Using Nature-Based Solutions to Tackle the Climate Emergency and Biodiversity Crisis

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CIEEM

THE CHARTERED INSTITUTE OF ECOLOGY AND ENVIRONMENTAL MANAGEMENT (CIEEM) IS THE PROFESSIONAL BODY FOR ECOLOGISTS AND ENVIRONMENTAL MANAGERS WORKING TO MANAGE AND ENHANCE THE NATURAL ENVIRONMENT IN THE UK AND IRELAND.

We, like many other organisations, recently declared a climate emergency and biodiversity crisis. In doing so we recognise that these crises are inextricably linked and cannot be addressed in isolation , and nor can they be fully understood without reference to social issues. We acknowledged that nature-based solutions, which our membership are well placed to instigate, must play a key role in mitigating against, and adapting to, climate change, and reversing ongoing declines in biodiversity. This briefing sets out what nature-based solutions (NbS) are and why we should use them.

What are Nature-Based Solutions?

The International Union for the Conservation of Nature (IUCN) defines NbS as "*actions to protect, sustainably manage and restore natural or modified ecosystems, which address societal challenges [such as food security, climate change, water security, human health, disaster risk, social and economic development] effectively and adaptively, while simultaneously providing human well-being and biodiversity benefits*"[1]. The IUCN has grouped the NbS approach into five categories[2]:

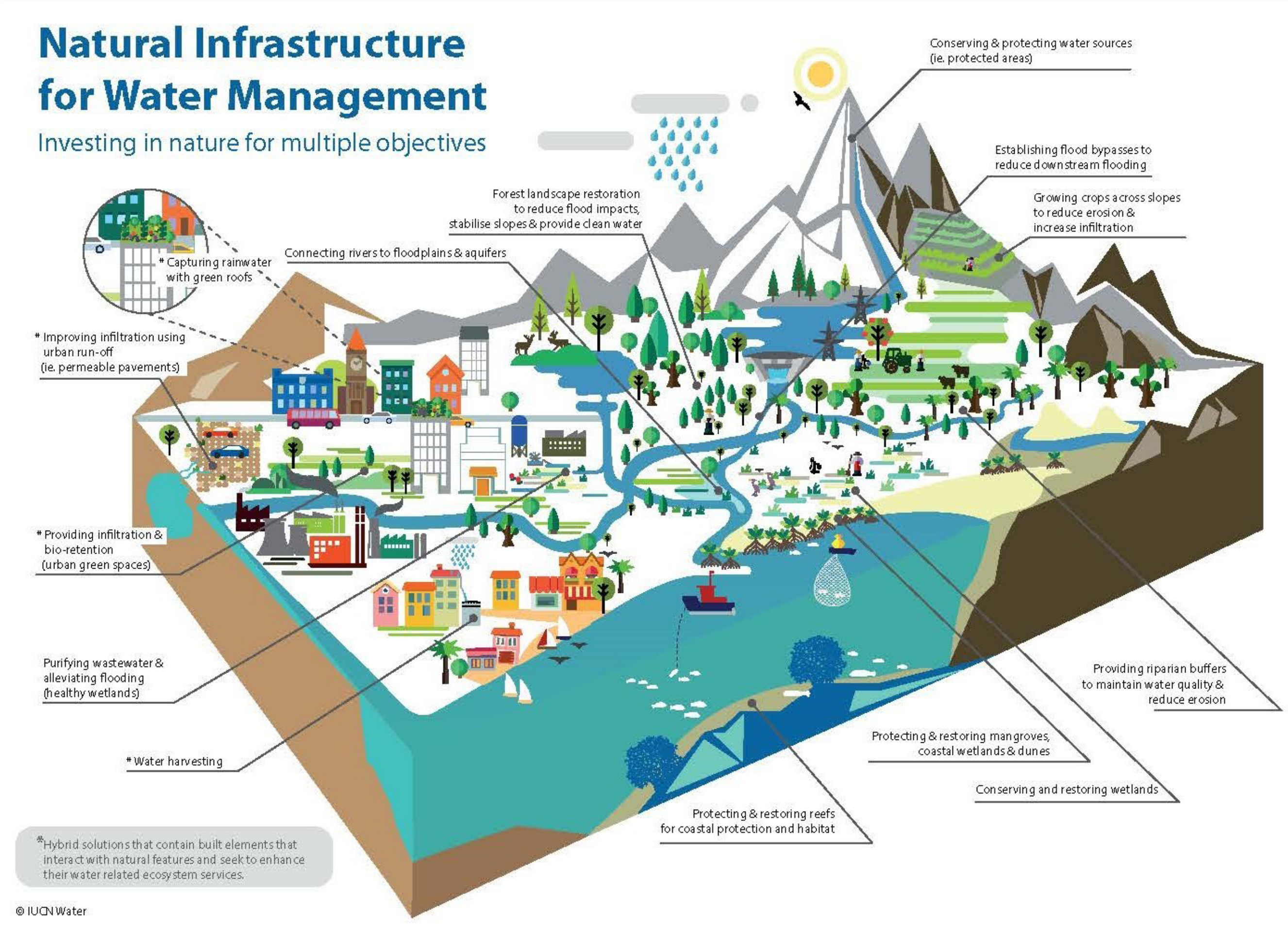
- Ecosystem restoration approaches: ecological restoration, ecological engineering and forest landscape restoration
- Issue-specific ecosystem-related approaches: for example, climate adaptation
- Infrastructure-related approaches: green infrastructure and natural infrastructure
- Ecosystem-based management approaches: integrated coastal zone management and water resources management
- Ecosystem protection approaches: area-based conservation

There are slight variations in the definition of NbS, for example, the European Commission (EC) has developed its own definition which varies in that the core of IUCN's definition is to

make use of existing natural ecosystems and manage and restore them, while the EC definition also promotes constructed solutions supported by nature[3]:
"*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*"[4].

Examples of NbS include restoring habitats such as peatlands, woodlands and kelp beds to absorb carbon dioxide. Creating and restoring wetlands also works to protect against flooding; and creating green and blue spaces in urban areas can also combat urban heating and enhance human health (see Figure 1 for example).

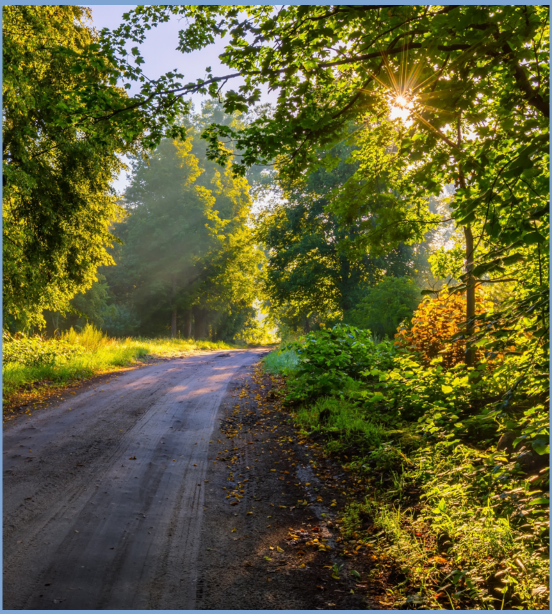
NbS for the current climate emergency need to increase carbon sequestration by improving existing habitats and/or creating different habitats to combat rising greenhouse gas emission levels. Consideration should also be given to the timescale of habitat creation as initially there may be a rise in green house gas levels, for example wetlands can produce methane when land is initially flooded. However, over the longer-term, these habitats will store carbon.



Source: IUCN (as part of 'WISE-UP to Climate' project). See http://www.iucn.org/theme/water/our-work/wise-climate

Figure 1. Functions of ecosystems for water management. Reprinted from Cohen-Shacham et al. (2016), p. 21.

Soils also play a significant role in carbon sequestration and storage due to the burial of organic matter and storage of carbon in root systems. The extent of the organic matter content, in the form of humus, depends largely on the above ground habitat and management[5]. Studies have shown that conversion from farmland



to grassland and species-poor to species-rich grassland can significantly increase the soil carbon sequestration rate[6]. The net impact on both carbon sequestration and biodiversity should be considered fully when creating new habitat.

Similarly, healthy fungal networks in soil are essential as they account for a large proportion of carbon sequestration and storage in the soil. These fungi can be depleted by contaminants such as pesticides and nitrogen pollution which can reduce their abundance or viability and increases soil bacteria which could potentially degrade soil more rapidly and release carbon.

Creation of habitat, whether it is grassland, wetland, woodland or other high value carbon sequestering types, will increase soil carbon on previously degraded soil or bare ground. However, to provide these benefits into the future, the habitat needs to be maintained.

Do They Work?

Evidence of effectiveness to support the use of NbS can be found worldwide. The Nature-Based Solutions Initiative, based at the University of Oxford, has developed an Evidence Tool which draws together global scientific evidence of the link between NbS and climate change adaptation outcomes[7].

In 2012, Natural England conducted a review of carbon storage values by habitat and how different management options may impact sequestration or loss of carbon by habitat[8]. Similarly, in 2019 the Office for National Statistics published ecosystem service accounts, on behalf of the Scottish Government, which estimate the quantity and value of services being supplied by Scottish natural capital, including carbon sequestration[9,10]. This evidence can be used when considering land-use change for NbS. This research should be coordinated across Great Britain and the island of Ireland to provide comparative measurements as carbon storage values will vary considerably depending on local climate and water availability.

Woodland Restorat on and Tree Planting

Increasing tree cover is widely recognised as an effective method of increasing carbon sequestration and storage. The Committee on Climate Change recommends that UK forestry cover should be increased from 13% to 17% by 2050[11] and the

target in the Republic of Ireland is to increase cover from 11% to 18% by 2050[12]. However, there are additional considerations that need to be made.

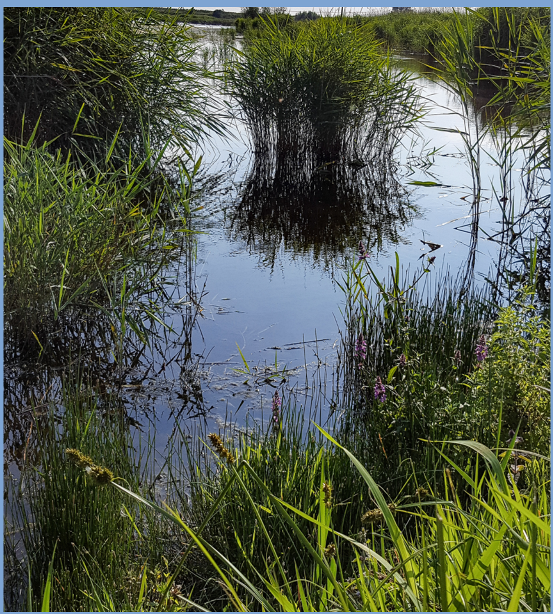
Carbon storage needs should be balanced with other objectives, for example, protection of biodiversity. Conifers can sequester and store more carbon in the short to medium term due to their fast-growing nature. However, evidence suggests that in the long-term, native oak and beech species store an equal or greater amount of carbon[13] and can provide additional benefits for biodiversity. Any planting should follow the principle of 'the right tree in the right place', i.e. using native species of local provenance where possible and avoiding 'planting up' of key open habitats that are not only important for biodiversity, but may also have a higher carbon capture capacity. Any tree planting programme on existing habitat should be subject to an Environmental Impact Assessment.

Management techniques have a significant impact on a woodland's ability to store carbon. Natural England's review shows unmanaged forest nature reserves have higher carbon stocks than combined objective forestry. Comparatively, coppiced woodlands will have lower carbon stocks that unmanaged woodland if the felled stems are removed from the site. However, coppicing and leaving deadwood can benefit biodiversity through habitat provision[14].

Woodland expansion and restoration can also provide additional ecosystem services, such as the regulation of water, mental and physical well-being, and soil protection[15] which can ultimately achieve the objectives of several public bodies and foster partnership working. For example, tree planting is often used to reduce nitrogen pollution of water courses on agricultural land. Nitrogen losses from woodland are lower than agricultural land and nitrate deposition to woodland is higher than it is for shorter vegetation[16]. This can have benefits for freshwater biodiversity, water regulation and carbon storage.

Peatland Restoration

Peatlands have been referred to as the most efficient store of terrestrial carbon[17]. However, when degraded, they can act as a source of greenhouse gases, reduce water quality and have reduced biodiversity. Research has found that re-vegetation of eroded peat can result in significant and rapid reductions in sediment and particulate organic matter downstream (within five years)[18]. Improved water quality has also been measured where drainage systems of peatlands have been blocked to



allow re-wetting of the habitat. This has been linked to higher biodiversity and abundance of freshwater invertebrates[19].

Evidence has shown that converting drained blanket bog back to intact blanket bog can result in absorption of approximately five tonnes of carbon dioxide equivalents per hectare per year[20]. Stopping peatland degradation through re-vegetating and blocking drains and gullies also stops the loss of stored carbon which represents a reduction in carbon dioxide production into the future.

Coastal Protection

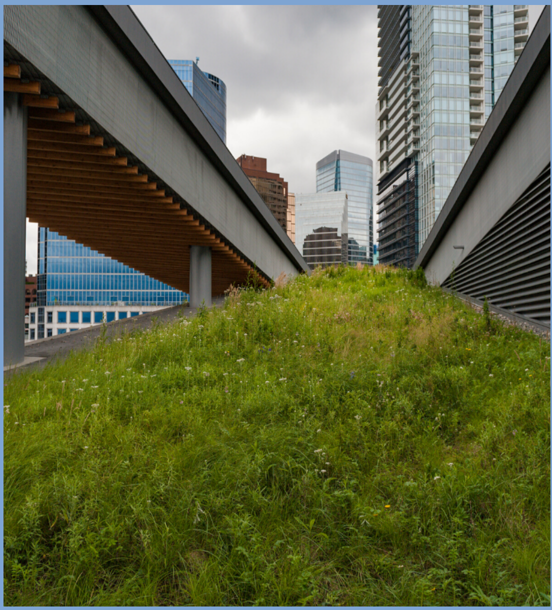
The restoration of coastal habitats such as salt marshes and mud flats offers significant benefits for biodiversity such as wading birds. The provision of these habitats and managed retreats from the coast (coastal realignment) are also valuable in reducing storm surges and, therefore, the risk of flooding.

Cohen-Shacham *et al.* (2016) outline a case study in which a managed realignment project in the Solent, England, shows how careful realignment of a river can have significant beneficial impacts for flood protection and wildlife. A partnership of residents and statutory bodies was formed to implement a managed realignment at Medmerry in the Manhood Peninsula due to ongoing issues with flooding in the area. A Habitat Creation Working Group was also formed, and the RSPB helped to manage impacts on birds. Construction was completed in 2013 and, despite that winter being one of the stormiest in 50 years, there was no significant damage. Previous storms of similar scale had caused up to £6 million in damage. Monitoring also shows the site has been successful in conserving intertidal mudflat and saltmarsh habitat and it is being occupied by birds, water voles and fish[21].

In addition to protection, salt marshes, mudflats, corals and sea grass can act as significant carbon sinks and stores[22]. There is, however, evidence that restored areas do not retain deposited material as effectively as natural ecosystems and so they may not match the full functionality[23]. A continued focus should be on maintaining and protecting existing ecosystems wherever possible.

Flood Protection

NbS can also be implemented to reduce inland flooding. This can be in the form of floodplain meadow or wetland protection and restoration, restoration of river meanders, planting of hedgerows and trees to slow water flow, and Sustainable



Drainage Systems (SuDS). SuDS, for example, use a mixture of assets, such as green roofs, permeable paving and retention ponds, to mimic the natural drainage of water through a site. In some cases, these have been shown to have lower whole of life costs than traditional systems[24] and can enhance biodiversity, help to meet water efficiency targets and reduce flooding risk[25].

These benefits have also featured significantly in the discussions surrounding rewilding. For example, Keestra *et al.* (2017) outlined the results of rewilding abandoned agricultural land in Slovenia, which improved soil function in terms of organic matter content and stability, and reduced flood risk in the area[26].

Urban Living

Many studies have demonstrated that natural environments in urban areas can provide health-related benefits, including heat reduction, reduced air pollution, stress reduction, water management, increased physical activity and improved mood[27]. A review of the cooling effect of urban greening found that, on average, parks can be almost 1°C cooler in the day compared to neighbouring built-up areas[28]. In addition, biodiverse green space can have economic benefits due to increased attractiveness for housing and tourism[29].

Green Versus Grey

Despite the benefits evidenced by NbS, there have been relatively few studies directly comparing their use to artificial alternatives. Vineyard *et al.* (2015) showed that the use of rain gardens in a residential area in Cincinnati reduced costs by 42% compared to a typical detain and treat system, as well as providing a 62-98% environmental impact reduction over the lifecycle of the project[30]. Additionally, studies have shown that green roofs can create a more constant internal temperature than conventional roofs[31].

Morris *et al.* (2018) reviewed evidence for the effectiveness of nature-based coastal protection (saltmarshes, sea grass beds, mangroves etc.) versus artificial protection (breakwaters and seawalls)[32]. The evidence suggests that restored coral reefs, mangroves and dunes can be at least equivalent to artificial structures at maintaining or building the shoreline. The researchers also recommended that cost-benefit analyses should consider all ecosystem services provided, not just coastal protection and urged the need for further direct comparison.

It is essential to take a 'whole-ecosystem-approach' when implementing NbS. Traditional 'grey' infrastructure may well offer immediate solutions and use less land. However, NbS can offer more effective and resilient solutions in the long run and have been shown to be cheaper in many cases (Figure 2) [33,34]. Grey infrastructure, such as drainage systems in cities, often only provide one service and can struggle to meet increased pressures such as more frequent and intense storm events, causing further issues[35].

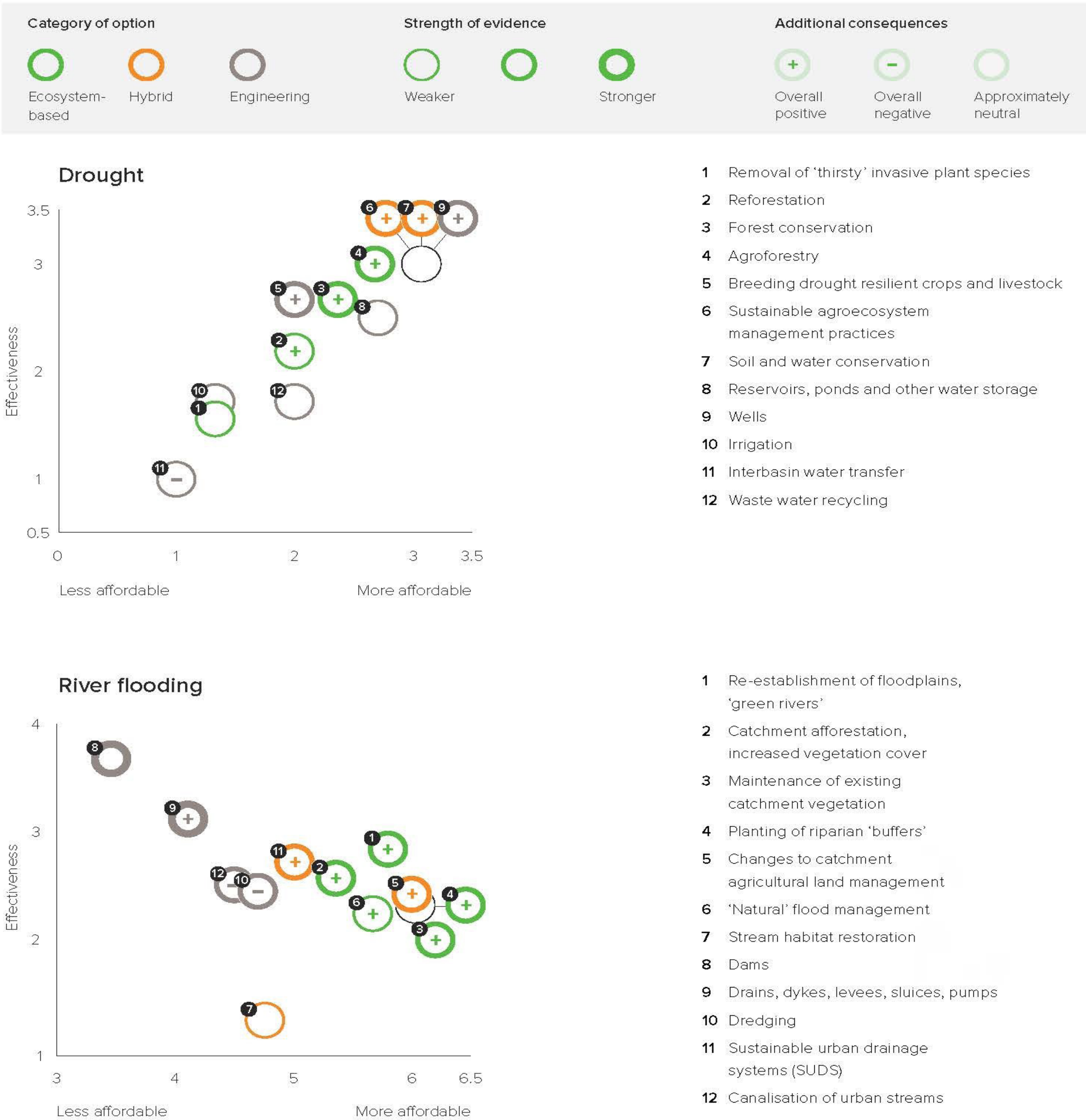


Figure 2. The effectiveness, affordability, strength of evidence and additional consequences of different options designed to reduce the impact of drought and river flooding. Reprinted from The Royal Society (2014, p. 61). ©Royal Society 2014.

Implementation

The Intergovernmental Panel on Climate Change (IPCC) has recognised the need for NbS to form a significant part of the response to the climate emergency. However, they have also warned that some types of NbS, such as afforestation, could have adverse effects on other Sustainable Development Goal areas including biodiversity and food security if appropriate scale and land type are not considered fully[36]. Opportunity mapping and modelling should be used to identify optimum land type and area scale, which can then be implemented as part of a strategic plan, for example, the Nature Recovery Network[37] in England, the Local Nature Partnerships in Wales[38] and the master planning approach championed by Scottish Natural Heritage[39].

Each site considered for NbS must be assessed individually, and in its landscape context, so that appropriate action can be taken. The climate emergency and biodiversity crisis must be addressed in tandem and, if properly implemented, NbS can provide an effective and economic tool. As such, ecosystem services afforded by NbS should also be considered in Cost Benefit Analyses.

In addition, one of the keys to implementing NbS successfully is ensuring buy-in from all stakeholders, particularly landowners and the local community. This is best achieved by developing projects with stakeholders from the outset, for example the Maharees Conservation Association in Co. Kerry, Ireland, was formed by the local community to design coastal management solutions with advice from academics[40].

The IUCN are currently working on a global standard which will allow users to design solutions, verify projects and upscale pilot projects[41]. This standard will further increase the effectiveness and quality of NbS, provided they are implemented by appropriately qualified ecologists and environmental managers. The IUCN and Commission on Ecosystem Management have also developed eight core principles to help with the implementation of NbS. These state that NbS:

1. embrace nature conservation norms (and principles)
2. can be implemented alone or in an integrated manner with other solutions to societal challenges (e.g. technological and engineering solutions)
3. are determined by site-specific natural and cultural contexts that include traditional, local and scientific knowledge
4. produce societal benefits in a fair and equitable way in a manner that promotes transparency and broad participation
5. maintain biological and cultural diversity and the ability of ecosystems to evolve over time
6. are applied at a landscape scale

7. recognize and address the trade-offs between the production of a few immediate economic benefits for development, and future options for the production of the full range of ecosystem services
8. are an integral part of the overall design of policies, and measures or actions, to address a specific challenge[42].

What We Are Doing

In 2019, we launched a working group on the climate emergency and biodiversity crisis called Action 2030. The Action 2030 group is working to:

- Challenge and provide advice to CIEEM on achieving net-zero carbon emissions by 2030 in all of its operations and activities.
- Identify means by which CIEEM can lead change to professional practice to reflect opportunities to address the climate emergency and biodiversity crisis.
- Provide information and advice to members on how they can help to address the climate emergency and biodiversity crisis through their professional work.
- Promote the use of NbS to address the climate emergency.
- Build relationships and share knowledge with other relevant climate emergency and biodiversity crisis working groups.

Our members are at the forefront of implementing NbS so we will continue to provide support in this area. We will be publishing blogs, *In Practice* articles and webinars, and will be holding Member Network events in the coming months to showcase this advice.

References

1. World Conservation Congress (Year) WCC-2016-Res-069-EN: Defining Nature-based Solutions (1-10 September 2016) [ONLINE] Accessed: 19/11/2019). Available from: https://portals.iucn.org/library/sites/library/files/resrecfiles/WCC_2016_RES_069_EN.pdf
2. IUCN (no date, a) Nature-based Solutions. Available at: https://www.iucn.org/commissions/commission-ecosystem-management/our-work/nature-based-solutions
3. Cohen-Shacham, E., Walters, G., Janzen, C. and Maginnis, S. (eds.) (2016). Nature-based Solutions to address global societal challenges. Gland, Switzerland: IUCN. xiii + 97pp. DOI: https://doi.org/10.2305/IUCN.CH.2016.13.en
4. Horizon 2020 Expert Group on 'Nature-Based Solutions and Re-Naturing Cities' (2015) Towards an EU Research and Innovation policy agenda for Nature-Based Solutions & Re-Naturing Cities, Luxembourg: Publications Office of the European Union, p. 24. Available at: http://ec.europa.eu/newsroom/horizon2020/document.cfm?doc_id=10195
5. Deng L., Zhu G., Tang S., Shangguan, Z. (2016) Global patterns of the effects of land-use changes on soil carbon stocks Global Ecology and Conservation, 5, pp. 127–138
6. Yang Y., Tilman D., Furey G. and Lehman C. (2019) Soil carbon sequestration accelerated by restoration of grassland biodiversity, Nature Communications, 10, 718.
7. Nature-based Solutions Initiative (2019) Nature-based Solutions Evidence Tool. Available at: https://www.naturebasedsolutionsevidence.info/
8. Natural England (2012) Carbon storage by habitat: Review of the evidence of the impacts of management decisions and condition of carbon stores and sources (NERR043). London: Natural England. Available at: http://publications.naturalengland.org.uk/publication/1412347
9. Office of National Statistics (2019) Scottish natural capital: Ecosystem Service Accounts, 2019, Edinburgh: Environment and Forestry Directorate. Available at: https://www.gov.scot/publications/scottish-natural-capital-ecosystem-service-accounts-2019/pages/2/
10. https://www.nature.scot/professional-advice/planning-and-development/social-and-economic-benefits-nature/natural-capital-asset-index
11. Committee on Climate Change (2020) Land use: Policies for a Net Zero UK. Available at: https://www.theccc.org.uk/publication/land-use-policies-for-a-net-zero-uk/
12. Department of Agriculture Food and the Marine (2018) Forestry Programme 2014 – 2020: Midterm Review, Co. Wexford: Department of Agriculture Food and the Marine. Available at: https://www.agriculture.gov.ie/media/migration/forestry/forestservicegeneralinformation/2014-2020midtermreview/MidTermReview210218.pdf
13. Natural England (2012) Carbon storage by habitat: Review of the evidence of the impacts of management decisions and condition of carbon stores and sources (NERR043)
14. Crane E, (2020) Woodlands for climate and nature: A review of woodland planting and management approaches in the UK for climate change mitigation and biodiversity conservation. Report to the RSPB.
15. Burton V., Mosely D., Brown C., Metzger M.J. and Bellamy P. (2018) Reviewing the evidence base for the effects of woodland expansion on biodiversity and ecosystem services in the United Kingdom, Forestry Ecology and Management, 430, pp. 366-379.
16. Woodland Trust (2012) Planting trees to protect water: The role of trees and woods on farms in managing water quality and quantity, Lincolnshire: Woodland Trust: Available at: https://www.woodlandtrust.org.uk/media/1818/planting-trees-to-protect-water.pdf
17. Bonn et al. (2014) Investing in nature: Developing ecosystem service markets for peatland restoration, Ecosystem Services, 9, pp. 54-65.
18. Martin-Ortega J., Allot T.E.H., Glenk K. and Schaafsma M. (2014) Valuing water quality improvements from peatland restoration: Evidence and challenges, Ecosystem Services, 9, pp. 34-43.
19. Ramchunder S.J., Brown L.E., Holden J. (2011) Catchment-scale peatland restoration benefits stream ecosystem biodiversity, Journal of Applied Ecology, 49(1), pp. 182-191.

20. Bonn et al. (2014) Investing in nature: Developing ecosystem service markets for peatland restoration, Ecosystem Services, 9, pp. 54-65.
21. Cohen-Shacham, E., Walters, G., Janzen, C. and Maginnis, S. (eds.) (2016). Nature-based Solutions to address global societal challenges. Gland, Switzerland: IUCN. xiii + 97pp. DOI: https://doi.org/10.2305/IUCN.CH.2016.13.en
22. Natural England (2012) Carbon storage by habitat: Review of the evidence of the impacts of management decisions and condition of carbon stores and sources (NERR043)
23. Taylor B.W., Paterson D.M., and Baxter J.M. (2019) Sediment Dynamics of Natural and Restored Bolboschoenus maritimus Saltmarsh, Frontiers in Ecology and Evolution, 7, Article 237. DOI: 10.3389/fevo.2019.00237.
24. Duffy A., Jefferies C., Waddell G., Shanks G., Blackwood D. and Watkins A. (2008) A cost comparison of traditional drainage and SUDS in Scotland, Water Science and Technology, 57(9), pp. 1451-1459.
25. Gordon-Walker S., Harle T., and Naismith I. (2007) Cost-benefit of SUDS retrofit in urban areas, Science Report – SC060024, Bristol: Environment Agency. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/290993/scho0408bnxz-e-e.pdf
26. Keesstra S., Nunes J., Novara A., Finger D., Avelar D. Kalantari Z and Cerda A. (2017) "The superior effect of nature based solutions in land management for enhancing ecosystem services", Science of The Total Environment, 610-611, pp.997-1009.
27. Bosch M. and Sang Å.O. (2017) Urban natural environments as nature-based solutions for improved public health – A systematic review of reviews, Environmental Research, 158, pp. 373-384.
28. Bowler D.E., Buyung-Ali L., Knight T.M., Pullin A.S. (2010) Urban greening to cool towns and cities: A systematic review of the empirical evidence, Landscape and Urban Planning, 97, pp. 147-155.
29. Eftec (2013) Green Infrastructure's contribution to economic growth: a review, Report commissioned by DEFRA and Natural England. Available at: http://randd.defra.gov.uk/Document.aspx?Document=11406_GI_Economic_Catalyst_Final_Report_July2013.pdf
30. Vineyard D., Ingwersen W.W., Hawkins T.R, Xue X., Demeke B. and Shuster W. (2015) Comparing Green and Grey Infrastructure Using Life Cycle Cost and Environmental Impact: A Rain Garden Case Study in Cincinnati, OH, Journal of the American Water Resources Association, 51(5), 1342-1360. DOI: 10.1111/1752-1688.12320.
31. Scottish Green Infrastructure Forum (no date) Green Roof Benefits. Available at: http://www.sgif.org.uk/index.php/benefits-and-evidence/green-roof-benefits.
32. Morris R.L., Konlechner T.M., Ghisalberti M. and Swearer S.E. (2018) From grey to green: Efficacy of eco-engineering solutions for nature-based coastal defence, Global Change Biology, 24(5), 1827-1842. DOI: 10.1111/gcb.14063.
33. The Royal Society (2014) Resilience to extreme weather, Chapter Three. [ONLINE] Available at: https://royalsociety.org/-/media/policy/projects/resilience-climate-change/resilience-full-report.pdf
34. Reguero B.G., Beck M.W., Bresch D.N. and Calil J. (2018) Comparing the cost effectiveness of nature-based and coastal adaptation: A case study from the Gulf Coast of the United States, PLoS One, 13(4) e0192132.
35. Kabish N., Korn H., Stadler J. and Bonn A. (Eds.) (2017) Nature-Based Solutions to Climate Change Adaptation in Urban Areas: Linkages between Science, Policy and Practice, Springer International Publishing: Switzerland, p. 124.
36. IPCC, 2019: Summary for Policymakers. In: Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems [P.R. Shukla, J. Skea, E. Calvo Buendia, V. Masson-Delmotte, H.- O. Pörtner, D. C. Roberts, P. Zhai, R. Slade, S. Connors, R. van Diemen, M. Ferrat, E. Haughey, S. Luz, S. Neogi, M. Pathak, J. Petzold, J. Portugal Pereira, P. Vyas, E. Huntley, K. Kissick, M. Belkacemi, J. Malley, (eds.)]. In press.

37. HM Government (2018) A Green Future: Our 25 Year Plan to Improve the Environment. London: HM Government.
38. Wales Biodiversity Partnership (no date) Local Nature Recovery Partnerships. Available at: https://www.biodiversitywales.org.uk/Local-to-You
39. Scottish Natural Heritage (no date) Nature-based Solutions: urban. Available at: https://www.nature.scot/climate-change/nature-based-solutions/nature-based-solutions-urban
40. https://www.mahareesconservation.com/
41. IUCN (no date, b) A Global Standard for Nature-based Solutions. Available at: https://www.iucn.org/theme/ecosystem-management/about/our-work/a-global-standard-nature-based-solutions
42. Cohen-Shacham E. et al. (2019) Core principles for successfully implementing and upscaling Nature-based Solutions, Environmental Science and Policy, 98, pp. 20-29.

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