BALANCE

Balance™ Methodology Part Three

Lessons From Nature-Based Solutions

Balance Eco Ltd.

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Contents

Abstract

In recent years, nature-based solutions (NbS) have grown in number, scope, effectiveness and appreciation as perhaps the most comprehensively beneficial methods through which climate mitigation strategies can be performed. With increasing understanding of the many ways in which NbS, depending on context and enactment, can aid in carbon sequestration, creating and rewarding ecosystem services, and accruing social and economic benefits, NbS are increasingly being incorporated within the carbon market. NbS also encapsulate the new opportunity provided by recent growth in climate consciousness, policy and action, providing synergy between biodiversity and social agendas, the joint causes of climate mitigation. Many companies are beginning to make commitments beyond carbon to encompass these causes, and NbS-related carbon offsetting projects are increasing in number and scale; according to the McKinsey Report (2021), NbS now account for around 40 percent of retired carbon credits in voluntary carbon markets, up from only 5 percent in 2010.

'Balance Methodology Part Three: Lessons From Nature-Based Solutions' serves as a review of the recent history of NbS and its lessons for carbon offsetting initiatives, and for organisations wishing to understand the relative benefits of NbS in comparison with previous and competing approaches. In particular, as is discussed in 'Balance Methodology Part One: Balance in Practice and Planting Obligations', Balance has adopted the lessons learned from NbS to create the Balance ethos and the specific focus on biodiversity and the creation of ecosystems as a whole as the most effective, sustainable and resilient form of carbon offset initiative. As such, a detailed history of NbS as a concept is outlined below, with attention to its various forms, its successes, failures and benefits with respect to climate mitigation in general and carbon sequestration in particular. **The purpose of this paper is to provide the reader with an understanding of the critical importance of evolving carbon offsetting to include ecosystem approaches, and for considering social, economic and ecological co-benefits, and, in particular, biodiversity, as essential in the establishment of any carbon offset project.**

1. Introduction

1.1 The Origins of Nature-Based Solutions

The term ‘nature-based solution’ arose, before its official definition, in Europe at the start of the 21st century, in the broader context of the biodiversity extinction crisis [1]1 and the essential need to protect, restore and manage ecosystems. It focused on ecosystem-based initiatives for biodiversity conservation, re-establishment of natural biotopes, renaturing and building corridors between fragmented ecosystems, as well as environmental management, which was influenced by the prevailing approaches for addressing climate change and biodiversity loss at the time when approaches typically relied on engineered inventions such as sea walls and embankments while deforestation and land use change continued to accelerate. In practice, NbS come to encompass a range of practices that vary in the quality and quantity of the services they generate. NbS became an umbrella term to include both some of the most acclaimed projects for climate mitigation and provision of ecosystem services as well as some actions that can instead result in losses to biodiversity or ecosystem vitality because they are far from optimal for climate mitigation outcomes. NbS as a class now encompasses a number of different pre-existing concepts, such as ecological engineering and catchment systems engineering, green-blue infrastructure, natural infrastructure, ecosystem approach, ecosystem-based adaptation/mitigation, ecosystem services, renaturing, and natural capital, all of which promote an integrated approach that considers ecosystems as a whole entity while incorporating human activities and their impacts. A majority of studies have shown NbS to be more effective than alternative approaches in reducing climate impacts. Among 19 cases analysed by Chausson et al. (2020), 12 compared nature- based intervention to engineered approaches, with eight cases showing the nature-based intervention to be more effective.

Officially, NbS was only formally and explicitly defined in 2015 in the European Commission’s guiding document, 2 though several precursors had appeared in the years prior. Initially, the term NbS was put forward in the late 2000s by various international bodies, including the IUCN and the World Bank, as uncovering alternative ‘solutions’ to mitigate climate change, whilst simultaneously protecting biodiversity and improving sustainable livelihoods. Reports in the early 2010s nurtured extensive discussions on the nexus between nature and human wellbeing and served as a field for experimenting with natural elements of the NBS concept. The first high-profile report of this group is ‘EU Research-Natural Hazards and Disasters’, published in 2012 (European Union, 2012), which, amongst a number of other key topics, discussed nature and the function of resilience, defined here as “the ability (of nature) to resist, absorb, accommodate and recover from the effects of a hazard in a timely and efficient manner”. (EU, 2012).

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[1] The biodiversity extinction crisis is still, of course, one the most pressing challenges that the world faces. It is currently suggested that the time window to mitigate mass extinction is three decades at maximum, while the current rate of extinction, to many, suggests that the tipping point has already been reached. cf. Ceballos et al. 2017

In 2014, an important publication by the European Union, named “Biodiversity” (European Union, 2014), based on the concept that humans rely entirely on what nature provides, or ecosystem services, emphasised the importance of international collaboration and increased understanding of designing feasible action plans to slow down biodiversity loss both for its intrinsic benefits and for its benefits to humans. The more significant and consistent promoters of NbS from its early conception have included influential inter-governmental institutions such as the World Bank, the IUCN, and particularly the European Union.

Although the simplicity and width of the concept of NbS is certainly a strength, it has also been cause for general confusion as to what an NbS project should entail. Since 2015, NbS as cost-effective interventions to address biodiversity loss, and, increasingly, the climate crisis as well as both local and global social and economic challenges, have been extensively debated in political and scientific spheres, with the aim of solidifying the definition and conceptualisation of NbS as well as promoting it internationally.

The commonly referenced goals of NbS projects today include restoring and rebalancing relationships between nature and society, constructing and/or protecting resilient and adaptive natural ecosystems, protecting biodiversity, optimising ecosystem services and/or natural resources, more efficiently storing carbon (particularly in the context of forest-based projects, and with reference to carbon offsetting initiatives), revitalising and stimulating business and economy both locally and internationally, as well as improving quality of life, health, wellbeing, and inclusiveness.

In 2020, the European Commission’s definition was updated to further emphasise that “nature-based solutions must benefit biodiversity and support the delivery of a range of ecosystem services” (EU, 2020), a statement which was reinforced by the IUCN (2020). [2] Nonetheless, there is still uncertainty as to what exactly ‘counts’ as an NbS, and the extent to which NbS represent a departure from existing concepts and practices. For the purposes of this methodology, NbS shall be defined as: *actions that are broadly categorised as the protection, restoration or management of natural and semi-natural ecosystems, or the creation of new ecosystems*.

Critically, NbS must deliver benefits both for biodiversity as well as for people, so that NbS can be distinguished from actions that benefit humans but destroy biodiversity, such as commercial forestry and recreational activities, or vice-versa. More recently, focus has been centred on the efficiency and sustainability of NbS, as well as their adaptation to local systems and their mitigation of various social, environmental and economic challenges (Thinknature, 2019).

The various types of NbS projects have been defined and categorised by a number of bodies. For example, the IUCN categorised NbS into ‘ecosystem restoration approaches’ (including ecological restoration, ecological engineering and forest landscape restoration), ‘issue-specific ecosystem-related approaches’ (including ecosystem-based adaption,

[2] The European Commission’s influential 2015 document defines NbS as “solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes and seascapes through locally adapted, resource-efficient and systemic interventions”. See European Commission, 2015.

ecosystem-based mitigation, and climate adaptation services), ‘ecosystem-based management approaches’ (including integrated coastal zone management and integrated water resources management), ‘ecosystem protection approaches’ (including area-based conservation approaches and protected area management) and ‘infrastructure-related approaches’ (including natural infrastructure and green infrastructure). Thinknature (2019) offers three types of NbS: ‘Better use of protected/natural ecosystems’, ‘NbS for sustainability and multi functionality of managed ecosystems’, and ‘design and management of new ecosystems’, all of which might be located in different ecosystems, have vastly different scales and incorporate any of the different facets to differing degrees.

Fundamentally, NbS consist of creation, management, protection, and improved use of any ecosystem type, aiming towards the provision of numerous benefits which, again, vary based on the nature of the project. The key factor in NbS projects of recent years is the establishment, protection or management of biodiversity in the identified ecosystem. Various types of NbS have been created to tackle particular UN SDGs as established by the UN 2030 Agenda for Sustainable Development (2015); for example, ‘green investments’ are linked to SDG 1 for tackling poverty, urban agriculture is linked to SDG 2 for ensuring food security and improved nutrition, natural water retention projects are linked to SDG 6 for the sustainable management of water, climate adaptation strategies can be also linked to SDG 7 for sustainable energy, vegetated roofs and pocket parks are linked to SDG 11 for sustainable cities and communities, afforestation of rural areas is linked to SDG 15 which aims at protecting, restoring, and promoting sustainable use of terrestrial ecosystems as well as SDG 13, and the creation of residential Green Corridors is linked to SDG 16 for the promotion of inclusive societies for sustainable development, as well as to SDG 3.

Forest-based projects are the most common types of NbS, and are most comprehensively discussed, researched, and highlighted within political contexts. Afforestation specifically accounts for 22 percent of the 64 adoption targets included in 30 National Determined Contributions (NDCs) within which NbS are directly included (Seddon, 2020), and by 2020, nearly half (41 percent) of the adaption components of NDCs more loosely referred to forests or woodlands as necessary ecosystems to protect and/or regenerate. This reflects, most evidently, the larger number of forest-related NbS projects from which a more extensive evidence base for their effectiveness in providing ecosystem services and storing carbon, particularly compared with grasslands, montane or marine habitats, which fewer studies have examined in as great detail. In practice, NbS have included established approaches such as ecosystem-based disaster risk reduction, natural infrastructure, green and blue infrastructure, and forest and landscape restoration, as well as the more recently coined "natural climate solutions' (Griscom et al. 2017).

As an additional subset of NbS, ecosystem-based adaptation (EbA) is widely referred to as NbS which targets human adaptation to climate change. This is defined by the Convention on Biological Diversity (CBD) as “the use of biodiversity and ecosystem services … to help people adapt to the adverse effects of climate change” (Seddon, 2020). Examples include protecting natural wetlands and forests in upper catchments to reduce the impacts of flooding downstream; restoring mangroves and salt marshes to protect communities and infrastructure from storm surges and to reduce coastal erosion. Restoration and protection of biodiverse forests are thus EbA strategies as ecosystem services and local alterations to climates as a result of the presence of forests can dampen the impacts of climate change in specific localities, but shall be referred to as NbS in this methodology nonetheless because the primary purpose of such projects is to aid in climate mitigation and various other benefits which are not exclusive to humans and their resilience to climate change.

1.2 Nature-Based Solutions and Modern Policy

As the evidence base for their efficacy strengthens, nature-based solutions are increasingly prominent in climate change policy, with their implementation debated as key to meeting global goals for climate and biodiversity. Of particular importance, the Paris Agreement of the United Nations Framework Convention on Climate Change (UNFCCC) recognises the importance of ecosystems for mitigation and adaptation. It calls on all Parties to acknowledge:

> “the importance of the conservation and enhancement, as appropriate, of sinks and reservoirs of the greenhouse gases,” and to “note the importance of ensuring the integrity of all ecosystems, including oceans, and the protection of biodiversity.” (UNFCCC, 2015)

It then includes in its Articles several references to ecosystems, forests and natural resources; for example, Article 5.2 encourages Parties to adopt:

> “…policy approaches and positive incentives for activities relating to reducing emissions from deforestation and forest degradation, and the role of conservation and sustainable management of forests and enhancement of forest carbon stocks in developing nations” (UNFCCC, 2015).

This evokes the approaches taken by NbS carbon offsetting projects. The prize for integrating NbS into NDCs and SDGs at every level is large; one report suggests that NbS projects alone could yield nearly a third of the emissions reductions needed, or close to 7 $GtCO_2$ per year, by the end of the current decade (McKinsey report, 2021), mainly from avoided deforestation and ecological destruction, but also from reforestation and increased sequestration across many ecosystem types. In the 2019 UN Climate Action Summit, NbS became one of the most discussed topics as an effective method to combat climate change. Following the summit, a "Nature Based Solution Coalition” was created, which included dozens of countries led by China and New Zealand.

The extent to which the rapidly increasing interest in NbS from political and public bodies has translated into high-level national intent cannot be quantified definitively, but a comparative study analysed the prominence of NbS in NDCs submitted to the UNFCCC by signatories of the Paris Agreement (Seddon, 2020). The study found that two-thirds of all NDCs now acknowledge, at the very least, that ecosystems are vulnerable to climate change, with varying degrees of specificity in how climate change impacts biodiversity, its consistency, limitations and geographic distribution. The protection of ecosystems from climate change and direct human impacts such as land-use change is a declared motivation for adaptation planning in 63 percent of NDCs, and was the fifth most frequently mentioned intended outcome of adaptation planning. While some nations aim to address ecosystems directly through a number of declared strategies to optimise their innate value, others instead explicitly state that protecting ecosystems is for the benefit of human communities; for example, Cambodia's main national development priority, enshrined in the National Strategic Development Plan (NSDP) for 2014-2018, calls for: "promoting and improving the adaptive capacity of communities, especially through community based adaptation actions, and restoring the natural ecology system to respond to climate change". (Food and Agriculture Organisation of the United States, 2015)

In total, Seddon found 104 nations which include NbS and/or conservation actions in the adaptation components of their NDCs, with 77 nations including them in both adaptation and mitigation components and 27 nations including them as part of their mitigation plans only. 66 percent of all signatories to the Paris Agreement have thus articulated intentions of working with ecosystems, in one form or another, to address the causes and consequences of climate change. Many of the 104 NDCs that include NbS actions still lack clear, actionable targets for the role of NbS; in total, only 30 of the 104 provide measurable or context-specific targets, with the remainder providing only broad and ambiguous goals, which leaves an uncertain future for NbS in terms of their actual implementation and what can be achieved with their wide scale adoption.

Nevertheless, funding for NbS is increasing rapidly among many countries; in the US, for example, a recent report found that approximately $US133 billion per year currently flows into NbS, mostly through public funding (UNDRR, 2021). Of the public funds, which total $US 115 billion/year, over a third is invested by national governments into protection of biodiversity and landscapes, nearly two thirds of that sum spent on forest restoration and peatland restoration, as well as agriculture, water conservation and natural pollution control systems (State of Finance for Nature, 2021). In the US, it is estimated that investment in NbS might at least triple by 2030 and increase fourfold by 2050, if they continue to be positioned as central to mitigating the anticipated effects of climate change.

Despite their growing popularity, NbS are not equally appreciated across the world. National intentions to incorporate NbS for climate change adaptation vary by level of economic development, region, and ecosystem type, with NbS projects increasingly identified as viable and significant strategies to tackle the climate crisis amongst low-income nations. As opposed to high-income nations, a high proportion of the world's poorest countries; 28 of the 30 nations classified as 'low income' by the World Bank, now ostensibly include NbS as an adaptation tool in their NDCs (Seddon, 2020). All except for 4 of the 47 'least developed' nations, classified by the same parameters, include NbS too, whereas only 9 of the 34 'high-income' nations directly include NbS, and none of the Annex 1 nations include NbS in the adaption component of their NDCs.

The most obvious explanation is that the world's poorest nations, given their more direct associations with the most severe socioeconomic and environmental impacts, at least initially, of climate change, require more urgent and efficient adaptation and mitigation action. Similarly, the discrepancy reflects the larger dependency of the poorest nations on their natural resources and thus the need to protect them. Finally, like the carbon offset projects previously discussed, the economic costs of implementing NbS are comparatively lower and more readily actionable than alternatives to them.

Although high-income nations have not overtly, at least until recently, relied on or adopted NbS for their ecosystem services or climate-related benefits to the same extent as lower income nations, the prioritisation of ecosystem and biodiversity establishment has been bolstered considerably by recent political and academic support in the First World.

The potential of NbS to address the climate crisis is increasingly gathering political and public traction. For example, all in 2019, NbS were highlighted in the Intergovernmental Science- Policy Platform on Biodiversity and Ecosystem Services (IPBES) Global Assessment (IPBES, 2019), the Global Commission on Adoption Report (Global Commission on Adoption, 2019), and the Climate Change and Land Report of the Intergovernmental Panel on Climate Change (IPCC, 2019). At the 2019 UN Climate Action Summit, NbS were included as one of nine key action tracks, with the UN and other national governments declaring their endorsements for NbS.

The extent to which NbS will be incorporated more directly into NDCs, and the extent to which they are acknowledged for both their benefits and carbon storing abilities, remains to be seen. However, current trajectories suggest that NbS projects will far outweigh those which currently exist in only a few years. A prevailing lack of synthesis of the evidence on the effectiveness of NbS for climate change mitigation in comparison with alternative approaches needs to be addressed too, as existing evidence is scattered across disciplines in the physical, natural, and social sciences and is thus not easily accessible to policymakers and decision-makers. A rigorous scientific evidence base is crucial for development of policy and practice on NbS, including further identification of synergies and trade-offs and how they vary across different project types, locations and scales.

2. The Benefits of Nature-Based Solutions

2.1 Biodiversity, Ecosystem Services and Sustainability

Despite a lack of overarching systematic evidence, nature-based solutions, particularly large-scale projects, are widely recognised as capable of providing considerable ecological benefits, such as protection of habitat and species biodiversity, soil and water quality, which in turn entail considerable ecosystem services and ecosystem resilience and longevity. NbS projects, for example, have proved successful in protecting against soil erosion and promoting soil health in cases both where this was the prime objective as well as where it represents just one of many co- benefits.

In China, a combination of afforestation, reforestation and conservation of existing natural forests over 25 years in the Poyang Lake basin halved heavy soil erosion while increasing net carbon sequestration five-fold and net income for local farmers six-fold (Huang et al., 2012). On the Loess Plateau in Northwest China, the restoration of natural shrubland vegetation reduce soil erosion to a far greater extent than low-diversity tree plantations (Jia et al., 2017). This shows the importance of analysing the suitable NbS for specific locations, as soil health can be impacted variously by the presence of different vegetation in different locations; here, soil health was aided by shrublands, whereas in the UK soil health is often more favourable in forested regions.

An influential study produced last year outlined the various ecological and climate mitigation impacts of NbS projects (Chausson et al., 2020), and displays that forest-based NbS have proved largely beneficial in their contribution to reduced soil erosion, biodiversity and ecosystem services. By creating the first global systematic map of evidence of the effectiveness of NbS for contributing to climate mitigation and combating the climate impacts on people and economic sectors, the study catalogues evidence by geographic position, national income group, ecosystems, and type of NbS intervention. In this process, a number of synergies and trade-offs were detected between climate mitigation and ecological l outcomes by analysing various studies which discuss nature-based interventions (in essence NbS before the term had been explicitly defined) published across 168 academic journals in a 30 years span from 1988 to 2018.

The great majority of the analysed studies are quantitative and use biophysical measures. Overall, 34 percent of studies reported on the ecological outcomes of interventions, including effects on plant or animal species populations, diversity of species or habitats, community composition, or habitat quality. Quantitative assessments measured changes in ecological parameters from species to ecosystem scales, including measures of diversity, richness, function, cover, structure, abundance, and indices of ecological resilience. About half of the studies report positive outcomes in relation to ecosystem creation and protection, whereas, in terms of ecosystem creation projects, which are most commonly associated with afforestation or reforestation, only approximately 20 percent reported negative impacts from such projects.

The vast majority of these negative effects were associated with the issue of water availability and/or water quality, even in regions not necessarily experiencing frequent climate hazards, causing trade-offs between water supply and other ecosystem services. However, in all, negative effects were rarely reported independent of correlative positive impacts on, for example, reduced soil erosion, biomass cover, reduced flooding and biodiversity. Mixed ecological outcomes were reported by about a quarter of the studies, and occurred when intervention impacts caused leakage in different locations; for example, when the displacement of drivers of deforestation led to relocation and thus ecological damage elsewhere.

It must also be acknowledged that most of the evidence gathered in this study was reported from large-scale afforestation politics in China, such as the Grain for Green Program, which does not explicitly incorporate biodiversity and its benefits, using primarily fast-growing non-native species which have been shown to reduce water supply and have resulted in a decrease of 6 percent in active forest cover. Accordingly, despite the general positive outcomes outlined, it is likely that the study undersells the positive ecological benefits of the most effective NbS performed today.

NbS have proved successful in contributing to protection against climate and disease-related risks with projects targeting various ecosystem types; for example, restoring and protecting coastal ecosystems can defend against flooding, storm surges and sea-level rise, while restoration and protection of forests and wetlands can improve water security, and reduce risk of floods, soil erosion and landslides (Chausson et al., 2020).

Agroforestry, or nature-based agriculture including the partial rewinding and growth of trees, can increase the resilience of food supplies to pests, diseases and climate extremes, and, as reported by a considerable influx of studies in recent years, urban NbS are capable of aiding in reducing of the Urban Heat Island effect, and contributing to flood mitigation (Marando et al., 2019), although mottled concerns for increase of fire risks have been raised (Thinknature, 2019). Creation of semi-natural water bodies and networks is considered effective to prevent and reduce fluvial and pluvial flooding, coastal flooding, landslides and drought (Browder et al., 2019). Providing protection and enhancing the world's most vulnerable ecosystems is also a task undertaken by NbS, including protecting against dredging of the sea floor, logging, drainage and infrastructure development, which all contribute considerably to reduction of global carbon stores (Tan et al., 2020).

The frequency and intensity of extreme weather events is likely to reduce the functionality and effectiveness of NbS (at least in their present capacity) in the long-term, decreasing the capability of NbS to cope with risk and to deliver benefits (Gómez-Martin et al., 2020). Even if measures to limit temperature increase to 1.5 ºC are successful, some impacts, such as sea-level rise, it is argued, will continue to increase due to the longevity of climate system feedback.

In order to reduce the impacts of climate change on the functionality of NbS, the necessity for NbS projects to be established and to adapt with longevity and resilience in mind, as well as to optimise climate mitigation benefits, is therefore also critical. The sustainability of landscapes is strongly influenced by biodiversity, as functional resilience to stressors such as climate change, invasive species and new pathogens is strongly determined by the connectivity of ecosystems and diversity at multiple trophic levels. Connectivity of similar ecosystems across landscapes enables recovery of disturbed habitats by smoothing the dispersal from surrounding intact areas. Connectivity also allows species to follow their preferred ecological niches across the landscape in response to changing environmental conditions, such as climatic drying or damage to soil health.

While biodiversity boosts the delivery of many ecosystem services in the short term, it also supports the health and resilience of ecosystems in the long term through its ability to build resistance to or quickly recover from perturbations. In the short term, more biodiverse ecosystems have greater productivity in biomass, species diversity and density, and, in general, a higher level of ecosystem service provision (Cardinale et al., 2012). The diversity of species, and their various ecological traits and genes contained within communities of plants or animals acts as insurance against disturbance factors that target individual species or locales, such as diseases and climate change (Alvarez et al., 2019).

It is strongly evidenced, for example, that mixed species forests with high biodiversity indexes have more stable carbon stores during climate extremes, including fires, compared with species-poor forests and monoculture plantations (Osuri et al,. 2020). Biodiversity can also increase crop yields by enhancing soil health and the extension of growth periods (Bender, Van der Heijden, 2015). In order to achieve biodiversity in NbS projects based in forest landscapes, it is widely acknowledged that forest-based NbS projects benefit from the favourable selection of tree species suitable to the regions in which projects are located.

Undesirable trade-offs are more present within projects which select unsuitable and exotic species. For example, systematic global review by Smith et al. (2017) noted that water supply trade-offs were apparent mainly for plantations of fast-growing non-native species, such as pine and eucalyptus, in water-scarce regions, while native broadleaved forests in temperate regions, such as the UK, tended to have benefits for water supply by improving infiltration. Maintaining healthy ecosystems which can continue to deliver ecosystem services in NbS projects thus requires the explicit design of forests, or indeed any ecosystem involved, to protect and enhance biodiversity.

2.2 Social and Economic Co-Benefits

Social and economic benefits, among others, are similarly tied to the multi-functional conceptualisation of NbS. With NbS, healthy, resilient and diverse ecosystems (whether natural, managed or newly created) have been evidenced to provide solutions for the benefit of societies, addressing both climate change and biodiversity loss while supporting sustainable development, the regeneration and improvement of wellbeing in urban and rural areas, increasing sustainability of produced goods and energy use. As such, a large part of the appeal of NbS is their potential to address multiple SDGs simultaneously by harnessing a range of benefits, as evidenced by a rapidly growing range of studies which promote their provision of a wide range of benefits.

A 2020 study analysed the potential of NbS to deliver co-benefits while simultaneously reducing the negative effects of various hazards, hypothesising that enhancing the understanding of the social, economic and environmental factors of the system, including mutual influences and trade-offs, could improve the decision-making process and thereby enhance the capability of NbS to contribute to the achievement of the SDGs (Gómez-Martin et al., 2020). In this study, an NbS is only considered effective if the delivery of environmental, social and economic co-benefits is present and balanced, with minimisation of undesirable trade-offs, meaning that if the increase of a certain co-benefit decreases the delivery of other co-benefits, the effectiveness of this NBS will be reduced. Overall, most studies report at least one broad benefit of NbS in addition to the effect on climate impacts, though few provide in-depth assessments of the social, ecological, economic and climate mitigation outcomes all together. Only 18 percent of studies recorded by Chausson et al., (2020) reported social outcomes of NbS explicitly linked to a specific group of people, and 29 percent reported the economic costs or benefits.

Despite the limited number and scope of such studies, they often report more synergies than trade-offs between the co-benefits found in NbS projects, including climate impacts and broader ecological, social, and climate change mitigation outcomes. Of those which report positive social impacts, quantitative measures are commonplace, and include assessments of different aspects of social vulnerability including adaptive capacity or social sensitivity, employment, equity, or the number of site visits as an indicator of recreational health benefits.

It must also be noted that just because co-benefits have not been examined n in many studies does not mean that benefits or “co-benefits” are absent. Various complex trade-offs and synergies exist which are near impossible to detect, and the limited scale of studies often denotes the reluctant or deliberate leaving out of evidence through limitations to measurement capabilities, time, funds or resources.

Nevertheless, the reporting of social outcomes and economic costs/benefits was particularly prevalent in studies from lower-income nations, perhaps highlighting the elevated capabilities of NbS to facilitate social and economic development in poorer regions of the world. It is widely suggested that NbS have and can foster capital flows, in particular, to forest-rich countries in the Global South in support of sustainable development, with one report suggesting that capital flows greater than $100 billion, providing a considerable incentive for the further growth of NbS (McKinsey Report, 2021).

With all NbS, the potential for job creation and increased monetary value of produced goods in production-based projects, such as agroforestry, can provide economic benefits to participants wherever the projects are located, whether in the Global South or Global North. A report by the British Ecological Society (2021) highlights the ability of NbS, in the wake of the COVID-19 pandemic, to stimulate ‘green’ employment in the short term while supporting sustainable economic growth in the medium term, forming a critical part of renewed investment in economic recovery, and offering sources of income and security which will prove resilient to future stressors as well as climate extremes. In a particularly optimistic estimation, the total social value of carbon requested in the woodlands of the UK is valued at £UK239 per hectare per year, far greater than expected returns for timber production, and NbS is emphasised for its potential role in increasing the value and scale of social benefits. To achieve this, state investment as well as changes in legislative and policy architecture to encourage private investment, both within the UK and around the world, is required, and markets beyond corporate social responsibility must be identified and developed. There is considerable promise in this regard, however, as the acceptance and performance of NbS continue to grow.

In the European Commission’s 2015 report titled “Towards an EU Research and Innovation Policy Agenda for Nature-Based Solutions & Re-Naturing Cities” (European Commission, 2015), the variety of environmental, social and economic challenges facing humanity which NbS can address are comprehensively outlined. Among key ecosystem regeneration and climate mitigation factors, the improvement of wellbeing, enhancing sustainable urbanisation and local economic development are all discussed.

Among potential social benefits of NbS are availability of food and water security, livelihood diversification (e.g., provisioning of non-timber forest products such as medicinal plants and building materials), recreation opportunities, employment, capacity building and empowerment, social cohesion, or issues of equity, discrimination and conflict. Through NbS, and through the enhancement of natural ecosystems, cultural ecosystems might also be enhanced; for example, more species-rich green spaces have been shown to support greater personal physical and mental wellbeing, as a comprehensive amount of local vegetation is an efficient strategy to improve health and quality of life in urban and rural areas with the creation of a variety of attractions, restorative environments and aesthetically inspiring multi sensory landscapes. Also, more visitors are attracted to protected areas with more habitat types and threatened species and/or higher species richness (Siikamäki et al., 2015).

In cities, the presence of nature results in numerous wellbeing and health benefits; Aerts et al., (2018), for example, list a wide variety of evidence-based impacts, such as stress reduction, amelioration of depressive symptoms, and mood improvement while living in close contact with nature. Such contact reduces chances of getting cancer, obesity and type 2 diabetes, as well as boosting our immune systems and helping to avoid allergic symptoms.

Focusing on children, natural places and green spaces provide a great source of stimulation and entertainment. Some studies emphasise that playgrounds with natural elements are preferred over other kinds of playgrounds (Thinknature, 2019, p.67). As such, NbS can contribute to mental recovery in the context of the COVID-19 pandemic by creating restorative spaces to offer physical and mental relief and enhance community cohesion. The provision of spaces for recreation and its creation of links between natural ecosystems, particularly forests, and mental health, is well recorded. Perhaps as a result, the fairly instinctual logic which lends a sense of compulsion to this concept, the term “biophilia” was coined, and was popularised by biologist E.O. Wilson in the early 1980s as shorthand for the idea that humans are innately drawn to and require a connection with nature to live healthy, fulfilling lives. The theory of biophilia is grounded in real science. Studies show that greater access to nature reduces stress, lowers levels of anxiety, and increases cognitive function.

The necessity of spending time among nature became particularly apparent during the recent pandemic as more people spent time in nature benefitting from its restorative effects. Researchers also found that Chicago public housing residents who lived in buildings closer to trees and grass experienced a reduction in aggressive behaviour influenced by noise, crowding, and safety concerns (Prow, 1999). Adding greenery to urban spaces offers a myriad of environmental benefits. Urban tree canopy and green roofs improve air quality, reduce the urban heat island effect, and lower carbon emissions; rain gardens manage stormwater; bird feeders, butterfly gardens, and the addition of native species and wildflowers enhance urban biodiversity. Despite concerns of the conflation between ‘green spaces’ and inherent virtue being an essentially western concept with long historical roots, the inclusion of green spaces is nevertheless net positive in their environmental impact and should not necessarily be ousted as the symbol of an ideal, modern urban life. NbS, in this capacity, have the ability to reduce the degree to which individuals and societies are affected by various stressors, including climate change, and their related impacts, through providing a range of social benefits.

2.3 Inclusivity

The long-term effectiveness of NbS in delivering co-benefits is now increasingly seen as at least partly dependent on the socioecological context in which NbS are applied, meaning that the identification of unnecessary potential trade-offs, for example the increase of carbon sequestration resulting in reduced biodiversity or the increase in resource productivity resulting in decreased social access and cohesion, is necessary in planning stages of the project. The analysis of social trade-offs has often been lacking in past projects; for example, in Kenya, establishing conservancies on grazing lands diversified income sources for landowners from wildlife tourism, but non-conservancy members and the landless, particularly women, were not eligible to receive tourism payments and were negatively impacted by livestock grazing restrictions imposed by the conservancies (Chausson et al. 2020).

In order to increase the likelihood of attaining the social benefits of NbS, it is crucial that local communities are at the heart of projects, because working with local people encourages successful and more sustainable outcomes for the project, while providing social benefits to the community by creating employment in land preparation and enhancing management and rate of project implementation, while providing opportunities to co-learn and develop other sustainable NbS- related enterprises.

It is also important to consider the kinds of social relations that are required to shape a project's decision-making processes, as well as prioritising and identifying the predicted social outcomes while planning a project. Inclusivity in NbS governance has been found to redress inequalities in access to the benefits of projects, with overall positive outcomes arriving when the dominant views about what the project is and whom it serves are acknowledged, as well as when recognising differences in how people connect to and value 'nature' (Tozer et al. 2020).

An emerging research agenda has sought to resolve whether and how NbS, in particular urban NbS projects such as the 'greening' of cities, might actually reinforce existing inequalities or lead to new forms of social exclusion and gentrification. For example, it is debated whether creating 'hypermodern' NbS in affluent urban areas creates new expectations for the socioeconomic stratification of access to urban nature and thus commodifying, at high value, urban-based climate mitigation. Similar debates have occurred around topics such as access to electric or hybrid vehicles, sustainably-sourced foods and sustainable fashion.

To mitigate the further socioeconomic division of NbS and of climate action in society more generally, it is necessary that governance processes support more equitable distribution of secured and long- lasting access to both urban nature and land, as well as more diverse perspectives on which kinds of socio-nature are seen to have value, for whom, in diverse urban contexts. In projects located in the developing world, it has also been stressed that NbS must also be implemented with the full engagement and consent of Indigenous Peoples and local communities in a way that respects their cultural and ecological rights (Seddon et al. 2021), where some NbS projects have gone ahead with worryingly little acknowledgement of the potential concerns of indigenous peoples and their own traditions, preconceptions and understandings of nature, let alone incorporating them into decision making processes.

The removal of boundaries in access to decision making processes as well as economic and social input to NbS projects would allow for greater diversification and spread in social benefits. NbS can also help to build the adaptive capacity of local communities to future stressors if participatory design and management is implemented, as allowing local people to be involved in leadership roles can bolster their ability to comprehend and address future climate hazards.

Complimentary education action can provide further benefits and greater future employment in climate action and involvement in creating adaption strategies. Bolstering community-based management of the NbS project can in turn build social cohesion, which can feed back into the improvement and sustainability of management of the ecosystem to protect the delivery of ecosystem services. NbS programmes must be 'just'; they must prioritise the needs and livelihoods of the vulnerable, perhaps by offering financial support during the wait for benefits to arrive, and must seek to include all impacted communities, not only in labour, but in decision making, regulatory frameworks and in the experience of benefits (Chausson et al. 2020). Balance will incorporate this by facilitating accessibility of NbS projects to small and medium sized businesses, with the resulting social benefits to be experienced by all. Balance will also, as part of our due diligence process, examine every partner project to ensure that issues of inclusivity, equality, and economic benefits are both understood and that mitigation strategies have been implemented, particularly in locations where local communities are relatively disadvantaged. These issues are addressed as one of Balance's planting principles, as outlined in Part One.

2.4 Carbon Sequestration

NbS have altered the understanding and attitude towards ecosystem creation and protection protection for carbon storing purposes, both within and outside the cabin offsetting context. Influential research conducted in 2017 (Griscom et. al., 2017), led by The Nature Conservancy, demonstrates optimistically that NbS can, remarkably, provide up to 37 percent of the emission reductions needed by 2030 to keep global temperature increases under 2°C – 30 percent more than previously estimated; according to the study, of the 30 gigatons (one gigaton is equal to one billion metric tons) of excess carbon emitted into the atmosphere every year, 11 gigatons could be removed using natural solutions through carbon sequestration. While others are less optimistic with regard to the capabilities of NbS to contribute to global targets, it is universally agreed that global goals for mitigation cannot be met without a significant contribution from carbon storage in ecosystems, particularly forests as well as peatlands, wetlands and mangroves.

The long-standing incentives for planting and maintaining monoculture or non-native forests for their greater carbon storing rates, for example, have long obscured the greater mitigation benefits of protecting or reestablishing more stable and resilient carbon stocks which develop within natural forests. In recent years, however, the topic of NbS and, in particular, its underlying propensity for facilitating biodiversity development for increased efficiency and longevity of carbon sequestration, has flourished.

Scientific and political consensus increasingly disputes the benefits of commercial, monoculture forest planting initiatives, and proposes NbS as a potential solution to the problem. While fast-growing single-species plantations, as have been created on enormous scales by a number of high-profile projects, may sequester carbon and reduce vulnerability to particular climate change impacts, their impact is, most often, short term. Their capacity to provide co-benefits and to store carbon in the long term is impaired by creating a deficit of species diversity and sustainability, particularly in the face of rapidly changing climate conditions.

For example, studies have examined the outcomes of large-scale non-native and monoculture afforestation projects in China; while reduced soil erosion and at least initial significant increase in carbon sequestration has been observed (Liu et al., 2008), the plantations have created higher rates of evapotranspiration compared with natural vegetation (Cao et al, 2016), creating shortages in water (Zhang et. al., 2017) and negatively impacting biodiversity (Hua et. al., 2016). Still, however, only 19 percent of studies identified by Chausson et al. (2020) directly reported GHG mitigation outcomes of NbS, with even fewer (13 percent) based on empirical evidence, suggesting that much more needs to be done in academic spheres to monitor and analyse carbon sequestration of NbS.

Those which do report such impacts, however, are largely positive (73 percent), with none reporting exclusively negative effects. In Ethiopia, for example, farmer-managed natural regeneration of 2728 ha of degraded native forests with living tree stumps reduced soil erosion and flash flooding and increased crop productivity, while removing an estimated 870,000 tonnes of CO2 equivalent (Brown et al. 2011).

In spite of the absence of a strong academic foundation, in the context of the growth in popularity of NbS, the understanding of the importance of biodiverse ecosystems as carbon sinks is garnering political traction. The Paris Agreement, for example, states that: “parties should take action to conserve and enhance, as appropriate, sinks and reservoirs of the greenhouse gases, including forests.” (UNFCCC Article 5 2015). Additionally, the role of ecosystem processes in the conservation of carbon sinks is included, “noting the importance of ensuring the integrity of all ecosystems, … and the protection of biodiversity.” (UNFCCC Preamble, 2015)

In the years since the Paris Agreement, however, progress in this regard has been slower than anticipated. Many NDCs, to this day, for example, still include only ambiguous afforestation goals which lack consideration for which, where and why trees are planted, and the necessary considerations for creating sustainable biodiversity. Bolivia states that it will: “increase forest areas with integrated and sustainable community management approaches with 16.9 million hectares in 2030, in reference to 3.1 million hectares by 2010,” while Burundi states it will increase “forest cover by 20 percent by 2025” (The World Bank, 2018). Mongolia includes an intention to increase forest area:“to 9 percent by 2030 through reforestation activities” (NBSPP, 2020). Meanwhile, only 31 nations include intentions to improve ecosystem resilience, with none outlining how this might practically and logistically be achieved, and only two NDCs, Jordan and Rwanda, explicitly linking biodiversity with ecosystem resilience. None at all directly reference the link between biodiversity and carbon sequestration in NbS for climate mitigation purposes.

Of particular importance to the potential of NbS to reach their potential is the longevity and stability of carbon sequestration afforded by NbS forest projects and their support for biodiversity. The stability of forest ecosystem carbon sinks depends on maintenance of ecosystem integrity in terms of the ecosystem's structure, composition and functioning which includes its resistance to external pressures, resilience (i.e. capacity for self-regeneration following perturbations) and adaptive capacity; all of which are addressed and protected in the most beneficial NbS projects. NbS can also increase the size of effective land and ocean carbon sinks through their protection and regrowth of intact ecosystems, as well as the creation of new native vegetation cover and the more sustainable management of worked lands such as plantations and pastures (Busch et al. 2019). According to de Lamo et al. (2020), conservation actions in areas rich in both carbon and biodiversity were recently estimated to secure nearly 80 percent of the potential carbon stocks and 95 percent of the potential biodiversity benefits that would be achievable if either carbon or biodiversity were prioritised alone, highlighting the importance of biodiversity particularly within areas of high carbon storage and the high potential of NbS projects focused on biodiversity in carbon-rich areas.

Overall, evidence is varied on the total contribution of NbS to climate mitigation through carbon sequestration, and rely on a number of factors, such as the extent to which NbS are constrained by economic or political feasibility, their potential scope, the projected growth of NbS, land rights and local needs, and resilience from various industries to increased NbS implementation.

Despite these sources of uncertainty, an influential oft-cited statement regarding NbS has been circulating in business and policy discourse: decreasing sources and increasing sinks of GHGs through NbS have the potential to provide around 30 percent of the cost-effective climate mitigation needed through to 2030 to achieve the targets of the Paris Agreement. However, this statement is not always accompanied by the essential caveat that this potential can only be achieved in tandem with the decarbonisation of the global economy at unprecedented rates.

A more recent estimate modeled the extent to which NbS could limit peak warming this century, suggesting that the most significant contributions for avoiding emissions of CO2 come from protecting intact ecosystems, while the greatest potential for growing the global carbon sink comes from restoring native forests and wetlands, cited at 2 Gt CO2 per year (Girardin et al, in press), with the total mitigation potential of NbS projects on land is cited at around 10 Gt CO2 per year, allowing for potential reduction of peak warming of up to 0.1ºC in the 1.5ºC scenario. In order to allow for the development of scientific understanding on how such results might be continually achieved, accounting for carbon stocks and flows in the planning and performance of projects must integrate an accounting for biodiversity in its multiple roles as ecosystem services and carbon sequestration.

At the moment, accounting approaches are typically based entirely on flows of carbon (net flows including emissions and removals), that obscure the mitigation benefits of stable and long-lasting carbon stocks which develop within biodiverse ecosystems. As observed by Keith et al. (2021), the focus on carbon flows creates the image that all that matters is immediate or medium-term removal of emissions, favouring the creation and maintenance of young, fast-growing forests. It is also important to disentangle the carbon created by short-term, less sustainable forests and the long-term, stable carbon sinks created or maintained by a number of NbS projects, such as Balance.

While carbon quantity is currently the only barometer of carbon removal projects, carbon quality, including the extent to which the carbon contributes to the various co-benefits of NbS outlined above, as well as longevity and ecosystem stability, will create far more useful and promising outcomes for climate mitigation, particularly in the context of the carbon market and carbon offsetting. As such, NbS should be explicitly designed to provide measurable benefits for biodiversity.

Given the significant and critically under-explored potential of a great variety of ecosystems for carbon sequestration, including grasslands, coastlands and marine habitats, it is also necessary that NbS should involve a wide range of ecosystems while maintaining efforts in forest ecosystems. In all, then, NbS might increasingly be redefined based upon evidence and conceptions of ideal practice to increase specificity and scope. Perhaps they might now be summarised as actions that are underpinned by biodiversity and designed and implemented with the full engagement and consent of Indigenous Peoples and local communities; as such, people and nature, together, can co-produce a variety of outcomes which benefit society, and which can, in turn, support ecosystem health and enhance ecosystem services. To qualify as an NbS, perhaps, a project must evidently and sustainable create at least one benefit for people while causing no loss to biodiversity or ecological integrity.

It is necessary to add the caveat used with all carbon offsetting projects, which is to say that NbS by themselves are not a panacea for meeting Net Zero by 2050 targets , and cannot be viewed as a substitute for the emissions reductions required across sectors and within companies. It is also important to avoid the assumption that all NbS are designed, even in part, to reduce atmospheric GHG levels; some NbS, including forest and peatland restoration, are valuable because they reduce emissions, and other NbS can help to offset emissions that cannot feasibly be reduced by economic, behavioural or technological change (British Ecological Society, 2021,), while some projects can provide very little or no benefits for carbon sequestration, and instead help with adaption to climate change or climate risks. The best-executed NbS, however, will simultaneously provide such benefits as well as social, economic and, most importantly, biodiversity benefits. Either way, it is essential for NbS to be implemented at a large scale to deliver sufficient benefits for climate mitigation.

2.5 The Future of NbS

The future presents considerable promise for the increasing relevance and performance of NbS to global climate mitigation goals. Further research into the potential role of NbS is regarded as high priority by a number of international bodies; the EU’s ambition, for example, is to position Europe as the world leader in NbS Research and Innovation, implementing NbS by identifying innovative approaches and best practices, as well as in a global market. Considerable efforts have also been made by the European Commission and Horizon 2020 (Research and Innovation) projects that span the period from 2012 to 2020 (Davies et. Al., 2021).

There are areas for further NbS research and innovation, however, particularly in respect of mechanisms for delivery of NbS and policymaking as well as the potential of NbS as a socio-environmental instrument. The recently launched EU project “Horizon Europe”, the successor to Horizon 2020, promises to integrate NbS further with global understanding of climate change. In the case of the United Kingdom, there is potential for post-Brexit proposals, combined with long-term targets (e.g. Net Zero for greenhouse gas emissions by 2050), to create a favourable environment for adopting NbS and for stimulating private and public investment. Increasingly, multiple interests are involved in the governance of NbS across a variety of scales, and challenges associated with working across different policy areas, as well as the generation of effective partnerships, are being addressed (British Ecological Society, 2021).

Nevertheless, achieving collaboration requires mechanisms that can build the necessary social capital and help normalise NbS environmental management within the land and marine management communities, and in local communities and societal beneficiaries of NbS. Among these bodies, there remains a range of attitudes towards the necessity of NbS, the prioritisation of biodiversity, carbon sequestration of co-benefits of NbS, as well as methods of management and the requirements and means of climate change adaptations and mitigation. State governance, in every country must be involved for the effectiveness and scale of NbS and the necessary enforcement of relevant regulations to be realised.

Similarly, it is argued, an assessment framework for NbS that enables transparent assessments at multiple spatial scales and through multiple phases to incorporate all types of NbS projects is needed, and is vital to successful monitoring and consistent updates to best practice (British Ecological Society, 2021). Existing assessment frameworks, such as the Strategic Environmental Assessment Regulations and the Environmental Impact Assessment Regulations, should be evaluated and adapted to ensure they are able to assess NbS initiatives. With the right frameworks in place to optimise the performance of NbS, and with sufficient long-term investment, research and monitoring, they can make a significant contribution to all national and international commitments. It is highly likely that NbS will emerge in this regard this decade, particularly for its role in contributing to sustainable economic growth as part of the “green recovery”, and the carbon market is positioned to benefit from this development. Without investment in nature, and the increasing scope of NbS, there is no clear path to deliver effective climate mitigation. Balance will play a role in this by providing NbS projects to the voluntary carbon market, and with our understanding of the necessary implementation strategies for effective and sustainable reforestation projects, we have set the marker for other offset providers to follow.

3. Conclusion: Learning from NbS

The journey of NbS has seen scientific and political momentum growing annually, with increasing understanding and experience of the various co-benefits which NbS provide. While this must continue through processes of multi-level government policymaking to embed NbS strategies more firmly within NDCs, and through the promotion of the delivery of co-benefits through NbS, it is also critical, considering the parallel growth of the carbon market with that of

NbS, that carbon offsetting adopts lessons learned from NbS to create both higher quality and more sustainable emissions reductions, while simultaneously creating and protecting biodiversity, optimising ecosystem services and various other co-benefits. While trade-offs and synergies of the co-benefits must also be acknowledged and incorporated into planning and execution of NbS projects, and while NbS, like carbon offsetting, should not simply substitute for the rapid phase-out of fossil fuels, it is clear that they are primed to play a key role in climate action in the coming decades by increasing increase the size of land and ocean carbon sinks and providing multiple co-benefits, including more efficient and sustainable carbon sequestration on a global scale. The ability of NbS to contribute towards socioeconomic levelling, particularly in developing regions of the world, enhancing employment, mental health and social cohesion in local communities, and their potentially vital contribution to combating the global biodiversity crisis, seems increasingly apparent.

For this to occur, it is essential that the right data, systematic analysis and the capacity and expertise to interpret and find solutions to improve NbS is improved, which requires an increase in funding and investment, as well as more employment opportunities for specialists within the NbS field, and a collaboration between the private and public sectors both nationally and locally while ensuring validity and uniformity of assessment frameworks beyond narrow sectoral interests.

In the UK, for example, current planning systems for NbS are fragmented, with multiple bodies governing different sectors, which does not benefit the strategic design and cross-disciplinary approaches which successful NbS delivery often requires. Particularly in recent years, a number of interdisciplinary and evidence-based planning approaches have emerged, and aim to target biodiversity conservation while promoting the sustainable use of natural resources with equitable sharing of the potential co-benefits, including climate change mitigation, but much more needs to be done to create a uniform framework by which NbS can be compared and the most effective NbS can be identified.

Included in this is the improvement and homogeneity of techniques for measuring carbon sequestration, which, at this time, are predominately context- specific and differ between ecosystem types, and thus are rarely used for evaluating wider environment management or large-scale monitoring and surveys. What is beyond doubt is that NbS are being elevated both politically and economically as a key component both of the effort to reduce and sequester carbon emissions, and of the necessary campaign to combat biodiversity loss. International focus on these twin crises, as well as the necessity to provide as many co- benefits as possible, is still growing, and governments and companies are making bolder commitments. The time has come, therefore, to scale up NbS within the carbon market framework and turn these commitments into further action. This, in essence, establishes the framework from which Balance has conceptualised its biodiversity and ecosystem-centred carbon offsetting approach, and has constructed its Planting Principles. With the lessons learned from NbS in mind, Balance will hopefully, in time, evolve the way carbon offsetting is performed.

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