean water, and protect biodiversity on the planet. This coincides with the UN Decade of Ocean Science for Sustainable Development, which aims to reverse deterioration in ocean health. If executed in a holistic and coordinated manner, signatory nations could stand to deliver on both these UN calls to action.

In parallel with global initiatives, the UK and devolved Governments have ambitious targets to stem national biodiversity loss and contribute to social, economic, and health and well-being improvement. The Environment Strategy for Scotland recognises that “our natural environment contributes to our health and well-being in countless ways” and its Biodiversity Strategy aims “to protect and restore biodiversity, support healthy ecosystems, connect people with the natural world, and maximise the benefits of a diverse natural environment and the services it provides, contributing to sustainable economic growth in Scotland”. The ecosystem approach is at the heart of the Wales Environment Bill, which aims to ensure the right legislative frameworks are in place to sustainably manage natural resources in an ecologically coherent manner with effective governance to deliver lasting economic and social benefits. The 25-year plan for England sets out goals for improving the environment within a generation and sits alongside the Industrial Strategy and Clean Growth Strategy. As recommended by the Natural Capital Committee, making the vision of a healthier environment a reality requires solid foundations: comprehensive, reliable data; strong governance and accountability; a robust delivery framework, and everyone to play a role. Northern Ireland launched its Environment Strategy in 2022 to address the challenges of biodiversity loss and climate change and forms part of the Executive’s Green Growth agenda.

The benefits saltmarshes provide to people fall into three broad services (Hudson et al 2021):

1) Regulating services. Saltmarshes are the most widespread and important of the ‘Blue Carbon’ habitats outside the tropics, providing an important climate regulation service by burying and storing carbon. Ecologically healthy and naturally functioning saltmarsh is a major contributor to flood and erosion risk management. Where waves travel over healthy and extensive saltmarsh wave breaking happens away from critical flood defences and in doing so marshes provide a natural and valuable flood defence service in their own right. Saltmarshes can also reduce high levels of nutrients such as nitrates and phosphates regulating water quality.
2) Provisioning services. On the margins of land and sea, saltmarshes are highly productive ecosystems. They provide important habitats for a wide range of plants and animals for both terrestrial and marine species. They provide resources of breeding, over-wintering and migratory bird species as well as nursery grounds of many fish. Beef and lamb produced from saltmarsh grazing livestock is a premium product and commands higher prices than traditionally farmed meat.

3) Cultural services. There are strong links between the natural environment and psychological well-being. Saltmarshes attract visitors with an interest in natural history such as bird watching, wildfowling or fishing. Often isolated from human habitation saltmarshes offer peace, solitude, emotional healing and are often depicted in TV, film, and radio as dark and mysterious places.

There has been considerable recent attention and research devoted to the role of blue carbon habitats such as saltmarsh in climate change mitigation. However, the quantitative empirical evidence behind carbon accumulation and sequestration rates, as well as detailed analysis to identify drivers that control net rates over time remain scarce and need to be improved. Reported rates are also highly variable, with two recent reviews reporting 8.2 ± 5.94 (Mason et al., 2022) and 4.34 (Parker et al., 2020) t CO_2e ha^{-1} y^{-1} for natural marsh, 13.3 ± 15 (Mason et al., 2022) and 3.53 ± 1.11 (Parker et al., 2020) for restored. These differences, in part, reflect the site-specific nature of sequestration rates and how these change with time since restoration. They also demonstrate how a deeper understanding of the environmental characteristics that best explain the spatial variation in rates of carbon sequestration, accumulation, and GHGs would enable much more specific estimates of the climate mitigation benefit of saltmarsh restoration.

However, even with the current knowledge gaps in the evidence base, there is firm and consistent endorsement of the carbon benefit from saltmarsh restoration. The cross-administration UK BCEP – set up in 2021 – have the remit to progress the evidence base on blue carbon habitats in UK waters recognising their role as a nature-based solution to prevent biodiversity loss, support adaptation and resilience to climate change, alongside carbon sequestration benefits. Through the UK BCEP, UK administrations are working together with the Department for Business, Energy & Industrial Strategy (BEIS) and Defra to address key research questions related to blue carbon policy. The first aim of the Partnership is to identify and clearly set out key research questions, including those hindering inclusion of coastal wetlands in the UK GHGI, by producing an Evidence Needs Statement (Spring 2023) intended to act as a signal to the research community of the most pressing and relevant blue carbon evidence needs. Internationally, there is a similar movement with the creation of the Global Blue Carbon Coalition – led by Conservation International and announced in early 2022 – with an aim to fill gaps in scientific understanding. Although the coalition has more of a focus on Mangrove habitats, their plan to accelerate the growth of climate financing to support biodiversity and communities globally by establishing strong global standards, has the capacity to benefit all blue carbon habitats.

1.2 Comparative analysis of international saltmarsh codes

There is wide variety in the terminology used by organisations involved with the voluntary carbon market, including codes, standards, methodologies and schemes. For the purposes of this analysis, a “code” is a document, or set of documents, detailing the requirements and rules to establish and run a project that aims to generate verifiable carbon credits under the auspices of a certification programme and registry (c.f. Black et al., 2022). Codes were included in the comparative analysis if they:

- Provide detailed guidance on both governance and methods for MRV; and
- Were publicly available and open access online.

This led to the selection of six codes for analysis:

- VM0024 Methodology for Coastal Wetland Creation
- VM0033 Methodology for Tidal Wetland and Seagrass Restoration, v2.0
- Restoration of California Deltaic and Coastal Wetlands
- VM0007 REDD+ Methodology Framework
- Australian Carbon Farming Initiative: Tidal Restoration of Blue Carbon Ecosystems
- Plan Vivo

The first four were reviewed by Holehouse et al. (2021). Subsequent to this, as part of this project, two additional codes were identified and reviewed to complete a comparative analysis of all codes in operation or under consultation at the time of the review (see Appendix 1 for the analysis of additional codes). Based on the aggregated review of all six codes shown in Table 1, VM0033 (which is currently being merged with VM0007 – as of 2022) was identified as potentially suitable for use in the UK, and that with some adaptation, Plan Vivo may also be applied in the UK. A future UK Saltmarsh Code could usefully draw on aspects of both, with the integration of useful insights from the other standards reviewed in Holehouse et al. (2021) and Appendix 1.

Key features of VM0033 that make it potentially applicable in the UK, and from which a UK code could draw on:

- VM0033 operates globally and applies to all tidal wetland systems including those with peat and mineral soils, so technically can already be applied in the UK.
- Baselines are calculated using the CDM AR-Tool02 and require the generation of plausible scenarios that could have occurred in the absence of the project using data sources available in the UK
- Leakage includes activity-shifting, market and ecological leakage, and project designs for UK projects should be able to account for these.
- Eligible activities under VM0033 include the sorts of managed realignment projects most commonly seen in the UK (in addition to other activities that could in theory be applied, such as re-introducing native plant communities and improving management practices, e.g., grazing).
- The approach to uncertainty is arguably more robust than the UK's two main carbon codes, the Woodland Carbon Code and Peatland Code, as uncertainty must be calculated on all key measurements and assumptions and a variable

pooled buffer is operated to mitigate precision risks and unintended reversals. The variable buffer is calculated on the basis of the net change in carbon stocks generated by the project and the risk of non-permanence, calculated using the VCS AFOLU Non-Permanence Risk Tool. This includes internal risks, external risks and natural risks and risk mitigation measures, leading to a total buffer of between 10-60%.

- However, the approach to additionality is arguably weaker than the UK's two main carbon codes, in which they only have to pass a legal additionality test (in which they demonstrate that they are not already required by law and show that they are carrying out one or more of the eligible activities described in the methodology. These weaker additionality rules are justified on the basis that well under 5% of degraded wetlands have been restored in any country (2.74% have been restored in the USA, which is deemed to have the highest level of wetland restoration internationally). This implicitly applies a 'positive list' (all eligible activities are deemed additional) and common practice additionality test (commonly set a 5%) in which activities are deemed additional as long as no more than 5% of a region applies the activities.
- The approach to MRV could easily be adapted for the UK context. Emission reductions and removals can be included for changes in biomass (above- and belowground for trees and other vegetation, litter, dead wood and wood products), soil organic carbon (SOC), and avoidance of prescribed fire and wildfire. These are estimated primarily on the basis of ecological changes that occur as a result of project activities, including changes in vegetative cover and water table depth, subsidence and carbon stock change. Measurement options include proxies, peer-reviewed models, default emissions factors (included in VM0033) and local published values (including historical data or chronosequences). Projects must take projected sea level rise into account in their calculations. Detailed guidance is provided for the collection of monitoring data prior to verification visits, including sampling herbaceous vegetation, soil coring for estimating soil carbon, monitoring different GHGs, soil subsidence, erosion and water table.
- The project went on to review the monitoring data within VM0033 for 'Data and Parameters Available at Validation', and 'Data and Parameters Monitored', filtered for those parameters applicable to UK saltmarsh, and providing an indication of the level of expertise needed to apply the method. This is presented within the Feasibility study of VCS VM0033 report, section 4.8

Table 1: Summary of the suitability in the UK of international codes for the creation/restoration of saltmarsh.

		Variable	Conditions of use	Boundaries	Baseline	Permanence	Leakage	Additionality	GHG emissions quantification	Monitoring
VM0024 Methodology for Coastal Wetland Creation	Method 1	Saltmarsh creation	Amber	Amber	Grey	Grey	Green	Green	Green	Amber
		UK	Red	Green	Grey	Grey	Green	Red	Green	Amber
VM0033 Methodology for Tidal Wetland and Seagrass Restoration, v2.0	Method 2	Saltmarsh creation	Green	Grey	Green	Green	Amber	Green	Amber	Grey
		UK	Green	Grey	Green	Green	Amber	Amber	Amber	Grey
Restoration of California Deltaic and Coastal Wetlands	Method 3	Saltmarsh creation	Green	Green	Green	Amber	Amber	Grey	Grey	Amber
		UK	Red	Red	Red	Amber	Amber	Grey	Grey	Amber
VM0007 REDD+ Methodology Framework	Method 4	Saltmarsh creation	Green	Grey	Green	Grey	Amber	Green	Green	Green
		UK	Green	Grey	Green	Grey	Amber	Green	Green	Green
Australian Carbon Farming Initiative: Tidal Restoration of Blue Carbon Ecosystems	Method 5	Saltmarsh creation	Green	Green	Green	Green	Grey	Grey	Green	Green
		UK	Amber	Amber	Amber	Green	Grey	Grey	Red	Green
Plan Vivo	Method 6	Saltmarsh creation	Green	Green	Amber	Green	Green	Green	Red	Amber
		UK	Amber	Amber	Amber	Green	Green	Green	Red	Amber

Red	Amber	Green	Grey
Unlikely to work without significant amendments	**Possibility of working with minor amendments**	**Possibility of working in current state / minor amendments**	**Nothing specific noted**

1.3 The need for a UK Saltmarsh Code

Saltmarsh codes operating internationally were reviewed, concluding that VCS VM0033 methodology should be considered for potential application in the UK (section 1.2, and Appendix 1). If this were not feasible, then lessons from this and other international codes (e.g., Plan Vivo) could be used to inform the development of a UK Saltmarsh Code. However, the additionality rules are considerably weaker than existing carbon codes in the UK, notably lacking an investment test to show that the work would not have been possible without carbon finance. This is problematic, given the range of additionality tests proposed for use across global carbon markets by the Integrity Council for the Voluntary Carbon Market (ICVCM) (currently under consultation) and likely recommendations for additionality to at least include an investment test in Defra's Ecosystem Market Framework, consistent with the approach currently used in the Woodland Carbon Code and Peatland Code (although more may be included if recommended by ICVCM).

Moreover, evidence from the illustrative investment cases presented in the Feasibility study of VCS VM0033 report suggests that validation and verification are likely to represent high upfront and annual costs, and so may only be absorbed by either large, high-budget, or highly carbon-sequestering sites that can generate larger revenue streams. Given that many restoration sites in the UK are small, the investment case is not likely to be viable in the vast majority of cases.

For these reasons, we have concluded that developing a UK Saltmarsh Code is the best approach, rather than adopting a methodology already in operation. The details behind this decision can be found in the accompanying Feasibility study of VCS VM0033 report. The benefits of developing a UK Saltmarsh Code are:

- It enables the Saltmarsh Code to align key aspects with the other UK domestic codes (e.g., Woodland Carbon Code and Peatland Code), ensuring a comparative level of rigour in relation to additionality.
- It would be possible to accredit the Saltmarsh Code to a future BSI standard to ensure the highest possible standards of rigour across all components of the code, giving the opportunity to integrate the code into the UK's Environmental Reporting Guidelines for use by companies who follow this guidance for their corporate accounting, helping expand the UK market for saltmarsh carbon.
- The Saltmarsh Code can be streamlined to be applied to the UK specifically, resulting in a more straightforward, easy to follow process, with lower validation and verification costs.
- It gives greater flexibility to be able to update the code when new evidence becomes available

2. Recent developments in the UK voluntary carbon market

The UK participates in compliance markets such as the Emissions Trading Scheme and can engage with international voluntary carbon markets to meet its obligations under the Paris Agreement (the rule book for this was agreed under Article 6 at COP26). The majority of voluntary carbon market transactions take place via the Woodland Carbon Code, with the Peatland Code now rapidly scaling up its operation. Version 2.0 of the Peatland Code extends operation to lowland fens and wetland agriculture on lowland peats, and projects funded by NatureScot's Investment Ready Nature Scotland fund are currently exploring the integration of biodiversity and community benefits with the Peatland Code. A number of initiatives are underway to develop new carbon codes to expand the domestic voluntary carbon market in the UK, including:

- The Wilder Carbon standard was developed by Kent Wildlife Trust to enable the generation of carbon credits from rewilding activities including woodland creation, peatland restoration and other forms of restoration, using metrics developed by the Woodland Carbon Code and Peatland Code, and requiring the collection of biodiversity data using Defra's biodiversity offsetting metric. In contrast to other UK domestic carbon markets, it requires buyer checks to ensure those investing in projects have done everything possible to reduce emissions at source before offsetting their residual emissions. It also has unusually long minimum contract lengths of 100 years, or 50 years with conservation covenants that would ensure projects are effectively permanent;
- The development of a Hedgerow Code is being led by the Game and Wildlife Conservation Trust's Allerton Project, funded by the Environment Agency's NEIRF. While its initial development will focus on carbon in aboveground biomass and soils, projects will monitor biodiversity benefits for potential use in BNG and similar programmes. There is no set date for the launch of the code;
- Building on the recent launch of the Blue Impact Fund in the UK by Finance Earth and World Wide Fund for Nature (WWF), Adur District & Worthing Borough Councils were also awarded NEIRF funding to explore carbon market opportunities for sea kelp restoration and Plymouth City Council are exploring carbon markets for sea grass, which may lead to the development of a new domestic market for blue carbon;
- An Agroforestry Code is being developed by the Soil Association in collaboration with the Woodland Carbon Code and Scotland's Rural College (SRUC), funded by NEIRF, either for integration with the Woodland Carbon Code or as a stand-alone Code. It will include both above- and belowground carbon sequestration, and is being designed to dovetail with the Hedgerow Code, given that hedgerows are a form of agroforestry.

Currently, UK corporate demand for local offsets far outweighs supply. As a result, UK nature-based solutions projects that are able to blend some public grant (e.g., England Woodland Creation Offer, Nature for Climate Peatland Grant Scheme) with carbon income are able to attract private sources of repayable investment including project finance to fund upfront costs. A number of approaches are currently being developed for blending public and private finance for nature-based solutions to climate change, to help scale these markets. In England, Defra has established the Big Nature Impact Fund (BNIF), to be managed by Finance Earth and Federated Hermes, where £30m of seed investment from Defra is to be provided for nature-based solutions projects and enterprises in England. Finance Earth and Federated Hermes intend to create a UK-wide investment strategy of up to £400 million, made up largely of investments from institutional investors, within which BNIF will sit. It is expected to be ready to invest in 2023.

In Scotland, work is underway to establish a Scottish Carbon Fund to catalyse investment in high quality carbon projects. Alongside this Fund, the Scottish Government is looking to develop a number of other supportive mechanisms to de-risk and crowd in private investors into this emerging market. In parallel with these developments each of the UK's four governments are designing post-Brexit agricultural support schemes, with the goal of making room for, or in some cases leveraging, private investment alongside public payments for ecosystem services. At minimum, newly emerging agricultural schemes tend to be following the current practice of allowing stacking of private finance on top of public payments where this meets the additionality criteria of a relevant code, for example where public funding alone is insufficient to make the change in land use or management possible. However, where the public funding is sufficient to make the necessary changes, stacking of private payments for ecosystem services resulting from those changes would not be additional and so not viable. As a result, a range of options are being considered (Reed et al., 2022), including for example:

- Funds delineation where public funding is either: a) reserved locations or services that are deemed important for society but for which there is no market; or b) delineated in time by offering projects to the market first (e.g. via reverse auction) before opening a window for public funding applications for those who do not want to participate in the market or for priority projects that were too expensive to be funded via the reverse auction. This approach does little to leverage private investment but avoids competition between public and private sources of funding, ensuring public funding prioritises market failures;
- Trigger funds require projects that are only part funded via public schemes, and have to receive a certain level of private investment before they can trigger the remaining public payments. Although this has the potential to use public funding to leverage private investment, there are a number of risks and complexities; and

- Price floor guarantee mechanisms use public funding to create a guarantee for investors that means they get a guaranteed price for carbon, but can sell their carbon to the market if prices are higher than the price floor. This has the potential to use public funding to leverage private investment at scale, and is being trialled for peatland restoration in Scotland at present.

However, the Committee on Climate Change (2022) recently concluded that voluntary carbon markets had the potential to endanger net zero targets if they facilitated offsetting of anything other than residual emissions after everything possible had been done to reduce emissions at source. There is a range of quality in the market in terms of both quality of projects and quality of buyers. For example, some woodland projects deliver minimal social and/or biodiversity benefits; some buyers of offsets from UK projects are not Paris-aligned.

A lack of ethical buyer checks and concerns over the accuracy of measurement, verification and reporting in some schemes and codes, has fuelled concerns around the use of these markets in greenwashing. As a result, the Committee recommended tighter regulation of domestic voluntary carbon markets, including the integrity of both business claims and the codes they use to make these claims. They recommended that any expansion of carbon markets into new land uses and habitats should be limited until carbon credit integrity and the integrity of claims could be ensured.

Framework	Governance mechanism	Description	Example	Status
Standards framework (Generalisable)	Market principles and reporting guidelines	Minimum requirements for the design and operation of high-integrity ecosystem markets and corporate reporting in a given jurisdiction (or internationally)	ICVCM Core Carbon Principles could be supplemented with other ecosystem market principles (e.g. stipulating responsible investment principles or essential additionality tests for all codes). UK Environmental Reporting Guidelines and UK Sustainable Finance Taxonomy might allow corporate reporting against codes that meet these principles and minimum requirements (see below).	a
Standards framework	Policy co-ordination group	Co-ordination between policy and expert groups	Regular meeting between expert group chairs and key policy teams	b
Standards framework	Aggregation, integration and blending mechanisms	Place-based mechanisms to aggregate supply & demand, co-ordinate ecosystem service delivery in space and stack (private) or blend (public) payments for multiple services at project design	Landscape Enterprise Networks, Wilder Carbon and Rural Land Use Partnerships (Scot) doing this at regional scales and could be adapted and/or scaled. Stacking and blending is currently via additionality criteria of codes and full stack must be agreed pre-contract. New blending options under development	Developed and in operation
Standards framework	Independent expert groups manage minimum requirements for codes in each habitat, land use and ecosystem service	Expert groups set minimum requirements (e.g. for additionality and permanence), list approved methods (e.g. carbon models and MRV sampling regimes) and evaluate codes, updating requirements as evidence becomes available	An independent soil carbon expert group stipulates a minimum permanence period for all soil carbon codes, states minimum soil sampling depth, approves models to estimate carbon in project design documents, and evaluates soil carbon codes against these requirements e.g., for inclusion in Environmental Reporting Guidelines	c
Standards framework	Independent accreditation to relevant ISO standards	Individual codes and standards are checked to ensure they comply with relevant ISO standards	UKAS checks the integrity of the Peatland Code and then accredits verification bodies to ISO14065 to work with it	Developed and in operation
Standards framework	Individual codes	A document, or set of documents, that set out the requirements and rules to establish and run a project that aims to generate verifiable carbon or other ecosystem credits	The Woodland Carbon Code and Peatland Code, and other codes under development, for example for hedgerows, agricultural soil carbon, saltmarsh and agroforestry	Developed and in operation; c
Standards framework (Land use or habitat-specific)	Verification bodies	Organisations that validate projects and verify ecosystem service claims of projects against the requirements of individual codes	OF&G is a verification body for the Peatland Code and Woodland Carbon Code which is accredited by UKAS to ISO 14064/3 and 14065	Developed and in operation
Assurance framework	Financial regulation	Protection for ecosystem market buyers/sellers from fraud and ensuring healthy competition	Financial Conduct Authority could extend its jurisdiction to ecosystem markets	a
Assurance framework	Market infrastructure	Market registries, online marketplaces, model contracts and legal mechanisms, and insurance	UK Land Carbon Registry and insurance exist with new marketplaces, investment platforms, contractual models and insurance products being developed	Developed and in operation
Assurance framework	Project developers, intermediaries and brokers	Organisations that may develop projects under codes, sourcing both buyers (e.g. offsetters) and sellers (e.g. landowners)	Forest Carbon Ltd develops peatland and woodland projects and sells or retires credits via the UK Land Carbon Registry	Developed and in operation
Assurance framework	Projects generating ecosystem services	Interventions undertaken in a geographically defined area to sequester carbon, avoid emissions and/or deliver other ecosystem services that adhere to a relevant code	Carrick Peatland (restoration project) developed by Tillhill Forestry	Developed and in operation

Key: Developed and in operation; Under development by a) Defra and Scottish Government; b) JNCC; c) Environment Agency NEIRF and Defra

Figure 1: Governance hierarchy showing mechanisms that can increase the integrity of ecosystem markets.

In response to these challenges, Defra and Scottish Government have been devising new regulatory and governance regimes to ensure the development of high-integrity ecosystem markets across the UK. Drawing on these developments, experience from the development of ecosystem markets internationally (Reed et al., 2021; Black et al., 2022) and wider literature on the governance of ecosystem markets, it is possible to propose a governance hierarchy for the development and operation of high-integrity ecosystem markets (Figure 1). Starting from the bottom of the hierarchy and working upwards, it is possible to identify the following governance mechanisms:

- Ultimately, the goal of ecosystem markets is to fund projects that can generate real and effectively permanent flows of new ecosystem services, for example helping tackle the climate crisis and facilitate nature recovery. Projects are typically geographically constrained, often focussing on habitat creation, restoration or interventions designed to sequester and store carbon, and/or reduce or avoid emissions. In the UK there are no restrictions on who can take funding to create a project that generates ecosystem services, as long as care is taken about what the investor claims as a result of the project. This includes corporate social sustainability projects and initiatives to reduce corporate risk from climate change, that often have limited measurement, verification or reporting of outcomes, but it may also include payments for carbon, water, biodiversity and other ecosystem services. However, there is a risk that these projects do not deliver their intended outcomes, leading to a risk of greenwashing, even despite the limitations around claims that can be made for projects of this nature.
- Market infrastructure can help manage some of these risks, for example ensuring that there are robust contracts in place (e.g. England recently introduced robust legal conservation covenants, legal obligations to perform specified conservation activity on the land which continue to apply even to future owners of the land within the term of the covenant) and offering insurance products to protect buyers and/or sellers against non-delivery, typically as a result of factors beyond the control of the project. However, there is also a risk of fraudulent activity in these markets, especially given the intangible nature of the outputs being marketed. For example, demand-side actors may make unsubstantiated claims about the benefits arising from their investment, or supply-side actors might sell the same carbon abatement to multiple buyers.
- This raises the need for financial regulation in ecosystem markets, for example extending the jurisdiction of the Financial Conduct Authority in the UK to include ecosystem markets. However, this would not be sufficient to protect the integrity of these markets, because regulators only step in once things have gone wrong. The first verification point under many carbon codes is not until year five, and if significant issues were uncovered at this point, in large enough schemes, this could significantly undermine wider market confidence.

- Assurance may also be provided by accreditation bodies like the International Carbon Reduction and Offset Alliance (ICROA) or the UK Accreditation Service, who can accredit verification bodies to codes and standards, such as ISO standards and domestic voluntary carbon market codes like the Woodland Carbon Code. However, these organisations only do limited checks on the codes themselves, and do not have the expertise to be able to comment on the science underpinning measurement, verification and reporting methods. It is therefore possible that they accredit independent verification bodies to work with codes that are fundamentally flawed.
- As a result, it is important to pay attention to the codes themselves. With sufficient funding and expertise, it may be possible to create a robust set of codes for different ecosystem services, land uses and habitats, that are evidence-based and effectively managed. While this has already been done in the UK for peatlands and woodlands – and is now proceeding for other land uses and habitats (for e.g., Saltmarsh and Hedgerows) – private bodies can devise their own codes, and there are already multiple international programmes such as Verra and Gold Standard that are able to operate within any given jurisdiction. In the UK, for example, there are multiple private companies each with their own proprietary agricultural soil carbon codes in everything but name. However, these codes are of variable quality, so it is necessary to devise mechanisms to evaluate the integrity of codes, to direct buyers and sellers to the most robust codes. It will be important to maximise the rate of market adoption to ensure consistency in design and operation to the extent practical and possible across the "family" of UK codes, so it indeed feels like an aligned family to project developers rather than a confusing, heterogenous mix of contradictory codes with widely different sets of rules and protocols around key aspects such as additionality, stacking, project design, validation, verification etc.
- This is being done in the UK through the development of a set of minimum requirements for high-integrity codes across a range of land uses, habitats, and ecosystem services, which can be operated by an arms-length body like the BSI. The first set of minimum requirements has been developed for agricultural soil carbon, and once formally adopted by an arms-length body, it will be possible to accredit codes against these minimum standards, providing clear market signals to investors and landowners/managers alike, so that they work with the most reputable codes. Guidance will be given to codes that do not meet the requirements, to help them improve the integrity of their codes. As an incentive to submit codes for accreditation, UK compliance markets will only be able to offset using codes accredited to this standard. However, a BSI standard does not auto-update or adapt unless there is a body that can ensure the minimum requirements remain in line with the latest evidence and horizon scan for negative unintended consequences. In this way, sets of minimum requirements for codes can be adapted where necessary, or policy teams

alerted in case a regulatory response is needed. However, there is a danger that this leads to the development of a siloed system where each ecosystem service and habitat is managed separately, in contrast to the interdependencies we see in the real-world. Additionally, to ensure consistency, a transparent UK registry (the UK Land Carbon Registry contains both Woodland Carbon Code and Peatland Code project details) may be established as well as restrictions on what carbon can be sold in advance of verification on the registry.

- For this reason, it is also important to think about mechanisms for aggregating both supply and demand for ecosystem services; different investors may be looking for contradictory outcomes and land holdings may be highly fragmented and so not investible. These mechanisms need to be place-based because actual landscapes integrate multiple land uses and habitats, and produce many different ecosystem services. Also, some interventions will produce one ecosystem service at the expense of another, cancelling out benefits from different schemes and investors. In addition to thinking about how private payments for ecosystem services interact across landscapes, it is also important to think carefully about how private and public payments interact, and avoid situations where public funding outcompetes private investment – it is difficult to justify spending public money on outcomes that the market would have been happy to pay for (see above).
- Next, it is important to ensure there is a level of policy coordination to ensure things work smoothly. In many European countries ecosystem markets operate at sub-national scales, which is similar to the challenges posed by the UK's four countries, given that voluntary ecosystem markets are devolved to these administrations. Even where policy is national, there is a need to ensure the various government departments and delivery agencies are aligned. But where you have the potential for divergent regulatory constraints, such as a requirement for projects to contribute to community wealth funds, or tax regimes for example, there is the potential for competition between jurisdictions and a race to the bottom.
- Finally, to bring consistency across all of these policy and governance mechanisms, there is a need for core principles that can operate across markets for different ecosystem services in different habitats and land uses. Where possible, it would be useful if these built on international initiatives like the Voluntary Carbon Markets Integrity Initiative (VCMI) and ICVCM, creating consistency across global voluntary markets. However, Scottish Government have gone further in their Interim Principles for Responsible Natural Capital Investment, stipulating the need for community benefits from nature-based solutions projects.

3. UK Saltmarsh Code development: detailed recommendations for key elements

3.1 Eligibility

- Specify types of restoration practice (referred to hereafter as “practices”) that the Saltmarsh Code could cover:
  - Managed realignment– this has been the focus of our work so far. It is the most common practise in the UK
  - As more data becomes available, the Saltmarsh Code could include other activities such as Regulated Tidal Exchange (RTE) and Beneficial Use of Dredged Sediment (BUDS) which includes sediment recharge.
  - Also improving condition of existing marsh, by change of management practises
- Any additional practices must demonstrate through publicly available evidence that the practices implemented are likely (a) to lead to an increase in SOC stock, and/or reduce GHG emissions (b) do not increase other GHG emissions from the site, and (c) ‘do no harm’ to biodiversity, carbon stocks elsewhere, water and air quality. Evidence should consist of empirical studies relevant to UK saltmarsh systems including grey literature, but preferably peer- reviewed scientific articles and/or a meta-analysis of peer-reviewed studies.
- Practices must be implemented through clearly defined projects on specific saltmarsh sites with a clearly defined and quantified baseline.
- We recommend that the UK Saltmarsh Code should cover changes in biomass (above- and belowground), changes to the SOC stock, and GHG reduction or emissions. It is proposed the Code must address carbon dioxide (CO_2) and methane (CH_4) emissions from saltmarshes, and where significant, nitrous oxide (N_2O). Net carbon abatement should be expressed as CO_2e as the standard unit of measurement which can integrate across these different sinks and sources. The global warming potential (GWP) used by the Code should be clearly stated and a rationale for the use and a process for updating the GWP should be stated in the Code.
- Carbon credits should only be generated from the verified change in net carbon abatement over and above a baseline (expected removals or emissions of the same area in absence of a project) as a direct consequence

of project practices. This requires an approach that will determine how the baseline for business-as-usual would respond over the project duration. This can be achieved using different approaches including parallel monitoring of benchmark sites and/or modelling, and integration of default EFs for the previous land-use activity.

- To be eligible under the Saltmarsh Code, projects should have to provide evidence demonstrating they comply with all local, regional, national or UK law.
- The Saltmarsh Code should also include clear requirements and guidance on the systematic engagement of interested/affected parties during the design of a project. These should consider the potential economic, environmental, and equity impacts on the local community and other parties who may be affected by the project and provide mechanisms to ensure that all relevant voices are heard, and concerns are addressed effectively by project developers. Where project developers are not the landowner, they should be required to articulate who receives payments from the sale of carbon credits, and the landowner should be informed and consulted prior to the initiation of the project. Any legal requirements, e.g., conservation covenants, on the land should be disclosed as a part of the validation process.

3.2 Approach to additionality

- Additionality rules used within the Woodland Carbon Code (WCC) and Peatland Code (PC) have been approved by UK Government, as the carbon credits from these schemes are included within environmental reporting guidelines for UK corporate as sources of eligible offsets. As such, the UK Saltmarsh Code should align with these same rules where appropriate.
- The UK Saltmarsh Code should provide criteria about what qualifies as an additional practice. At a minimum:
    - The Code should establish a time period (no less than 5 years) wherein land use and/or management change is ineligible, for practices that, since the adoption of the Code, have demonstrated a net carbon abatement.
    - No practices may be credited by the Code if they are required by local, regional, national or UK law and/or regulation relevant to the region, jurisdiction and operations where a project is implemented.
    - The Code should only credit projects where changes in practices have been newly adopted. Having said this, it may be possible to retrospectively demonstrate additionality if projects have started prior to registering with the Code, if the project developer can supply evidence to confirm that carbon finance from selling carbon units or

'insetting' was considered in the planning stages of the project (for example the inclusion in minutes of board meetings or planning documents, cashflow or emails).
    - The Code should require that projects provide evidence that newly adopted practices would not have been viable and/or sustainable without revenue from saltmarsh carbon credits.
- The Code should not prevent the stacking of payments for other ecosystem services (other than net carbon abatement from saltmarsh restoration) from other financing schemes as long as the additionality requirements of each Code/funding scheme can be met on top of the implementation of all other financed schemes within the same project boundary. Key additional ecosystem services to consider are BNG, and Natural Flood Risk Management (NFRM). Carbon revenues alone are likely to be insufficient to fund entire projects given high development and restoration costs (Section 6.2 in Burden et al., 2023). Therefore, stacking can be much more easily justified from financial additionality point of view vs other Natural Capital markets.

It is suggested the UK Saltmarsh Code explore the evidence-base available for quantification of other co-benefits, and include in further development of the Code if and when robust evidence is available. To bundle co-benefits with saltmarsh carbon credits, the Code would need to include procedures and guidance for the quantification and MRV of these co-benefits in as robust a manner as for carbon gains to avoid un-evidenced claims and criticisms being made.

3.3 Approach to permanence, leakage and reversals

- The UK Saltmarsh Code should require projects to include mechanisms to reduce the risk of loss of net carbon abatement, for example by designing initial sea wall breaches and encouraging (by digging an initial creek system) movement of water in a way that reduces the risk of erosion both within and outside of the project boundary. It must also indicate how permanence will be maintained by a project beyond the project crediting period. Ideally, a permanence period should be stipulated with a minimum of 30 years beyond the crediting period. Additional strategies for ensuring permanence through other contractual arrangements should clearly stipulate how they will deliver permanence. All forms of permanence should address the risk of reversals and other non-permanence risks with appropriate risk management mechanisms put in place.
- The Code should clearly define the difference between the crediting and permanence periods. The Code should include monitoring requirements for projects to determine potential releases which occur after the crediting period and during the permanence period. Monitoring during the permanence period should occur on a regular basis, ideally at least every 5 years. The Code needs

to have clearly articulated processes for identifying and quantifying if / when release of net carbon abated has taken place. The Code should consider how it encourages the long-term adoption of practices to ensure the permanence of the carbon sequestered.

- Mechanisms should be included in the Code for assessing, accounting and compensating for any unintended reversals of net carbon abatement, such as natural disasters including drought, extreme temperatures, fire, and floods which can release GHGs and/or reduce saltmarsh stocks.
- A buffer pool should be included in the Code for the replacement of unintended release of CO_2e, and replacement of saltmarsh carbon credits should be from nature-based solution projects. Projects may also use insurance products to further protect against unintended reversals, but it is not recommended that this is required in the Code. Given the range of projects and risks likely to be put forward, it is recommended that a variable buffer is adopted, requiring higher risk projects to set aside proportionally more carbon credits than lower risk projects. A variable risk buffer can increase project uncertainty vs a flat buffer, and therefore it is important that projects have full transparency on how this is determined.
- For the effective management of the Saltmarsh Code buffer, it will be necessary to establish:
    - Evidence for determining the risk and criteria for contributions and a related quantification method for the level of contribution to the proposed variable buffer pool. It is recommended a tool is developed from this evidence, taking learning from the Feasibility study of VCS VM0033 report.
    - A procedure for the cancelation of credits after an unintended reversal
    - A length of time during which credits are maintained in the buffer pool, after which credits are returned to the project
- The Code should also include procedures to address situations where there is evidence of intentional reversal of net carbon abated, for example a change of management activity that results in a change to tidal inundation. The procedures should include a quantification of the amount of CO_2e reversed and procedures for the repayment of any revenue generated through saltmarsh carbon credits or retiring saltmarsh carbon credits in the amount of the net carbon abatement that is reversed.
- The Code should not allow projects to knowingly cause a decrease in carbon stocks or an increase in GHG emissions elsewhere as a result of implementing the project practices, with reporting requirements to demonstrate that leakage is minimal beyond the project boundary.

3.4 Monitoring, validation and verification procedures

- Monitoring of projects is necessary to assess how successful restoration activities have been in achieving their predicted carbon gains. Recommendations for how to monitor changes in biomass (above- and belowground), changes to the SOC stock, and GHG reduction or emissions need to be developed.
- The monitoring plan should be in place before the project begins, carried out at regular intervals, and adapted to incorporate new scientific understanding on an ongoing basis.
- Projects will need to establish a baseline against which changes in carbon emissions and reductions can be measured. We suggest this could be achieved by using default EFs for the previous land-use activity if available (for example, from the Land Use, Land Use Change and Forestry (LULUCF) sector of the UK GHGI).
- It is expected that EFs (described more fully in section 4) will be developed to estimate carbon gains using proxy measures as this reduces the cost of monitoring and verification considerably. However, some projects may opt for direct measurements, and so advice on how to do this will be needed to ensure the correct information is produced.
- Validation and verification of Saltmarsh Code projects should be carried out by independent Validation and Verification Bodies (VVBs) accredited to work with the Code by the United Kingdom Accreditation Service (UKAS), as soon as enough pilot projects are available for this purpose. VVBs should rotate throughout the lifetime of the project, with aspiration for projects not being verified by the same Validation and Verification Body (VVB) for more than two crediting periods or 10 years, whichever is the shortest.
- The Saltmarsh Code should require an initial validation of the project to confirm that it meets the requirements of the Code before a project is formally approved and accepted by the Code. Once a validation is approved, the project can undergo its initial verification by a VVB. A subsequent verification of the project by an independent third party, should be required prior to any issuance of credits. Verifications should be conducted at least once every 5 years.

3.5 Issuance of credits

- The Saltmarsh Code should provide information about how projects and their associated credits are tracked. This should include procedures for the listing and approval of projects as well as for the issuance and retirement of credits. This information should be contained in a transparent, public registry, such as the UK Land Carbon Registry (currently operated by S&P Global). In common with Woodland Carbon Code and Peatland Code projects on this registry, saltmarsh projects would be included in the registry with the date for the listing, credit issuance (including volume of credits issues) and the status of credits (e.g., retired, buffer pool, invalidated, etc). The registry would also include documentation about projects, including a summary, monitoring report, and documents associated with validation and verification. The retirement of credits would include the date retired, the entity retiring the credits, and the reason for retirement.

- The Code should stipulate what information is required to confirm the entities engaged with each project, including unique, verifiable identification for the landowner, project developer, and buyers of credits. There should be a process for identifying and confirming the identities of all entities participating in Saltmarsh Code projects.
- The purpose of the UK Saltmarsh Code is primarily to contribute towards the UK's climate change mitigation targets. For this reason:
    - No resale of credits should be permitted in version 1.0 of the Code;
    - Use of the Saltmarsh Code is restricted to projects within the UK and Verified Saltmarsh Carbon Units from Saltmarsh Code projects should only be used by companies to compensate for their UK-based GHG emissions (not for emissions outside of the UK);
    - Each of these considerations could be revisited and changed in later versions of the Code.
- The Code should state the number of years over which a project is allowed to generate saltmarsh carbon credits (the "crediting period"). A decision should be made about whether the crediting period can be renewed and, if so, the number of times it can be renewed and the requirements for subsequent crediting periods.
- Selling only verified carbon units (ex-post) and not PIUs (ex-ante, i.e., in advance of saltmarsh restoration) prevents risks to market integrity, such as the increased risk of greenwashing should the buyer become an irresponsible off-setter between the time of purchasing a PIU and the PIU converting to a verified unit. It also means projects can benefits from future increases in carbon prices. However, selling PIUs can generate upfront income to help with the establishment of projects. Analysis of these two options needs to be carried out to determine which approach is most beneficial.

4. Further considerations to establish Monitoring, Reporting, and Verification (MRV) guidelines

MRV is a multi-step process to measure, report and verify the carbon gains (or losses) from restoration projects entering the Saltmarsh Code. Within the current NEIRF project, we have reviewed MRV methodologies present within the VCS VM0033 Code (Feasibility study of VCS VM0033 report, section 4.8, Burden et al., 2023). We filtered for those parameters applicable to UK saltmarsh and commented on them in terms of the level of expertise needed. We recommend this review is used as a basis to build on for the UK Saltmarsh Code development, starting with collating information regarding data availability/state of knowledge both from published work and that from research ongoing.

The VCS VM0033 methodology gives flexibility to use a range of data types within MRV. It suggests seeking data in the order: local published values, proxies, models, default EFs. This flexible approach will be taken forward for the development of a UK Code, to ensure we are using the most accurate and relevant data we can for each restoration project. Projects could also take new direct empirical measurements, and so advice regarding standardised methodologies to use is needed to ensure the correct data is produced. We recommend direct measurements only be used if a research project is running alongside the restoration project, or as a development activity to improve the knowledgebase for development of proxy measures. From a commercial perspective, given the high restoration cost, ensuring the validation and verification process is efficient and cost effective is important (see section 6.3 in Feasibility study of VCS VM0033 report, which concludes that Verra with its high validation and verification cost is not likely a financially viable regime option for many UK projects due to their smaller scale compared to typical international Verra projects). In addition, removing or reducing uncertainty as far as possible around lifetime carbon unit generation is crucial at the time of project financing (i.e., pre-restoration) to ensure the code is commercially viable. In the Peatland Code and Woodland Carbon Code, this is achieved via the use of a ‘carbon calculator’ excel tool.

We recommend the development of EFs to estimate carbon gains using proxy measures, as this reduces the cost of monitoring and verification considerably. To do this, saltmarsh typologies would need to be developed. These would either be categories of UK saltmarsh with common environmental and physical characteristics that best explain the spatial variation in rates of carbon sequestration, accumulation, and GHGs such as latitude or accretion rate; or simple proxy measures linked to an associated carbon flux such as plant community or saltmarsh zone; or both. The emission factor (EF) is then derived from analysis of published data for that typology. To calculate the estimated carbon gain, the area of any given typology within restoration projects would then be multiplied by the associated EF. In the case of saltmarsh restoration, we would need published data on sediment and vegetation carbon stocks and changes, emissions or removals of GHGs, and losses/gains of carbon through connectivity to other habitats.

4.1 Regularity of monitoring

For the illustrative investment cases, verification regularity (and therefore associated monitoring) is assumed to be annual (section 5.4.3 in Feasibility study of VCS VM0033 report). We recommend this is revisited to be certain the frequency reflects the needs of the code. We have suggested in section 3.4, verifications should be conducted at least once every 5 years (after initial validation). Monitoring plans need to consider two phases of the code development, the first being project-based primary data collection to inform the development of proxy measures and EFs applicable at a UK-wide scale; and the second being monitoring techniques that use these proxies and EFs.

Timelines for monitoring the development of blue carbon within restoration sites have been presented in the Environment Agency's Saltmarsh Restoration Handbook, in the Restoration Methods chapter (Pontee et al., 2021). In addition to setting a baseline, it was recommended here to monitor:

- Accretion rate [at least] every month for the first 12 months post restoration as it is likely to change rapidly. Every 6 months for 2-5 years.
- Repeat all measurements at yearly intervals (to coincide with peak plant biomass annually
- Seek specialist advice to establish a reliable GHG flux monitoring programme – these measurements need to be taken at least seasonally.

This gives a baseline to work from when setting the monitoring plan for the first phase of code development.

4.2 Progress to standardise monitoring methodologies

The Blue Carbon Initiative published a coastal blue carbon manual (Howard et al., 2014) recognising the growing body of scientific knowledge on the direct and indirect effects of climate change and human development on coastal ecosystems. The objective of the manual is to provide standardised step-by-step methods for field measurements and analysis of blue carbon stocks and flux in coastal ecosystems. It includes protocols and guidance for measuring organic carbon stocks in soil and above- and belowground biomass, change in stock over time, and GHG emissions. However, whilst reviewing the published evidence it was clear standardised methods are not being used routinely (Mason et al., 2022), and anecdotally many within the research community are unaware of this manual. The recent Environment Agency Saltmarsh Restoration Handbook (Pontee et al., 2021) also outlines key considerations regarding monitoring and gives examples of monitoring methods.

The UK Blue Carbon Forum (UKBCF) – as part of the Habitats, Conservation, and Restoration working group – aim to produce advice on standardising methods in Summer 2023. A workshop took place in November 2022 where information about the current common methodologies used by the research community in the UK was collated and discussed (see Appendix 2 for more information). The advice will refer back to the blue carbon manual (Howard et al., 2014), and where necessary describe where a different approach is needed for UK saltmarshes specifically. It will also highlight where new methods need to be developed, and where current methods can be prohibitive due to the level of funding or expertise needed. The standardised methods will be with the Saltmarsh Code development and UK GHGI in mind. There is no commitment at this time for the inclusion of coastal wetlands into the UK GHGI, however methods that produce data suitable for both will align reporting mechanisms. The UK GHGI monitors progress on reducing GHGs and is a legal requirement for the UK's submission under the 1992 UN Framework Convention on Climate Change (UNFCCC) and satisfies the UK's legal obligations under the UNFCCC's Kyoto Protocol. It is also used for setting carbon budgets under the UK Climate Change Act (2008) and equivalent legislation in the Devolved Administrations. The UK GHGI reports emissions at different levels of detail and certainty – with tier 1 using default EFs allowing carbon gains or losses to be estimated where site-specific data has not been collected, through to Tier 3 using direct measurements and detailed process models. Table 2 contains the guidance for data needs at a Tier 1 and 2 level. The monitoring needs for Tier 1 inclusion are straight-forward, and we recommend these main requirements are included in monitoring guidelines for the UK Saltmarsh Code.

Table 2: Activity data (in addition to spatial extent data) needed for Tier 1 and 2 emission estimates from rewetting, revegetation, and creation of saltmarsh and seagrass beds. Summarised from the 2013 IPCC Wetlands Supplement for coastal wetlands (chapter 4). (EF = Emission Factor)

	Tier 1	Tier 2
Biomass	No data needed. Assumes no change in biomass stock as a result of rewetting.	▪ Annual aboveground increase due to biomass growth ▪ Annual aboveground decrease due to biomass losses ▪ Carbon content of dry biomass ▪ Proportion of woody and herbaceous biomass
Dead Organic Matter (DOM)	No data needed. Assumes no change in DOM as a result of rewetting	▪ Two DOM pools to address separately. ▪ Average annual transfer of biomass into and decay out of each pool due to processes and disturbances ▪ Carbon fraction of each pool
Soil Carbon	Estimate of when 10% of the overall area is colonised by vegetation	UK-specific EF disaggregating organic and mineral soil type
Non-CO_2 emissions	Assumes no non-CO_2 emissions as a result of rewetting if the salinity is greater than 18ppt	▪ Assumes no non-CO_2 emissions as a result of rewetting if salinity is greater than 18ppt ▪ UK-specific CH_4 EF based on water salinity if less than 18 ppt

4.3 Review of evidence applicable to UK saltmarshes

Existing standards commonly permit the prediction of carbon and GHG benefits arising from wetland restoration by the use of data from similar sites or by the modelling of data from similar contexts (e.g., VCS VM0033 Methodology for Tidal Wetland and Seagrass Restoration, v2.0). At the start of the Saltmarsh Code project in 2021, there was no systematic evidence review from which to extract such data. To address this knowledge gap we undertook two systematic reviews to answer: (a) what bio-environmental factors control carbon and GHG fluxes in natural and restored marshes, (b) how much of the captured carbon at sites counts as additional carbon sequestration (i.e., how much is autochthonously derived) and (c) how does carbon accumulation rate change over time since marsh restoration. The following presents a summary of the key findings of two systematic literature reviews and associated meta-analyses. The first review (Mason et al., 2022: 3,844 studies screened down to 35 relevant papers for data extraction) collated data from north-west Europe, encompassing the British Isles and the Atlantic coast of southern Norway to Brittany. This geographical region had the greatest relevance to a UK context. The second review synthesized global data, to broaden on parameters for which the European context had insufficient information (Mason et al., in prep: 29,182 papers screened down to 435 papers).

The European study (Mason et al., 2022) was biased by observations from natural marshes (150 of a total 178 independent observations) and was overall marked by scarcity of data for key variables (Figure 2a). There was insufficient data to link carbon stock and GHG fluxes from saltmarsh to bio-environmental predictors, such as salinity, pH, elevation, latitude, accretion rate and vegetation community composition. Only 2.9% of observations of carbon stock were from restored sites, whilst the majority of carbon burial rates were from natural sites (Figure 2a). Natural marshes had a slower carbon accumulation rate (8.2 ± 5.94 t CO_2e ha^{-1} y^{-1}) than restored marshes (13.3 ± 15.0 t CO_2e ha^{-1} y^{-1}), although this trend was not significant (Figure 2a) and likely because most restored sites were relatively young (< 20 years since restoration), when sediment accumulation is particularly rapid (Masselink et al., 2017). Sediment/carbon accumulation is expected to slow over time, although the European dataset did not reveal such a trend, due to paucity of observations for sites older than 20 years (Figure 2b).

The global systematic review expanded the European dataset significantly, although biased by data from north America, which had 38% of all studies and 57% of observations from restored sites (Europe: 35%). The global dataset showed carbon stock was best predicted by marsh age, climatic setting (temperature) and vegetation type. Stock decreased with marsh age and increased with temperature. GHG benefits from restoring marshes was particularly promising in Europe, where CH_4 and N_2O fluxes were 25 and 200 times lower than the global average (Table 3).

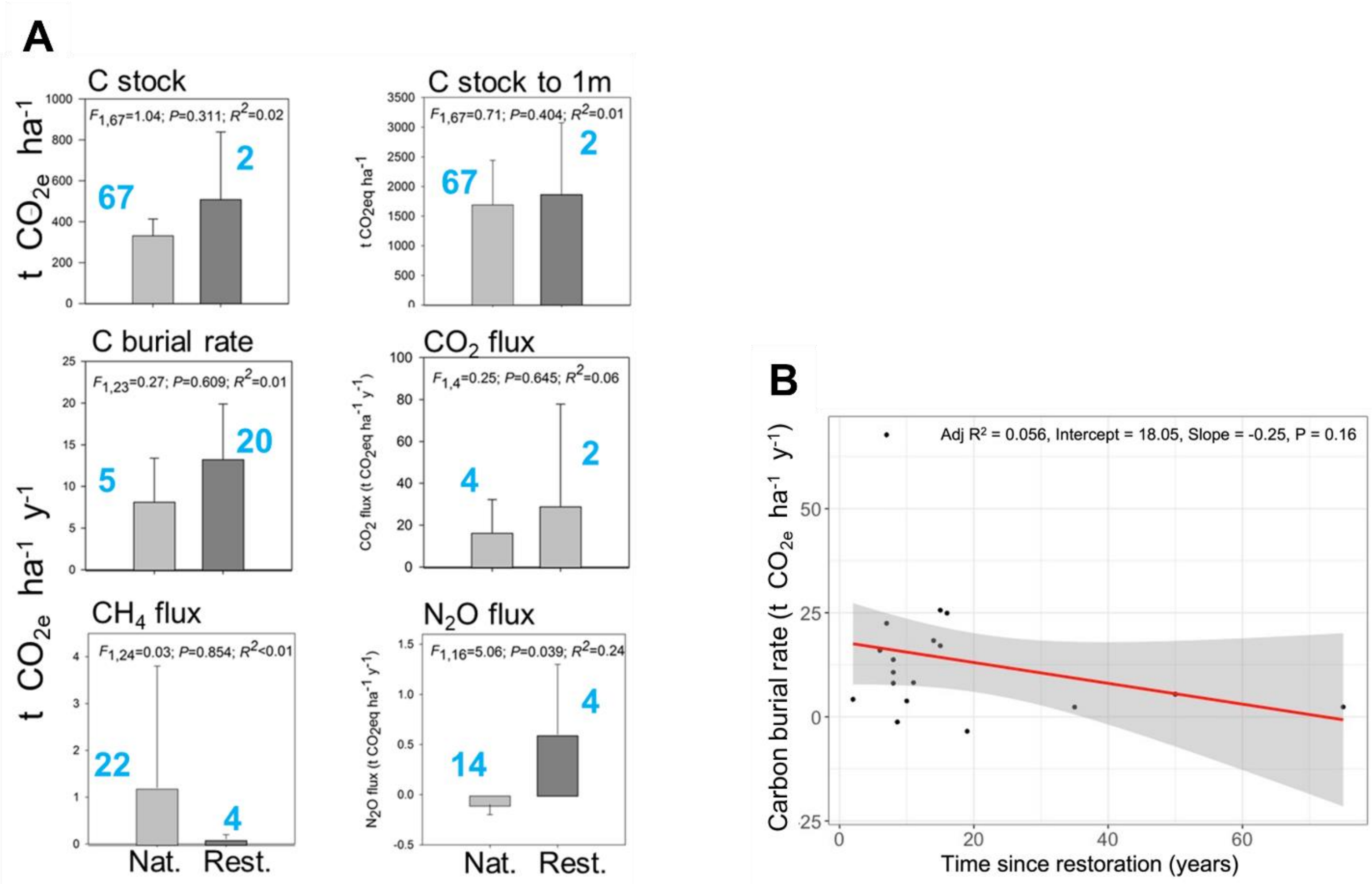

Figure 2: (a) the mean ± 95% Confidence Interval carbon stock and greenhouse gas fluxes from natural and restored sites in north-west Europe. Carbon stock was observed to variable depth by studies and is here presented in two ways: with extrapolation of original observations to 1 m depth (C stock to 1m) and without extrapolation (C stock). Blue digits show the number of independent observations per mean. (b) Carbon burial over time since site restoration. The relationship is not significant (P=0.16).

Carbon burial rates in Europe were also substantially faster than the global average (Table 3), although this might be partially explained by the European dataset having fewer observations from older restored sites, where accumulation rates are expected to drop (e.g., Figure 2b). Extrapolating the observed net carbon burial rate of restored sites (66.7 t CO_2e ha-1 y-1) onto the 0.2-3.2 million ha marsh sites that are thought realistically restorable (Griscom et al., 2017) indicated 0.04-0.59% of global energy related CO_2 emissions in 2021 could be removed through saltmarsh restoration. The equivalent calculation for the UK showed 0.05% of the 2020 CO_2 emissions would be offset if 22,000 ha were restored, in compliance with recommendations (Dickie et al., 2015).

Table 3: Mean ± standard deviation concentrations and fluxes of carbon and greenhouse gases in global observations from natural and restored marshes, as derived from a systematic review of 435 global publications. Contrasts between natural and restored sites are shown for European, North American and all global observations. %OC = percentage organic carbon of sediment. Brackets show the replication per mean (no. of independent sites/contexts). Blue values were significantly different between natural and restored sites

	% OC	Bulk density (g cm^{-3})	C stock (1m) (t C ha^{-1})	C burial rate (t C ha^{-1} y^{-1})	Net CO_2 flux (t CO_2 ha^{-1} y^{-1})	CO_2 respiration (t CO_2 ha^{-1} y^{-1})	CH_4 flux (t CO_2e ha^{-1} y^{-1})	N_2O flux (t CO_2e ha^{-1} y^{-1})
Europe								
Natural	7.00 ± 7.13 (211)	0.65 ± 0.32 (122)	342.10 ± 223.45 (154)	1.87 ± 1.77 (30)	NA	20.42 ± 50.88 (11)	0.20 ± 0.30 (20)	0.06 ± 1.00 (14)
Restored	4.37 ± 4.60 (88)	0.88 ± 0.33 (24)	438.83 ± 191.97 (22)	5.70 ± 8.81 (15)	NA	29.08 ± 35.11 (2)	0.05 ± 0.08 (4)	0.58 ± 0.67 (4)
North America								
Natural	11.39 ± 8.80 (464)	0.39 ± 0.29 (273)	360.00 ± 214.16 (295)	1.69 ± 2.25 (236)	-57.73 ± 84.26 (47)	30.32 ± 23.90 (57)	6.67 ± 25.99 (69)	-0.03 ± 0.77 (24)
Restored	8.52 ± 10.41 (99)	0.60 ± 1.14 (87)	247.23 ± 169.56 (79)	3.77 ± 4.53 (63)	-80.10 ± 48.13 (19)	5.33 ± 1.46 (6)	23.17 ± 54.47 (16)	0.19 ± 0.75 (16)
Global								
Natural	8.86 ± 8.56 (906)	0.67 ± 0.46 (581)	287.39 ± 238.64 (720)	2.13 ± 4.49 (312)	-41.82 ± 71.03 (74)	25.23 ± 28.19 (140)	4.99 ± 19.00 (198)	0.27 ± 0.86 (93)
Restored	6.50 ± 8.37 (195)	0.69 ± 1.01 (116)	272.81 ± 193.13 (109)	4.41 ± 5.91 (82)	-65.51 ± 52.27 (24)	15.68 ± 19.70 (16)	16.58 ± 42.34 (30)	0.39 ± 1.08 (27)

In conclusion, the global dataset firmly endorses the potential of carbon and GHG benefits arising from saltmarsh restoration. The review indicates more observations are required from restored sites in the UK, if the carbon and GHG benefits from restoration is to be predictable across variable bio-environmental contexts. Fortunately, the UK evidence base is continually expanding, and emerging studies look promising for closing some of the revealed knowledge gaps. For instance, members of the current team are leading the development of a flux tower network on saltmarsh habitat across the UK which will measure GHGs in real time from a diverse range of saltmarsh typologies, both natural and restored. Members of the team are also engaged in other ongoing work that uses existing and emergent data to test the following approaches for broad-scale predictions:

- Measuring carbon accumulation in restored marshes
- Using modelling of marsh accretion rates to estimate carbon stock accumulation rates
- Upscaling carbon stock from information of marsh vegetation zones
- Linking GHG fluxes to marsh zone and plant biomass – preliminary observations: belowground plant biomass may be a key, cost-effective predictor in carbon flux models
- Predicting the GHG effects of rewetting sites – preliminary observations indicate pulsed emissions of N_2O (the majority GHG) are predictable from data on tidal emersion and precipitation
- Using earth observation techniques (EO) to predict site expansion rates - EO approaches are used routinely in other wetlands (e.g., UK Peatland Code methodology and UK GHGI reporting)

4.4 Autochthonous/Allochthonous considerations

The losses and gains of carbon through connectivity to other habitats is a large known knowledge gap that has an impact to the development of a UK Code due to the need to separate autochthonous (originating from within the project area) and allochthonous (originating from outside the project area and then washed in) carbon. There are currently research projects within the UK looking at the split between the two, and in time, more data will be available. All autochthonous carbon is considered to be ‘credit-worthy’ for a project as it clearly represents real carbon gain due to the management activity. Allochthonous carbon is only considered to be worthy of credits for a project if it can be demonstrated it would have been returned to the atmosphere in the absence of the project. VCS VM0033 Methodology for Tidal Wetland and Seagrass Restoration, v2.0 contains detailed methodology to calculate a deduction from the total carbon to account for allochthonous material, and a recently developed UK conversion factor for loss on ignition (LOI) data (Austin et al., 2022) makes following this method easy to make more relevant to UK saltmarsh, and relatively cheap to implement as it does not require elemental analysis. We recommend the literature around auto- and allochthonous carbon be revisited to decide if the VM0033 methods are the best approach at this time, and to have a forward look as to how this may change with more available data.

5. Commercial considerations for the development of a UK Saltmarsh Code

The illustrative investment cases presented in the Feasibility study of VCS VM0033 report have shown a Saltmarsh Code could play various important roles.

1. **Facilitate private repayable finance to meet upfront capital costs:** For larger sites like Steart Marshes with higher carbon accumulation potential, private finance could play a significant role in funding restoration costs and ongoing maintenance costs, with verified carbon unit revenues providing an opportunity to repay finance together with a reasonable rate of return to private investors.
2. **Fund maintenance costs only:** For smaller sites like Old Hall Marshes with lower carbon accumulation potential, and/or significant engineering works required, private finance is likely to play a substantially smaller role in supporting upfront capital costs, but verified carbon revenues can still provide a source of long-term funding to cover lifetime maintenance costs.
3. **Insetting:** Steart Marshes restoration was as a result of compensatory habitat regime, which do not meet the additionality hurdle, and therefore carbon credits cannot be sold. However, carbon units generated can potentially be used for insetting purposes by, for example, public and privately owned bodies for projects they own/control.

For the Saltmarsh Code to unlock more restoration, the following commercial consideration are key for the development of a high integrity code and its successful uptake by UK projects.

Commercial considerations	
Development of carbon sequestration proxies	**Build targeted evidence base to support the creation of carbon sequestration proxies, focusing on regions of the UK with the highest carbon potential** • **Include proxies/default factors** to provide visibility on potential carbon units generation • Prioritise/identify areas with **high carbon accumulation opportunities** in the first instance
Cost effectiveness	**Ensure cost effectiveness for projects by streamlining project design, carbon calculations, validation and verification processes** • **Verification and validation costs:** Given the high upfront cost, ensuring the validation and verification process is efficient and cost effective is key to optimise operating cashflows (after validation, verification and issue cost) • **Restoration and construction costs:** Need for streamlining restoration projects by releasing technical guidance to deliver restoration in a cost-effective way (for example areas which do not require to build new embankments to protect assets), conducting trainings to ensure more local contractors are equipped to deliver such projects
High integrity on supply and demand side	**Where possible pursue simplicity over complexity but always maintain market integrity, taking into consideration quality of projects and also quality of offset buyers** • **Ensure consistency** in application, governance, integrity across domestic codes • **Ensure there are sufficiently resourced** accredited **validation and verification bodies** to support projects across the country • Integrate guidance on **buyer criteria into the standard** for users of the code
Alignment with sources of public funding	**Ensure public funding schemes support the development, restoration and maintenance and can be blended/stacked with carbon markets and private finance** • **Pre-construction cost**: Saltmarsh restoration projects are complex and often take multiple years for the initial design, stakeholder engagement and planning permissions to be completed. These pre-construction design and approval costs will require ongoing public funding support to ensure projects reach the "shovel-ready" stage where they are ready to receive private repayable investment. • **Maintenance grant**: Additionally, maintenance grant support for the first years post restoration would support projects seeking repayable sources of finance by providing a stable and secure income stream (in contrast to carbon revenues which are based on what remains a volatile and uncertain market). • **Restoration grant**: As saltmarsh restoration projects have typically much higher per ha restoration costs compared to woodland creation and peatland restoration, non-repayable contributions towards the upfront construction costs of a site will support the case for private finance to meet the gap for the remaining project costs, in particular for sites with low accumulation potential and/or high flood defence potential. Potential public funding sources in England include the EA's Flood & Coastal Erosion Risk Management Grant in Aid[1], and the Environmental Land Management scheme. For comparison, up to 75% of peatland restoration cost can be covered with upfront grants from the Nature for Climate Peatland Grant Scheme, which encourages recipient projects to blend the grant with carbon income through the Peatland Code[2].

[1] Flood and coastal erosion risk management projects and funding - GOV.UK (www.gov.uk)

[2] Nature for Climate Peatland Grant Scheme - GOV.UK (www.gov.uk

6. Next steps

The NEIRF funded project was the start of developing a UK domestic Saltmarsh Code, and this work will continue into a second phase. We envisage this being a 3-year project, with the launch of version 0.1 of the UK Saltmarsh Code at a mid-point of the project. This will allow for a further development and piloting phase, leading to UKAS/BSI accreditation and the launch of version 1 of the Code. We will use this recommendations report as the starting point, and the work will be split into four key areas (Figure 3):

1. The Science
2. Code Design
3. Finance/Business Plan
4. Ownership and Management

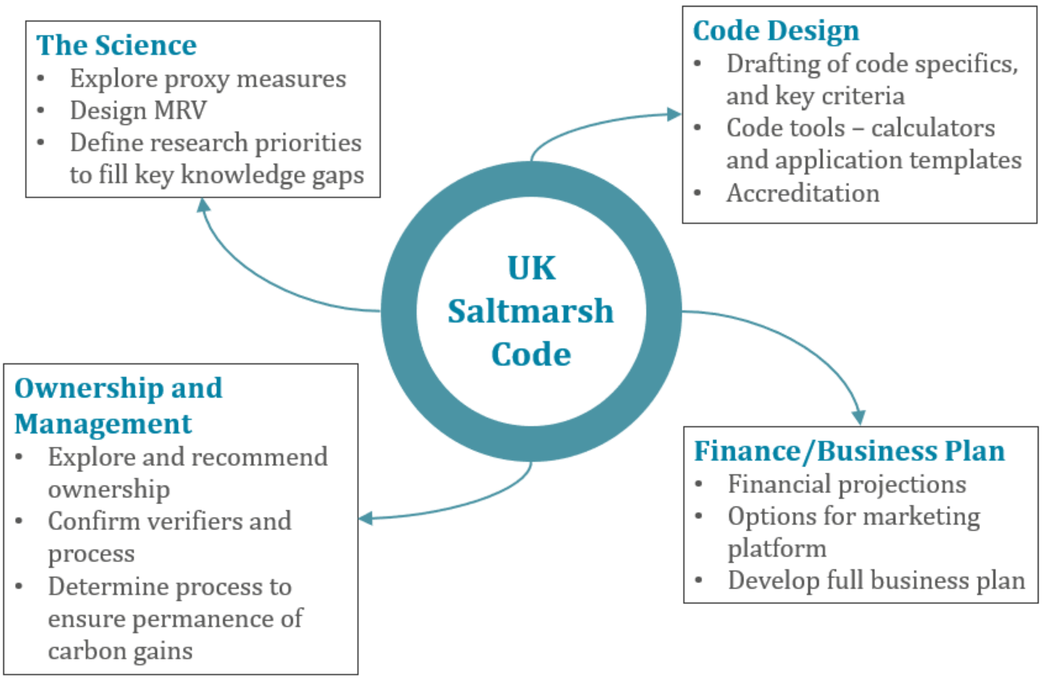

Figure 3: Four key areas for developing the UK Saltmarsh Code including an indication of high-level considerations within each.

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Appendix 1: Further comparative analysis of international codes for saltmarsh creation

A1.1 Introduction

Building on the initial review of four international saltmarsh codes by Holehouse et al. (2021), two further codes have been reviewed. The Australian Carbon Farming Initiative (2021)[1], which has just completed its public consultation period; the Plan Vivo methodology for voluntary carbon offset programmes (2013)[2], which has been used by a number of mangroves projects.

A1.2 Approach and methodology

The same approach and methodology as described by Holehouse et al. (2021) was used for the review: the technical themes to assess existing methods, and the application of considerations around whether these various aspects would work in a UK setting. Knowing if the codes were originally intended to work for saltmarsh creation in a managed realignment setting is important. Managed realignment is not called this elsewhere in the world. It may for example be called 'reintroduction of tidal regimes'. There are only around 45,000 ha of saltmarsh left in the UK (mainly in England)[3] and many have been degraded due to coastal erosion arising from engineered flood defences, accretion, dredging and pollution[4]. As such, projects under a future Saltmarsh Code would be creating or restoring saltmarsh in the UK. For restoration, we define it as the Society for Ecological Restoration (SER)'s definition states:

'Ecological restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed'[5].

This covers most types of intervention for habitat enhancement, or *restoration*. When it comes to *creation* the meaning is generally accepted as creating a habitat where one was not there before, picking up from the 'destroyed' part of the SER restoration

[1] https://consult.industry.gov.au/blue-carbon-method

[2] https://www.planvivo.org/

[3] Natural England, 2014. Climate Change Adaptation Manual-Evidence to support nature conservation in a changing climate (NE546).

[4] HMSO, 1995. Biodiversity: The UK Steering Group Report, Volume 2: Action Plans. HMSO: London.

[5] https://www.ser-rrc.org/what-is-ecological-restoration/

definition. Suitable in a UK context is the definition of *creation* as defined in Adam (2019)[6]:

'Habitat creation involves the creation of ecosystems at localities where systems of that type either did not exist previously or, if they did, the modification to the area in the time since the previous occurrence is such that all continuity has been broken'.

Holehouse et al. (2021) reviewed four codes, and this review provides a high-level analysis of two other methods and guides that might also be relevant in a UK context.

A1.3 Results of the further review

Australian Carbon Farming Initiative: Tidal Restoration of Blue Carbon Ecosystems

Overview
Australia has developed a blue carbon method under the Emissions Reduction Fund. Eligible projects will introduce tidal flows to completely or partially drained coastal wetland ecosystems. This is done by removing or modifying part of a tidal restriction mechanism such as a sea wall, bund, drain or tidal gate. The proposed method would enable projects that store carbon in biomass and soils and avoid emissions through the establishment of coastal wetland ecosystems. These blue carbon projects achieve carbon abatement by: increasing the carbon stored in soil and vegetation and; avoiding emissions from soils as they are rewetted, or as freshwater wetlands are returned to saline wetlands. Projects can earn Australian Carbon Credit Units for the emissions stored and avoided by their project. The method has just completed a public consultation (November 2021)[7].

Applicability to UK managed realignment projects
The findings of the high-level review of the applicability of this existing method to the creation of saltmarshes (in any country) for example by managed realignment, and applicability to the UK geographical context are given in Table A1 below.

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[6] Adam, P., 2019. Salt Marsh Restoration. In Coastal Wetlands (Second Edition) An Integrated Ecosystems Approach, p. 817-861.

[7] Carbon Credits (Carbon Farming Initiative—Tidal Restoration of Blue Carbon Ecosystems) Methodology Determination 2021 DRAFT ONLY https://storage.googleapis.com/converlens-au-industry/industry/p/prj1ac1360fd115354d81046/public_assets/Draft%20Carbon%20Credits%20Carbon%20Farming%20Initiative%20%E2%80%93%20Tidal%20Restoration%20of%20Bl....pdf

Table A1: Applicability of the Australian Carbon Farming Initiative to saltmarsh creation by managed realignment (MR) in a UK setting.

Variable	Evaluation
Conditions of use	Yes, where this requires the removal of tidal restriction mechanisms. The methodology is not specific to Australian saltmarshes, but it would only be applicable in the UK where MR requires removal of tidal restriction mechanisms, and this is not the main cause of saltmarsh degradation and loss in the UK.
Boundaries	Restricted to land where tidal flows have been impeded by tidal restriction mechanisms.
Baseline	Tidal restriction mechanisms have to be in place during the baseline period, and include a hydrological assessment in addition to GHG and above/belowground carbon stock measurements including biomass and soils.
Permanence	Possibly - permanence period can vary between 25-100 years and includes the use of a 25% buffer (discounted to 5% for 100-year projects, if 80-100% of land identified as impacted by the project).
Leakage	No information given
Additionality	No information given
GHG emissions quantification	Based on carbon stock changes before and after tidal restriction mechanisms are removed, based on avoided emissions of CH_4, N_2O and CO_2 compared to the baseline, and any other emissions during the reporting period, and changes in carbon stocks in soil and water calculated using the BlueCAM carbon accounting model. This model was developed for Australian ecosystems and is unlikely to be applicable in the UK.
Monitoring	Some of the monitoring protocols may be transferable. Projects must monitor establishment of the coastal ecosystem and natural disturbance, using one or more of: (a) on-ground observation, evidenced with time, date and geolocated photographic imagery; (b) digital date and time stamped, geolocated imagery; and (c) derived vegetation cover data.

Red	**Amber**	**Green**	**Grey**
Unlikely to work without significant amendments	**Possibility of working with minor amendments**	**Possibility of working in current state / minor amendments**	**Nothing specific noted**

Plan Vivo

Overview
Plan Vivo[8] is a carbon offset standard for forestry, agricultural, and other land-use projects that focus on sustainable development and improving rural livelihoods alongside the provision of ecosystem services. Plan Vivo projects work with rural smallholders and communities, where these groups have secure land tenure over land included in projects, and the standard emphasises participatory design with stakeholders. The Plan Vivo Foundation certifies and issues credits including both forward crediting and verified post-sequestration offsets called 'Plan Vivo Certificates', based on the Plan Vivo Standard, which it manages and periodically reviews in consultation with a Technical Advisory Committee and Stakeholder Groups. The Foundation approves third-party validators and verifiers and registers resellers of Plan Vivo Certificates. The participatory design and ongoing stakeholder analysis aspects and native species and biodiversity enhancement of this approach have applicability to the creation of saltmarsh in the UK.

Applicability to UK managed realignment projects
The findings of the high-level review of the applicability of this existing method to the creation of saltmarshes (in any country) for example by managed realignment, and applicability to the UK geographical context are given in Table A2 below.

A1.4 Discussion

A summary of the two further methodologies detailed in Tables A1 and A2 is presented in Table 1, in relation to their applicability to saltmarsh creation by managed realignment in the UK. This shows the additional methodologies compared against those reviewed by Holehouse et al. (2021). This table takes the eight key technical aspects or variables used in the high-level review and highlights a Red, Amber, Green or Grey status. This allows a quick comparison of the current and potential utility of each method for the contexts needed for any future confirmation/development of a Saltmarsh Code in the UK.

A1.5 Conclusion

Based on the aggregated review of codes, VM0007 & VM0033 seem suitable for use in the UK, and that with some adaptation, Plan Vivo could also be applied in the UK. A future UK saltmarsh Code could usefully draw on aspects of all three, with the integration of useful insights from the other standards we have reviewed. Given that VM0007 and VM0003 are currently being merged, it may be possible to suggest modifications whilst the revisions are being undertaken, before re-evaluating the applicability of the merged standard for application in the UK.

[8] The Plan Vivo Standard for Community Payments for Ecosystem Services Programmes https://www.planvivo.org/documentation

Table A2: Applicability of Plan Vivo to saltmarsh creation by managed realignment (MR) in a UK setting.

Variable	Evaluation
Conditions of use	Only land with secure tenure by smallholders and/or community groups is eligible, which may render many UK saltmarshes ineligible. It was developed primarily for application in developing world contexts, and so need significant adaptations for application in a UK context.
Boundaries	Although there have been applications of Plan Vivo to mangrove conservation and restoration projects in the developing world, there have been no applications to saltmarsh to date. The emphasis on restoration with native species in Plan Vivo is consistent with typical methods of saltmarsh restoration, however the emphasis on social and economic benefits to the livelihoods of local communities as part of Plan Vivo projects is less relevant to UK contexts.
Baseline	A baseline scenario must be provided for each project intervention, describing current land uses, habitat types, existing major ecosystem services provided in the area, and a socioeconomic baseline with information on the socioeconomic context in participating communities at the start of the project, describing how these conditions are likely to continue or change in the absence of the project. Technical guidance applies only to forestry and smallholder agriculture projects.
Permanence	Permanence is managed through a "non-permanence risk buffer" without stipulating minimum permanence periods: "Each project is required to apportion at least 10% (typically 20%) of the carbon services generated as a non-permanence risk buffer, which guarantees the integrity of Plan Vivo projects in the face of inevitable risks to permanence from factors such as a catastrophic loss event."
Leakage	The standard states that, "All potential sources of leakage and the location of areas where leakage could occur must be identified and any appropriate mitigation measures described. Where leakage is likely to be significant, i.e., likely to reduce climate services by more than 5%, an approved approach must be used to monitor leakage and subtract actual leakage from climate services claimed, or as a minimum, make a conservative estimation of likely leakage and deduct this from the climate services claimed." In addition, it states that "consideration of any likely 'knock-on effects' on non-participating communities living in surrounding areas" should be taken into account.
Additionality	Two additionality tests must be met, demonstrating that: 1) Project interventions are not required by existing laws or regulations (unless it can be shown those laws are not enforced or commonly met in practice and the support of the project is therefore justified); and 2) There are financial, social, cultural, technical, scientific or institutional barriers preventing project interventions from taking place.
GHG emissions quantification	Detailed guidance is provided only for forestry and agriculture projects
Monitoring	A monitoring plan must be submitted with the Project Design Document which must be approved by the Plan Vivo Foundation. The monitoring plan includes indicators and targets, methods, frequency and duration of monitoring and how local communities will participate in monitoring.

Red	Amber	Green	Grey
Unlikely to work without significant amendments	Possibility of working with minor amendments	Possibility of working in current state / minor amendments	Nothing specific noted

Appendix 2: Workshop Report

A2.1 Introduction

There is a common consensus on the need to coordinate efforts in the UK to ensure the correct governance structures, financial frameworks, and evidence grade data are in place to build the investor confidence and policy support needed to accelerate habitat creation to combat the twin challenges of Climate Change and Biodiversity declines. Moreover, the potential of blue carbon to mitigate and offset these challenges has attracted considerable interest across multiple sectors, in particularly the carbon stored and sequestered by saltmarsh habitats.

There are now many saltmarsh restoration projects in the UK contributing to mitigating climate change and biodiversity loss, and there is potential for a great deal more if the right mechanisms are put in place. However, the development of a market for carbon offsetting through saltmarsh creation is in its infancy and there is uncertainly around how a code is structured and what data is needed. To this end, an on-line showcase event was organised to introduce the NEIRF Saltmarsh Code project; to present a review of the evidence available to support a code; to show steps required to build an investment case from saltmarsh carbon; and to discuss the recommendations of the NEIRF Saltmarsh Code project and present the next steps. Presentations can be accessed here: https://iucn-nc.uk/projects/ncuk-expert-working-groups/erwg/saltmarsh-code-project/

Following the saltmarsh code showcase a follow-on meeting on measuring and monitoring saltmarsh carbon was held. The need for this meeting was identified at the first UK Blue Carbon Forum Saltmarsh Working Group meeting held in May 2022, hosted by University of Hull and chaired by James Robinson, Director of Conservation for WWT. The meeting brought together experts from across the UK to share the latest information around the blue carbon policy landscape, the GHG Inventory, and the Saltmarsh Code. Following the meeting there has been general agreement that a follow up workshop should be held to agree and standardise methods and instrumentation to measure and monitor saltmarsh carbon stocks and flows, in a way that meets both project specific and national data needs, in addition to contributing to international standards and goals. It was also agreed that standardised and credible data was required for the Saltmarsh Code to ensure investor confidence and verification, and to contribute to the possible inclusion of saltmarsh in the UK GHG Inventory. See agenda in section A2.

Across both meetings 292 participants registered across 97 organisations. Delegates came from all 4 nations of the UK representing Government agencies, global asset management and private businesses, environmental and engineering consultancies, a full range of UK based NGO's and a range of academics from universities and research institutes. Both meetings were hosted and organised by IUCN NCUK (National Committee UK). The afternoon session was supported by the UK Blue Carbon Forum and technology provided by Mindfully Wired.

A2.2 Agenda: UK Saltmarsh Day – exploring the Saltmarsh Carbon Code

Programme – 15th November 2022

1. Opening addresses
Chaired by James Robinson, Director of Conservation, Wildfowl and Wetlands Trust

10.00 Welcome
10.10 Richard Thompson, Deputy Director for Integrated Water Planning, Environment Agency
10.20 Rory Macfarlane, Defra - UK Blue Carbon Evidence Partnership
10.30 James Robinson – Standardised and coordinated effort is needed to provide evidence grade data for: 1) site specific metrics 2) saltmarsh code evidence and validation 3) GHG inventory data for LULUFC model.

2. Saltmarsh Carbon Code showcase

10.45 Introduction to the NEIRF Saltmarsh Code project – Annette Burden, UKCEH
10.55 Evidence review – Martin Skov, Bangor University
11.10 Building an investment case from saltmarsh carbon – Rich Fitton, Finance Earth
11.35 Conclusions, recommendations, and next steps – Annette Burden, UKCEH
11:50 Q and A (25-30 mins)
12.15 Close of morning session

3. UK Blue Carbon Forum workshop – Measuring and monitoring saltmarsh carbon; standardising the methods (Rotating groups facilitated by experts in each field)

13.30 Introduction - Angus Garbutt (UKCEH), Chair, UKBCF Habitat Restoration and Conservation Working Group
30 mins GHGs - Natalie Hicks and Amanda Cavanagh, University of Essex
30 mins Soil processes - Martin Skov, Bangor University; Graham Underwood, University of Essex
30 mins Waterborne inputs/outputs of sediment, and connectivity - Hannah Mossman, Manchester Metropolitan University; Annette Burden, UKCEH

4. Plenary

Feedback from group facilitators and next steps.
15.45 Closing remarks. James Robinson (WWT)

A2.3 Speaker Biographies

Chairing this event is Dr James Robinson, the Director of Conservation at the Wildfowl and Wetlands Trust, based at Slimbridge in Gloucestershire. James is also an elected member of the IUCN National Committee UK Executive and Chair of its Protected Areas Working Group. His previous roles include as the RSPB's Director for Eastern England, Head of Nature Policy, Director for Northern Ireland, and Conservation Manager for Northern Ireland, and at WWT, as Head of Wetland Biodiversity.

Richard Thompson is an environmental scientist with over 20 years' experience in the environmental sector. Currently Deputy Director for Water, Land and Biodiversity at the Environment Agency, he oversees a department leading the EA's water strategy, environmental planning and environmental monitoring portfolios, which includes the Restoring Meadows, Marsh and Reef Initiative (ReMeMaRe) and elements of the Environment Agency's work on Blue Carbon.

Rory Macfarlane is the Head of Ocean Climate Policy at the Department for Environment, Food and Rural Affairs. His role as policy lead sits within a wider multi-disciplinary team, working alongside scientists and economists on critical marine habitats, including saltmarsh, and ocean health and resilience. His work has both an international and domestic focus and he sits on the board of the UK Blue Carbon Evidence Partnership.

Dr Martin Skov is a Reader in marine biology with Bangor University. He researches bio-physical processes that underpin the provisioning of coastal ecosystem services, including natural flood protection, climate regulation and human wellbeing. Martin's work helped set up the world's first 'blue-carbon' trading project: '*Mikoko Pamoja*' in Kenya (https://aces-org.co.uk/). In the Code project, Martin led the systematic reviews on the blue carbon benefits from saltmarsh restoration.

Richard Fitton joined Finance Earth in 2019 and is responsible for managing its ongoing relationship and a diverse range of projects with the RSPB. He is also working on the co-design of the UK Nature Fund (https://finance.earth/uknature/) and has been managing Finance Earth's work in Policy and Advocacy, including the delivery of the Financing UK Nature Recovery initiative (https://financingnaturerecovery.uk/).

Annette Burden leads blue carbon research for the UK Centre for Ecology & Hydrology (UKCEH). She leads the development of the UK Saltmarsh Carbon Code, and is developing a pathway for potential inclusion of saltmarshes into the UK Greenhouse Gas Inventory and national monitoring networks to collect evidence grade data on carbon cycling.

Angus Garbutt is lead for research across the land-sea interface at the UK Centre for Ecology & Hydrology (UKCEH). He is Co-Chair of the UK Blue Carbon Forum Habitats, Conservation and Restoration Working Group and Chair of the UK Saltmarsh Specialists Forum. Angus' work has taken him to all the major saltmarsh complexes in the UK and Europe giving a unique insight into their diversity and cultural setting.

Dr Jo Preston is a Reader in Marine Ecology and Evolution, (https://www.port.ac.uk/about-us/our-facilities/lab-and-testing-facilities/institute-of-marine-sciences), University of Portsmouth and Co-Chair the of UK Blue Carbon Forum Habitats, Conservation and Restoration Working Group. Her research is focused on the interconnected restoration ecology of coastal habitats, particularly oyster reefs, seagrass and saltmarsh.

Dr Natalie Hicks is a benthic biogeochemist, lecturer and course director for Biological Sciences in the School of Life Sciences at the University of Essex. Her research focuses on understanding the carbon dynamics (sediment burial and sequestration; carbon dioxide and methane emissions) of marine sediments, including blue carbon habitats like salt marsh.

Dr Amanda Cavanagh is an expert in plant biology, photosynthesis, and climate change at the University of Essex.

Graham Underwood is Professor of Marine and Freshwater Biology in the School of Life Sciences at the University of Essex. His research covers estuarine ecology and biogeochemistry; from microbial diversity and function, primary production and organic carbon fluxes, to whole estuary budgets and approaches to restoration. He holds a NERC Knowledge Exchange Fellowship; "Delivering Multifunctional Natural Capital Approaches for Future Coasts".

Dr Hannah Mossman is a Senior Lecturer in Ecology at Manchester Metropolitan University. Her research focuses on the ecological development of restored saltmarshes, including investigating how to better replicate plant communities of natural marshes and quantifying how much blue carbon they store.

A2.4 Questions and queries raised in the chat function during the workshop

Initiating questions are numbered, with follow-up responses grouped and indented. Contributions have been anonymised. Text copied verbatim, with minor edits for clarity and referencing to previous questions and threads. There has been no attempt to answer or alter questions following the end of the meeting, however these will be taken forward into the next phase of the Saltmarsh Code development.

1. Why are we calling this a ' Saltmarsh Carbon Code'? As we will here today, so many more benefits than just carbon. This is why the Peatland Code dropped the Carbon as so many greater benefits are also acknowledged from restoring these ecosystems.
    a. The focus of the NEIRF project is on carbon.

2. Need to be clear by what you mean about wider benefits and aspirations to include them. If you want to include them, then you have to measure them, otherwise its potentially meaningless. If you measure in an auditable way then there is a cost implication. There is no specific requirement to monitor the wider benefits in the PC or the WCC - the WCC has a toolkit. Ultimately both of these codes are constructed around the carbon. Standards such as Verra have tools to monitor the wider benefits but delivery is very expensive.

3. Disagree that without measurement wider benefits are meaningless. Stating they are part of the code precludes stacking.

4. What were the views on permanence of Carbon, as we have a locked in sea level rise already before we consider future emissions?

5. Has an assessment been done on how much additional salt marsh we expect to lose if we do nothing over the next 30 years? How much of this salt marsh are we still likely to lose even if we do engage in active restoration work?
    a. Estuaries can fluctuate vertically in response to the tide a long way upstream of the highest saline influence, i.e., the water there is fresh (or of such low salinity that SM vegetation cannot survive).
    b. EA has released latest mapping of saltmarsh extent change. If I remember correctly it shows recent expansion of marshes in England over last decade.

6. How much potential for saltmarsh restoration does the UK have through restoring previously drained/ 'reclaimed' saltmarsh do we have?
    a. There are various estimates for potential area of SM that could be restored. 10k to >300k ha. The latter perhaps over optimistic since there will be constraints when the data is examined at a more local level.

   b. I am involved in two EA collaborative framework directive (CDF) projects on the south coast, which involve restoring previously drained saltmarsh (currently operating as coastal grazing marshland), collectively in the region of 50-60Ha. The main issue in both projects is that if we successfully restore the land and return it to saltmarsh habitat, we then need to identify compensatory habitat for the lost coastal grazing marshland (also designated SPA site for one of the projects). I think this could be a limitation to many potential saltmarsh restoration projects.

7. This (*the Code*) is being promoted at UK level but this is not a level playing field. A much smaller proportion of Scotland's intertidal area was subject to land claim, and a lot of the supposedly restorable saltmarsh is actually potential TIDAL marsh. Highest saltmarsh (SM vegetation) in Forth is 20km downstream of NTL. 18km in Clyde and 16 Km in Tay. There is thus a danger of raising expectations in Scotland beyond the potential for delivery. We do not have a reliable figure for potential restoration to actual saltmarsh in Scotland but believed to be below 1000 ha.

8. Somewhat in line with remark (*2*) above: Existing terrestrial carbon standards are not always fully aligned with restoration objectives, for example extremely difficult/cost ineffective to use them mosaic landscapes, introduction of grazers seen as not beneficial for carbon, working with monocultures is much more feasible than mix of native species. Are there similar conflicts with coastal restoration that are likely to arise with implementation of a saltmarsh code? How large would a salt marsh restoration carbon project have to be to be cost-effective?

9. How many years does it take to a restored marsh to become fully functional burying carbon?

10. Has anyone else done a similar evidence review for other blue carbon habitats, particularly Seagrass?
    a. We've done this for SMMR project ReSOW but not published yet. We are rapidly increasing the measurements we have right now for seagrass.
    b. Finance Earth and Plymouth City council on a Plymouth seagrass NEIRF project - I believe someone has been in contact and we may be meeting soon so discuss more then.

11. How are you able to determine the source of the carbon buried within the sediment, how can you distinguish if the carbon is derived from the salt marsh (autochthonous) as opposed to carbon deposited from external sediment (allochthonous) or are both considered buried by the saltmarsh?
    a. Using stable isotopes and carbon dating techniques can help identify the probable source of the organic carbon found within sediments. eDNA is also an option to get specific genetic sources of material.
    b. Thanks. I was just curious if carbon burial data is categorised as strictly saltmarsh derived carbon that the plants sequester or if it is a generalisation of all sources of carbon both saltmarsh derived and external sediment

deposits that introduce added carbon. Just thought it may be significant to determine how much carbon that is being buried and stored is a directly from the saltmarsh itself.

12. With estuary MR sites, would we be capturing carbon being lost from the hinterland - so would this be counted as a gain or a prevention of loss?

13. The "open" nature of salt marshes makes this allochthonous / autochthonous question much more problematic that say peatlands or woodlands. Salt marshes require tidal exchange, so material naturally moves around. What is the "net" contribution to C sequestration of having X hectares of new SM is what a code would have to price in? The examples in Finance Earth presentation were gross accumulation of C stocks, not new carbon I think. This makes the finance numbers even more challenging?

14. Is there any timeframe on when a saltmarsh carbon code may be published?

15. So we are looking at a usable code by 2025? After the 3 year project?

16. Most coastal saltmarsh restoration focuses on *Spartina* Spp. in the UK. If Carbon stocks are better in *Phragmites* coastal marshes should we also be looking at restoring more of these habitats?
    a. NE do not focus restoration on *Spartina* spp. We aim to restore healthy functioning saltmarshes with a varied species and NVC communities and zonations.

17. If saltmarsh is being restored for statutory compensation, can carbon credits apply?

18. Those £30k to £40k restoration costs, although not that surprising, are quite eye-watering. The Environment Agency will have a massive challenge on its hands to offset its own emissions and show additionality (never mind all the statutory requirements on top). Funding still seems to be a massive issue for us.
    a. I have been doing recreation of saltmarshes for 20 years. The costs do vary and you can find sites where the solutions are simpler but are not common. £40K is the high end. I did one site 20 years ago for £10K
    b. Great to hear you managed to do a restoration for 10k/ha, this level should make it much more investable, if there are any techniques or learnings from how to manage restoration costs please do let me know!
    c. Full restoration costs were not £10k/ha. The investment model cut out land purchase and design costs.
    d. What are the ballpark sequestration values per ha for UK salt marshes?

19. For filling financial gap can you also consider cost savings from managed coastal retreat (i.e. alternative hard engineering costs saved) in either case?
    a. Absolutely and great idea, if you can create a case for costs savings, there are financing mechanisms where you can agree to share in those savings

   and use that share to repay finance. Particularly interesting for risk management authorities responsible for mitigating that risk.
   b. It's important to note that the role that saltmarshes have on reducing maintenance costs of defences very much depends on setting. In exposed (waves) settings they can help. In more sheltered sites already fronted by marshes the impact is much reduce.
   c. Hydrodynamically exposed sites = little guarantee for carbon permanence, so mutually exclusive ecosystem services?

20. These are long-term commitments, beyond contract-holder lifespans and land tenure cycles, how do you address this at contract level?
    a. There are a few options for contracts, from last month conservation covenants were introduced in England, there are burdens in Scotland, and leasehold structures can also work. To incentivize the freeholder, revenue share mechanisms within those leases can make it more attractive.
    b. Ok, that legal conveyancing will enforce agreements on new land owners. But is it not likely that that will lower land value and disincentivise prospective landowners?
    c. that's possible. It could also increase land values by making future carbon credits lower-risk. You also have to ask what future value the land has given it is below sea level, which is rising.

21. Would you not also stack biodiversity net gain onto the carbon gains?
    a. Could this be made stronger by including other ecosystem benefits through stacking, such as with biodiversity net gain?
    b. Stacking - don't think you will be able to stack BNG and Carbon. Need to meet additionally rules. Same for compensatory habitats. #challenging
    c. Great to include wider benefits. As the Climate adaptation benefits form sea level rise particularly are undoubtable as important as the carbon. I'm sure the carbon will drive the funding for a while yet.
    d. The woodland carbon code does allow that stacking.
    e. - does it? On the website they say it might be possible in the future, but at present it is assumed that the wider benefits bundled with the carbon unit?
    f. BNG/Carbon. The WCC says "In England, woodland creation projects established to provide biodiversity credits under Biodiversity Net Gain......are unlikely to be eligible for the Woodland Carbon Code/voluntary carbon credits as their legal agreements are likely to specify that woodland creation is required."
    g. If you apply for EWCO you get the grant for the tree planting, a biodiversity uplift (which can be replaced by BNG) and enter the project in the WCC.
    h. Stacking BNG onto carbon would be great but you would need to pass the additionality tests for both BNG and carbon separately. The details of how to do this have not been confirmed…

22. Notwithstanding the very valid issues you raise with selling PIU's, is there an impact on the financials if you changed your approach and sold everything upfront (or significantly more upfront)?
    a. If you sold everything upfront, theoretically you could fund the entire project without the need for repayable finance. However as noted, it leaves the project extremely vulnerable to cost overruns which puts long term impact at risk.

23. Has Environment Agency been engaged? they have lots of managed retreat/saltmarsh creation projects that would cover creation/maintenance costs, problem is many are compensatory habitat so would these count as a 'gain' in carbon that can be sold as credit?

24. In the UK, huge tax reliefs are still being given to the oil and gas industry. Could we argue for these to be diverted to subsidise marsh restoration and make investment in them as carbon credit schemes more attractive for the private sector?

25. Wondering what would be some additionality considerations with the code, e.g., the two pilot sites are SSSIs, will existing level of protection at sites be a problem for baselines and potential risk for project image?

26. Could we get funding for a facility to be set up in the UK where samples for carbon could be sent to rather than doing in house - funding for this would mean more samples processed and more consistent data

27. Natural or semi-natural (i.e., non-restored) saltmarshes and sediment flats operate in alternative stable states. We know from the paper by Ladd et al that most of the UK saltmarshes are currently in an accretional phase. One day they will be in an erosional phase. By quantifying (including GHG Inventory) or even monetising the value to society of saltmarsh extent, are we in danger of locking society into maintaining saltmarsh extent by intervening in natural processes? 78% of Scottish saltmarsh is designated and as a conservation organisation we would wish to optimise natural processes. There is a danger here of creating an operating climate where this might not be possible due to the high values attached to maximum saltmarsh extent. Should the Code allow for such flexibility?

28. Accretion vs. erosion - as some saltmarshes will be susceptible to climate change impacts, If you develop enough projects at scale across the UK to 'account' (i.e. build ecological resilience) for natural dynamic changes that will take place, perhaps that would potentially help manage this from an overall ecosystem type perspective - admittedly this might make it challenging from an investment at 'site-level perspective' and providing assurance for the market in the long term. Would there be an opportunity to explore this from an overall UK-level saltmarsh (area and resulting carbon) perspective which would provide an additional level of assurance for the overall market to account for any 'failures'?

29. We need to look at the obstacles to delivery. 22,000ha is only possible if we gain significant political support.
    a. There are currently major bottlenecks in the verification body space in the UK - there are only 2 for Woodland Carbon Code and Peatland Code and a big backlog of projects, so we would need to invest in the independent validators and verifiers to enable them to scale
    b. Getting the public on board - as this would be the biggest obstacle - especially when it involves their homes

30. Thinking about scale: what infrastructure is required to help?

31. What about including restoration of existing saltmarshes too not just creating new.

32. Who's Carbon are we off setting? What checks will be in place to make sure this is not preventing real carbon reduction within businesses.
    a. Indeed. Organisations such as EA will be clambering over credits as part of their own targets. Does the 22,000ha cover for the internal targets of organisations trying to meet their own commitments?

33. Re. integrity of the buyers - the VCMI is doing work on this to ensure integrity and credibility of the market

34. There are a lot of non-estuarine marshes in the UK (back barrier, loch head), that will likely fare very differently under sea level rise...
    a. Work by Teasdale et al suggests that even these saltmarshes are matching or even surpassing RSLR, irrespective of GIA.

35. Sediment budget calcs also need to account for future risk related to changes in coastal management policy and agricultural policy, it is not just about now, it’s about in 30-50 years time

36. We need to consider maintenance dredging in rivers/estuaries. Sediment is being dredged and deposited outside of the harbour systems (e.g., Various harbour areas along the Solent), reducing the sediment availability. Sediment recharge via BUDS needs to be used more often.
    a. Agree with the use of BUDS to address the lack of sediment within the system. Increase in saltmarsh area could be to the detriment of mudflats and other intertidal habitats, this needs to be considered.

37. Can we say that saltmarsh creation is a form of carbon capture & storage? Should we modify our language to make it a more attractive investment?

38. Is it a bit of a juxtaposition that (UK) marshes depend so much on external allochthonous (organic and inorganic) sediment input to keep their heads above Mean High Water of Neap Tides but carbon credits should ideally only consider

carbon produced by the marsh vegetation itself? This is the main difference to peat based microtidal US marshes and tropical mangroves which often build on their own organic matter. The reason why global verification schemes won't work in the UK context?

   a. Yes, I am also thinking this (about the external allochthonous carbon) I am feeling confused as to why this aspect wouldn't be prioritised more
   b. I am mystified by the reluctance to include allochthonous input as this is usually generated by the saltmarsh vegetation. Would you include the organic sediments of the Inner Forth, that originated as alluvium from land improvements in the landward catchment?

39. History shows that flood risk management alone is rarely a strong driver. It has to be combined with other benefits - being habitat needs, or carbon, or other benefits.

40. This highlights again the need for a standardised method for sample for carbon in the intertidal.

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