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The Climate-Biodiversity Nexus Reviewed: Navigating Tipping Points, Science-Based Targets & Nature-Based Solutions

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Abstract

This paper offers a comprehensive assessment of the "climate-biodiversity nexus" and the latest research. It also covers real-world developments. It delves into synergies and trade-offs between climate action and biodiversity protection, as well as the role of nature-based solutions (NBS) in addressing both crises. It highlights how biodiversity degradation reduces ecosystems' capacity to store carbon, intensifying climate change, while climate change accelerates biodiversity loss by pushing species beyond survival thresholds. The paper underscores the need for an integrated approach to biodiversity and climate. It uses examples like the potential collapse of the Atlantic Meridional Overturning Circulation (AMOC) and the tipping point's implications for ecosystems and species. It also reviews recent European Union policies and initiatives, such as the European Green Deal, which aim to balance climate mitigation with biodiversity conservation. Additionally, the paper examines corporate initiatives, such as Science-Based Targets for Nature (SBTN), which integrate biodiversity into sustainability strategies.

Part I: Introduction, Research Questions & Methodology

Introduction

Early international treaties like the UN Framework Convention on Climate Change and the UN Convention on Biological Diversity were negotiated separately. As climate change rose as an important political topic, governments kept biodiversity policy making and climate policy making separate, often keeping ministries for the environment and forming new ministries for climate and energy. But the integration of climate mitigation and biodiversity protection holds benefits, and the search for synergistic solutions is making strides these years. This happens due to the realization that the climate crisis and biodiversity crisis share root causes. These include land-use changes like conventional agriculture, deforestation, urbanization, the expansion of transport networks, and the continued use of fossil fuels[1].

The climate-biodiversity nexus underscores the relationship between these domains. Climate change disrupts ecosystems, while biodiversity loss diminishes ecosystem services like carbon sequestration, air purification, and water filtration[2]. Therefore, the climate and biodiversity crises are not isolated phenomena but are deeply interconnected. They amplify one another and create compounded environmental risks[3].

This paper advocates in favor of a "nexus" approach, emphasizing the need for solutions that address both crises. The study explores how this is already achieved through policy and projects. It outlines future directions for nexus research in the light of recent findings on climatic tipping points and advances on nature-based solutions [1-5].

Research Objectives

- Optimize the integration of climate mitigation and biodiversity conservation through nexus-based approaches.
- Scale resilient nature-based adaptation strategies to protect ecosystems.
- Identify new areas for research, policy advancements, and corporate investments to ensure resilient development.

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2. Hald-Mortensen, Christian, "Cascading Nature Risks: Applying the Rumsfeld Matrix to Case Studies on Pollinator Decline, an AMOC Collapse, and Zoonotic Pandemics." Journal of Ecology & Natural Resources, vol. 8, no. 3, 2024, DOI: 10.23880/jenr-16000380.
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Research Questions

1. What are the recent advances in research on the climate-biodiversity nexus?
2. What are the key trade-offs and synergies between climate mitigation and biodiversity conservation, and how can these be managed to avoid unintended consequences?
3. How can scalable nature-based solutions, supported by corporate and policy initiatives, ensure climate mitigation and biodiversity protection in the face of rapid climate change?

Research Methodology

This paper uses a systematic literature review to analyze recent studies and policies that take a climate-biodiversity nexus approach. The aim is to offer project managers, policymakers, investors, and NGOs practical insights into strategies that merge climate mitigation efforts with biodiversity conservation [6-10].

The climate-biodiversity nexus literature review provides an overview by assessing academic literature, policy reports, and case studies sourced from databases such as ResearchGate, SSRN, and Google Scholar. A separate goal of the literature review has been to identify journal papers from the past 5–10 years on nexus thinking to identify trends and gaps. Another goal was to generate actionable insights for policymakers, investors, and practitioners, while placing this paper in a broader context[4].

PART II: Definitions and Drivers of Integrated Approaches

Part II examines the core definitions and drivers of integrated approaches to the Climate-Biodiversity Nexus, highlighting the interconnectedness of climate stability and biodiversity conservation. This section will define the nexus, explore synergies and trade-offs, in mitigating both climate and biodiversity challenges. It will analyze the extinction risks posed by climate change, such as the impacts on polar species and ecosystems. Additionally, new structural climate elements, like the potential collapse of the Atlantic Meridional Overturning Circulation (AMOC), will be explored as key tipping points that could drastically accelerate both biodiversity loss and climate instability by mid-century.

Definition of the Climate-Biodiversity Nexus

The nexus concept has gained traction in global governance. Nexus thinking advocates for addressing issue areas like biodiversity, water, food, and energy, in a holistic manner. Optimizing isolated sectors is seen as inefficient. Instead synergies and trade-offs between different goals ought to be explored. Here, nature-based solutions (NBS), which leverage biodiversity and ecosystems to address climate challenges, have emerged as a key strategy. In particular, the World Bank and the European Commission promoted nature-based solutions in recent years[5].

Climate change accelerates biodiversity degradation by altering ecosystems like coral reefs and rainforests. But while these changes threaten vulnerable species like polar bears and coral polyps, limiting warming to below 1.5°C could prevent the worst, but not all of these ecosystem impacts[6].

Biodiversity loss weakens ecosystems' capacity to regulate the climate by diminishing vital functions such as carbon storage in forests and water purification in wetlands[7]. These disruptions can trigger cascading effects on other critical systems, including freshwater supply, food production, and energy generation. This is evident in regions experiencing both drought and biodiversity decline, where these challenges are interconnected and mutually reinforcing [11-15].

Addressing the climate-biodiversity nexus requires a holistic and integrated approach to biodiversity conservation as well as to climate projects. Such an approach would ensure that interventions in climate mitigation do not compromise biodiversity, and vice versa. Effective management of this nexus is essential for planetary stability and that we stay within Resilience is needed in face of climatic tipping points. planetary boundaries for long-term environmental resilience[8]. Here, one of the most critical climatic tipping points is the potential collapse of the Atlantic Meridional Overturning Circulation (AMOC). An AMOC tipping point would cause drastic shifts in winter temperatures in Northern Europe and the North Atlantic, and alter precipitation patterns, severely threatening existing ecosystem stability and biodiversity.

Recent research emphasizes integrated approaches as central for sustainable planning. One paper introduces the climate-biodiversity-health nexus, outlining its domains and practical applications for guiding biodiversity conservation, health improvement, development, and community sustainability efforts[9].

A review of 194 studies assessed the links between biodiversity and key sectors like climate, food, water, energy, transport, and health. 53% of these links were negative, mainly due to land use changes. But 29% were positive, emphasizing the need for biodiversity-friendly management and restoration – pursuing an integrated approach to avoid unintended consequences while maximizing co-benefits across ecosystems[10, 11].

Extinction Risk to Biodiversity Due to Climate Change

How does climate change accelerate the extinction risks facing species across the globe? As ecosystems are pushed beyond their limits, the intricate feedback loops between climate dynamics and biodiversity loss become critical to understanding and addressing species risk. But ecosystem degradation also leads to more GHG emissions.

In fact, Natural ecosystems store large amounts of carbon through organisms that absorb it to build long-lasting structures

5. Rosas, Montserrat Koloffon, and Philipp Pattberg. "Partnerships for SDGs: Facilitating a Biodiversity–Climate Nexus?." The environment in global sustainability governance. Bristol University Press, 2023. 297-316.
6. Hoegh-Guldberg, O., et al. "The human imperative of stabilizing global climate change at 1.5°C." Science, vol. 365, no. 6459, 2019, eaaw6974.
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like tree bark and root systems. This carbon sequestration potential is closely tied to biodiversity. However, many models overlook biodiversity's role in carbon storage. Researchers assessed the impact of plant biodiversity loss on carbon storage under various climate and land-use scenarios[12]. Results show biodiversity loss could cause a global carbon loss of 7.44-145.95 PgC (petagrams of carbon, or 1 billion metric tons), depending on the scenario[12]. This forms a feedback loop: climate change drives biodiversity loss, leading to more carbon emissions, worsening climate change. Biodiversity conservation is thus essential for climate mitigation [16-20].

The lag between rising CO_2 levels and biological impacts masks the damage. Carbon released from degraded ecosystems is significant. Also ocean acidification endangers marine life, while melting polar ice caps reduce Earth's albedo, hastening warming and species extinction risks[13]. For instance, 60% of coral reefs are now at high risk due to climate change[14]. This feedback loop drives further instability.

When climate change and biodiversity loss are not addressed in tandem, compounded negative effects emerge. For example, polar bears and emperor penguins face extinction due to the rapid loss of ice habitats, a clear outcome of unchecked climate change. Desertification, driven by climate change and unsustainable land use, threatens food security and depletes ecosystems. Ocean acidification, caused by the absorption of excess CO_2, damages marine biodiversity, including coral reefs and shellfish. Moreover, thawing permafrost releases methane, a potent greenhouse gas, which in turn accelerates climate change and amplifies biodiversity loss. These feedback loops demonstrate the urgency of adopting integrated approaches to prevent ecosystem collapse.

Species extinction risks are accelerating as ecosystems rely on species adapted to stable climates[15]. This leads to habitat fragmentation, reducing population sizes and reproductive success. Many species, particularly insects, amphibians, and vertebrates, have shifted their distributions or altered their life cycles in response to changing conditions.

Species' ranges are shrinking due to rising temperatures, especially in environments like the polar regions, where species adaptation is challenging. In fact, warming has accelerated much faster in these regions than in others, further complicating their survival[16].

But some species face an even more immediate threat, as shrinking habitats exacerbate the risks of extinction long before they can adapt or relocate[17]. This interconnectedness reflects the climate-biodiversity nexus. The IPCC predicts that under high-emission scenarios, up to 48% of species could face high extinction risk by 2100, making immediate action essential[18].

While extinction risks highlight the immediate threats to biodiversity from climate change, another critical aspect of this relationship lies in how ecosystems function as carbon sinks. Natural systems not only support biodiversity but also play a crucial role in climate regulation, underscoring the need for a comprehensive understanding of their interdependence. In fact, Elizabeth Kolbert's The Sixth Extinction is one of the recent works that explores the crisis, driven by human-induced factors such as habitat destruction, climate change, and overhunting, mirroring past mass extinction events[19].

Moreover, climate change exacerbates extinction risks by intensifying extreme weather events. Species in coastal areas face dangers from rising sea levels and storm surges. Terrestrial populations, particularly those with limited mobility or narrow niches, are destabilized by increased drought and wildfires, such as those seen in Southern Europe[20]. Also, ecosystem dynamics are deteriorating with shifting disease dynamics, which also introduce risks to biodiversity in a warming world[21].

Climatic tipping points, such as an AMOC collapse, would exacerbate these extinction risks by radically altering oceanic and atmospheric systems, triggering habitat loss, and disrupting food webs, especially for species reliant on stable marine environments.

The New Structural Climate Element of Tipping Points: The AMOC Collapse and Biodiversity Impacts

A tipping point occurs when a series of small or significant changes suddenly leads to a critical shift. Typically, we cannot recognize a tipping point until after it has already occurred. Climate "tipping elements" refer to at least sub-continental scale parts (or subsystems) of the climate system that can pass a climate tipping point, or elements "that can be switched—under certain circumstances—into a qualitatively different state by small perturbations".

According to the IPCC, a tipping point is a critical threshold beyond which "a system can reorganize in an abrupt or irreversible manner". These thresholds are particularly concerning because they can lead drastic changes that are difficult to manage[22]. Climatic tipping points, such as the potential collapse of the Atlantic Meridional Overturning Circulation (AMOC), pose significant threats to biodiversity [21-25].

The AMOC regulates global temperatures and supports marine biodiversity by distributing heat and nutrients across oceans. Climate change-induced warming and freshwater influx from melting ice sheets are weakening the AMOC, potentially leading to drastic climate shifts that affect ecosystems on land and sea, with widespread consequences for species survival and human livelihoods.

The AMOC, crucial for regulating North Atlantic temperatures, is nearing a tipping point[23]. A 2023 study, using probabilistic projections, calculated that the AMOC would reach a tipping point by 2057 under business as usual global warming.

13. Sala, Osvaldo E., et al. "Global Biodiversity Scenarios for the Year 2100." Science, vol. 287, no. 5459, 2000, pp. 1770-1774.
14. Hoegh-Guldberg, O., et al. "Coral Reefs Under Rapid Climate Change and Ocean Acidification." Science, vol. 318, no. 5857, 2007, pp. 1737-1742.
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18. Intergovernmental Panel on Climate Change (IPCC). Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the IPCC. Cambridge University Press, 2022.
19. Kolbert, Elizabeth. The Sixth Extinction: An Unnatural History. Henry Holt and Company, 2014.

A 2024 study highlighted the potential collapse of the Atlantic Meridional Overturning Circulation (AMOC) due to climate change, using a long-term climate model that reveals subtle freshwater influx interactions as a tipping point for significant reorganization of Atlantic currents[24].

The Atlantic Meridional Overturning Circulation (AMOC) tipping point represents a threshold where shifts in ocean currents could trigger widespread climatic and ecological disruptions, intensifying both biodiversity loss and climate change[25].

Understanding Cascading Effects

If this tipping point is reached, it could trigger widespread disruptions in climate patterns, leading West Africa to more severe winters in Europe, shifts in monsoon systems, and significant changes to marine ecosystems. The consequences of inaction could be serious, for global food production, and socio-economic stability[26].

So-called cascading effects occur when natural systems change, and they intersect with human activities, such as unsustainable land use and deforestation. These impacts threaten ecological stability, food security, and water availability, underscoring the importance of addressing these interconnected crises[27].

Because of its magnitude, and the potential speed of winter temperature changes that prevents species from adapting, I believe that AMOC related climate-biodiversity nexus research will become a key focus area in the 21st century. The potential collapse of this system is not only a climate issue but a threat to local and regional biodiversity [26-30].

PART III: The Rise of the Climate-Biodiversity Nexus Among Policy-Makers & Corporations

This section explores how institutional investors and policy-makers are embracing the climate-biodiversity nexus, driven by the rise of ESG investing. It highlights the development of soft governance frameworks such as the Taskforce on Climate-related Financial Disclosures (TCFD) and Taskforce on Nature-related Financial Disclosures (TNFD), which are helping companies integrate biodiversity and climate risks into their financial reporting. As corporate transparency on nature-related risks improves, these initiatives are reshaping investment strategies, encouraging businesses to adopt more sustainable practices that align both climate action and biodiversity conservation [31-35].

The Climate-Biodiversity Nexus in Recent Global Governance Frameworks

The Glasgow Climate Pact, negotiated in November 2021, highlights the need to protect biodiversity in climate action. The text highlighting the nexus approach in the agreement is inserted here: "Emphasizes the importance of protecting, conserving and restoring nature and ecosystems to achieve the Paris Agreement temperature goal, including through forests and other terrestrial and marine ecosystems acting as sinks and reservoirs of greenhouse gases and by protecting biodiversity, while ensuring social and environmental afeguards"[28].

Nexus initiatives acknowledged biodiversity's role in climate action, with variations linked to sector focus and partnerships with environmental organizations. One recent study underscores the importance of integrating biodiversity into net zero strategies, offering policy recommendations for transnational initiatives to ensure climate action do not come at the expense of nature[29, 30, 31].

The 2022 Kunming-Montreal Global Biodiversity Framework

That pension funds and other ESG focused investors have come to expect better corporate data and disclosures on climate and biodiversity is also a result of the policy action and the global level. Indeed, the Kunming-Montreal Global Biodiversity Framework adopted at COP15 in 2022 marks a significant step in raising the ambition level on biodiversity, and seeking an integration of biodiversity with climate policy.

This agreement commits countries to protect 30% of the world's lands and oceans by 2030 and recognizes that biodiversity is critical to meeting climate goals under the Paris Agreement. The framework emphasizes the role of nature-based solutions, such as protecting forests and coastal ecosystems, which not only safeguard biodiversity, but also sequester carbon and protect against climate impacts[27].

The concept of the nexus has since broadened to include ecosystems, finance, hydropower and forestry. It emphasizes the interconnections between these systems and the importance of addressing them in an integrated manner. For example, as water use is expected to rise by 20–30% by 2050, water practitioners now focus on multi-sectoral approaches like integrated water resources management (IWRM), drawing attention to system interactions across sectors, coordinated strategies and their central role in policy-making[33, 34, 35].

The Example of the EU Green Deal, December 2019

The European Union (EU) has historically addressed climate change, biodiversity, and circular economy separately, despite the clear interconnections. But the European Green Deal, launched in December 2019, sought to change this by adopting a more integrated approach, aiming to transition the EU into a climate-neutral, resource-efficient economy while preserving its natural resources [36-40].

However, this shift towards a "nexus thinking" approach has not been fully realized in policy design. Synergies can be enhanced by focusing more on how resources are extracted and promoting

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22. Hald-Mortensen, Christian (2024) Tipping Points: A Brief Review of their Role as Wicked Problems in Climate Change. J of AgriEarth & Environmental Sciences 3(3), 01-10, Available from: https://www.researchgate.net/publication/381582054_Tipping_Points_A_Brief_Review_of_their_Role_as_Wicked_Problems_in_Climate_Change
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24. Van Westen, René M., et al. "Physics-Based Early Warning Signal Shows That AMOC Is on Tipping Course." Science Advances, vol. 10, no. 6, 2024, DOI: 10.1126/sciadv.adk1189.
25. OECD (2022), Climate Tipping Points: Insights for Effective Policy Action, OECD Publishing, Paris, https://doi.org/10.1787/abc5a69e-en.

regenerative practices. The EU Green Deal aimed to reflect the nexus approach, but more work is needed to manage trade-offs and synergies[36].

The Kunming-Montreal Global Biodiversity Framework align business practices with sustainable goals, emphasizing nature-based solutions. Embedding the climate-biodiversity nexus into global frameworks marks an evolution toward synergy between environmental and investment objectives. Global governance is essential to ensure these efforts succeed. National action plans must also be developed and implemented in the coming years to ensure real progress.

Integrating the Climate-Biodiversity Nexus into Corporate Sustainability Strategies

The 2007–08 global financial crisis brought attention to the interlinkages of water, energy, and food, which later expanded to include climate and biodiversity concerns. In 2009, UN Secretary-General Ban Ki-moon focused on the nexus of water, energy, food, and climate, further supported by the 2011 World Economic Forum (WEF) report[37]. But at the level of corporations, recent advances have been made during the last 5 years on systematic disclosures on corporate impacts on the climate but now also on nature and biodiversity, and to these developments the paper turns next.

The Soft Governance Provided by the TCFD, the TNFD, SBT and SBTN

With the rise of Environmental, Social, and Governance (ESG) reporting and ESG investing, companies and investors are increasingly focusing on sustainability and transparency in their operations. The Task Force on Climate-related Financial Disclosures (TCFD) was established in December 2015 by the Financial Stability Board (FSB). The FSB created the TCFD to develop consistent climate-related financial risk disclosures for companies, banks, and investors, aiming to enhance transparency and enable better-informed investment, credit, and insurance underwriting decisions.

Another climate initiative that has become a market standard among large corporations, is to set Science-Based Targets, and have them validated by the Science Based Targets Initiative (SBTi) who helps companies set greenhouse gas reduction goals aligned with climate science to meet the Paris Agreement objectives[38].

In the last three years, the Taskforce on Nature-related Financial Disclosures (TNFD) has become a new and important focal point for tools and methods to assess nature-related impacts of business practices with environmental goals, The TNFD encourages corporations to assess how their operations affect biodiversity[39].

The TNFD framework, similar to the climate-focused Taskforce on Climate-related Financial Disclosures (TCFD), also helps businesses identify opportunities for nature-based solutions that address both climate mitigation and biodiversity preservation[40].

In fact, the TNFD framework offers standardized guidelines for organizations to assess, manage, and disclose their dependencies and impacts on nature. This promotes greater transparency and accountability, enabling investors to make informed decisions. By integrating nature-related risks into financial disclosures, the TNFD aims to shift capital flows toward activities that support biodiversity conservation.

The previously mentioned SBTI have now also become an operational focal point for new Science-Based Targets for Nature. SBTI expanded to include Science-Based Targets for Nature. SBTN does not just extend climate goals. It introduces specific methodologies for addressing biodiversity loss, freshwater use, and land management, aiming for a nature-positive approach, which is more than just a co-benefit of climate actions. These targets guide companies in setting measurable goals to reduce their impacts on natural ecosystems[41].

TCFD and TNFD are primarily disclosure frameworks, while SBTI is focused on target setting for emission reductions, with the expectation that companies will report their progress using compatible disclosure frameworks like TCFD and TNFD. All in all, the differences between the corporate initiatives can be seen in table 1.

The alignment of climate and biodiversity target setting with corporate reporting is driving increased transparency. Reporting is becoming increasingly important at the corporate level in the EU with the Corporate Sustainability Reporting Directive (CSRD), which mandates detailed sustainability reporting from a broader range of companies, including non-EU firms with significant EU operations. Enhanced reporting strengthens accountability and responsible practices among listed corporations.

Initiatives such as the Task Force on Climate-related Financial Disclosures (TCFD) and the Science-Based Targets initiative (SBTi) have set clear “market standards” for climate-related disclosures, with growing adoption in the corporate landscape. Often, the reporting and analysis done internally in order to report with consistency feeds into the CSRD reporting [41-45].

Particularly for biodiversity reporting, companies are finding themselves in virgin territory. But with the emergence of the Taskforce on Nature-related Financial Disclosures (TNFD) and the expansion of the SBTi to include Science-Based Targets for Nature (SBTN), companies are now setting measurable goals for biodiversity conservation alongside climate, and it emphasizes that businesses need to take direct action on nature, independently from their climate actions. This integration allows businesses to better understand and disclose their impacts on nature, while meeting both climate and biodiversity targets.

26. Hald-Mortensen, Christian. "Cascading Nature Risks: Applying the Rumsfeld Matrix to Case Studies on Pollinator Decline, an AMOC Collapse, and Zoonotic Pandemics." Journal of Ecology & Natural Resources, vol. 8, no. 3, 2024, DOI: 10.23880/jenr-16000380.
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30. Rantanen, Mika, et al. "The Arctic Has Warmed Nearly Four Times Faster Than the Globe Since 1979." Communications Earth & Environment, vol. 3, no. 1, 2022, article 168.

Table 1: Comparison of Climate and Biodiversity Disclosure and Target-Setting Frameworks

Framework/Initiative	Climate Disclosures and Target Setting	Biodiversity Disclosure and Target Setting
TCFD (Task Force on Climate-related Financial Disclosures)	Primarily focuses on climate-related disclosures, including governance, strategy, risk management, and metrics related to GHG emissions. It serves as the foundation for many climate disclosure regulations globally. Companies must report on climate-related financial risks and opportunities (Scope 1, 2, and sometimes Scope 3 GHG emissions).	The TCFD does not address biodiversity specifically. It is focused entirely on climate-related risks, without integration of nature or biodiversity metrics.
TNFD (Taskforce on Nature-related Financial Disclosures)	While TNFD builds on the TCFD, its focus is on the intersection of nature and climate, encouraging integrated disclosures of nature and climate impacts. It helps companies understand their nature-related financial risks and opportunities, indirectly acknowledging climate connections.	TNFD provides a framework for companies to disclose nature-related risks, including dependencies and impacts on biodiversity, ecosystems, and nature-related assets.
SBT (Science-Based Targets)	Targets are set for reducing GHG emissions in alignment with the Paris Agreement. SBT focuses on creating actionable climate targets for businesses based on scientific consensus.	The SBT framework does not focus on biodiversity. It is climate-specific and does not address nature-related metrics.
SBTN (Science-Based Targets for Nature)	While incorporating climate considerations, SBTN broadens the target-setting to include nature alongside climate goals. It emphasizes creating synergies between climate and biodiversity actions.	SBTN extends the concept of science-based climate targets to nature, guiding companies on how to set measurable targets for biodiversity and ecosystem services. This includes preserving freshwater, land systems, and biodiversity as part of a nature-positive pathway by 2030.

As more companies adopt Science-Based Targets for Nature, reporting will likely lead to actions and project finance. To meet these objectives, businesses will require practical, scalable solutions, which will also strengthen their credibility and reputation. Indeed, the demand for Nature-Based Solutions (NBS) is expected to rise. SBTNs encourage corporations to reduce their environmental impact and restore ecosystems, which aligns naturally with NBS approaches. For instance, restoring forests or protecting marine ecosystems not only enhances carbon sequestration but also supports biodiversity. As companies take on more ambitious SBTN commitments, the integration of NBS into their strategies becomes essential for achieving both biodiversity and climate goals[46, 47].

NBS offers a pathway to address nature-related risks, enhance ecosystem services, and fulfill biodiversity targets while contributing to climate mitigation and adaptation. This increasing corporate commitment to nature-based targets is driving investments in large-scale landscape restoration, urban green infrastructure, and ecosystem conservation. While some corporations may focus on urban solutions, others may prefer large landscape projects, reflecting diverse approaches to nature-based strategies.

Looking ahead, corporations may seek to integrate their Science-Based Targets for Nature with their climate-focused SBTs. This nexus approach will streamline reporting and project management efforts, while ensuring that actions to combat climate change also support the preservation of natural ecosystems. This holistic method could result in greater corporate demand for NBS that deliver both emission reductions and biodiversity benefits. These themes are explored further in Part IV of the paper [46-50].

Part IV: The Climate-Biodiversity Nexus in Practice: Nature-Based Solutions

Part IV explores the practical application of the Climate-Biodiversity Nexus through Nature-Based Solutions (NBS), focusing on how these strategies can address both climate and biodiversity challenges. It begins by examining urban ecosystems, highlighting how projects like UNaLab in European cities leverage NBS to provide natural cooling services and improve resilience against climate extremes. The section then shifts to large-scale landscape restoration projects, and reforestation, emphasizing their role in carbon sequestration and biodiversity conservation.

Ecosystems Provide Natural Cooling Services in Urban Areas

One example of a Nature-Based Solution (NBS) project in the EU is the UNaLab (Urban Nature Labs) initiative[48]. It focuses on transforming urban areas with nature-based solutions to tackle climate challenges, improve air quality, and enhance biodiversity. The project has been implemented in cities like Eindhoven (Netherlands), Tampere (Finland), and Genova (Italy). Solutions include green roofs, permeable pavements, and urban parks. Benefits include reduced flooding, increased biodiversity, and improved urban resilience. However, costs include initial

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32. https://unfccc.int/news/new-international-biodiversity-agreement-strengthens-climate-action
33. Integrated Water Resources Management (IWRM) | International Decade for Action 'Water for Life' 2005-2015 (un.org)
34. Matthews, Nathanial, Bart Schoonbaert, and Elizabeth Burlon. "Unexpected bright spots: how the pandemic, climate change and biodiversity loss are shaping the evolution of the nexus." Water International 47.7 (2022): 1140-1146.
35. Sietz, Diana, and Regina Neudert. "Taking stock of and advancing knowledge on interaction archetypes at the nexus between land, biodiversity, food and climate." Environmental Research Letters 17.11 (2022): 113004.
36. Paleari, Susanna. "The EU policy on climate change, biodiversity and circular economy: Moving towards a Nexus approach." Environmental science & policy 151 (2024): 103603.
37. Matthews, Nathanial, Bart Schoonbaert, and Elizabeth Burlon. "Unexpected bright spots: how the pandemic, climate change and biodiversity loss are shaping the evolution of the nexus." Water International 47.7 (2022): 1140-1146.

investment in infrastructure and ongoing maintenance, making funding and long-term support critical for its success.

Urban ecosystems provide cooling services, combating the "urban heat island effect", and enhancing resilience when climate extremes lead to cloudbursts or heatwaves and heat stress. In fact, urban green spaces reduce surface temperatures through shading and evaporative cooling, much like how natural Arctic habitats regulate local climates. These nature-based solutions demonstrate the interconnectedness of biodiversity and climate adaptation, both in polar and urban environments, where preserving ecosystems is key to sustaining life and mitigating climate impacts.

Urban vegetation reduces surface temperatures through shading and cooling, intercepting solar radiation and limiting heat absorption. Trees can also provide shading and intercept solar radiation before it reaches the ground, thus reducing the amount of heat that penetrates the built environment.

Ecosystems provide natural cooling services, resilience and limit temperature fluctuations in urban areas[51, 52]. A study conducted by Kabisch et al. found that green spaces in cities provide important cooling effects, which have been shown to improve the well-being of urban residents[53]. Another study by Bowler et al. showed that urban green spaces, such as parks and gardens, can reduce air temperatures by up to 6°C compared to nearby built-up areas[54]. In the 21st century, the potential collapse of large-scale climate systems, such as the Atlantic Meridional Overturning Circulation (AMOC), could make weather patterns more extreme in urban areas, and create a stronger demand for these regulatory processes, intensifying heat stress in urban areas particularly in the Southern hemisphere, and along the Atlantic southern coastline.

These studies demonstrate the important role of ecosystems in promoting natural cooling services in urban areas. It also supports the idea that optimizing the nexus between biodiversity, water, food, and energy systems, highlights the importance of nature-based solutions.

In fact, urban green infrastructure policies and urban afforestation initiatives can serve twin purpose, following nexus thinking, ensuring that cities contribute to climate mitigation while preserving or designing ecosystems[55]. In turn, healthier urban ecosystems provide carbon sequestration and flood regulation, reducing climate-related risks and highlighting the relevance of nature-based solutions[56].

Nature-Based Solutions at the Landscape Level

One of the most effective approaches to addressing the biodiversity-climate nexus is through synergistic solutions, particularly nature-based solutions (NBS)[57]. These strategies, such as reforestation with native species, serve the dual purpose of enhancing carbon sinks and supporting biodiversity. Restoring wetlands, peatlands, and riverbeds is another example, where these ecosystems act as critical carbon reservoirs while reestablishing essential habitats . Such solutions align climate action with biodiversity conservation, maximizing benefits.

Nature-based solutions (NBS) offer a win-win by addressing both climate change and biodiversity loss. Reforestation, mangrove restoration, and sustainable agriculture are key examples. The successful scaling of these solutions faces significant financial and logistical barriers, particularly in regions with limited resources and capacities[59]. It requires capacity building and technology transfer to ensure effective implementation of NBS across diverse areas.

The following Table 2 explains the specific synergies and trade-offs within the nexus, when pursuing solutions to both crises.

Table 2: Synergies and Trade-offs to Consider Between Climate Mitigation Strategies and Biodiversity Conservation

Climate Mitigation Strategy	Synergies with Biodiversity Conservation	Trade-offs with Biodiversity Conservation
Nature-Based Solutions (NBS)	Nature-Based Solutions (NBS) offer synergies with biodiversity conservation, e.g by restoring wetlands, which in turn improve ecosystem health by improving water retention.	Large-scale NBS projects can compete with agricultural or urban development needs. Pricing of land may also make it difficult to implement local biodiversity priorities.
Urban Green Spaces	Reduces urban heat island effect, enhances urban biodiversity, e.g. for insects, amphibians and birds - by creating habitats, and improves local air quality, and retains water during cloudbursts.	May require non-native or low-biodiversity plant species to thrive in urban conditions, potentially reducing habitat quality for local wildlife. Fragmented sites may only offer token improvements to biodiversity.
Reforestation	Habitat Connectivity: Strategically placing monoculture plantations near or within natural forests can create wildlife corridors, enhancing species movement and connectivity, which supports broader biodiversity goals.	Fast-growing monoculture plantations, such as Sitka spruce (Picea sitchensis), efficiently store carbon but reduce biodiversity if poorly managed. These plantations often lack open areas and wetlands that support water retention and diverse habitats. Careful management incorporating plant diversity and natural features can balance carbon sequestration with biodiversity.

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42. https://tnfd.global/
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44. https://sciencebasedtargetsnetwork.org/companies/take-action/
45. https://finance.ec.europa.eu/capital-markets-union-and-financial-markets/company-reporting-and-auditing/company-reporting/corporate-sustainability-reporting_en

While advances in NBS have shown promise, there are still gaps in understanding their large-scale use, particularly in regions with limited resources. A nexus-based approach is useful for enhancing ecosystem resilience and addressing the interconnected challenges of climate change, biodiversity loss, and resource management. NBS involve a wide range of ecosystems on land and in the sea, not just forests[60].

A recent paper proposed a framework as a decision-making guide for optimizing natural climate solutions in situations where time and resources are limited, helping both public and private actors to make strategic choices for effective climate action.

A first step is to prioritize protecting, then managing, and finally restoring natural lands for climate mitigation[61]. This hierarchy is based on four key criteria: mitigation potential, immediacy of impact, cost-effectiveness, and co-benefits.

Reforestation

Large-scale reforestation projects with climate-resilient species can act as a buffer against tipping points by reducing the risks of desertification, e.g. projects are needed in Southern Europe where droughts are leading to desertification already. New forests can stabilize carbon sinks and prevent further ecosystem degradation that could worsen the impacts, if systemic collapses like the AMOC begins to unfold [50-55].

Therefore, the "LIFE REFOREST" project, located in Portugal, is useful to mention; it is a Nature-Based Solution aimed at restoring over 5,000 hectares of degraded forest ecosystems affected by wildfires. The initiative focuses on reforestation with native tree species, improving soil quality, increasing biodiversity, and reducing the risk of future fires. It also involves local communities in landscape-level restoration efforts. The project's benefits include enhanced carbon sequestration, restored habitats for wildlife, and improved water retention. The costs primarily involve reforestation activities, infrastructure development, and maintenance over time to ensure long-term sustainability[62].

Land Restoration

The "LIFE Terra" project is a large-scale landscape restoration initiative within the EU that aims to plant 500 million trees across 500,000 hectares, with individual projects covering areas of at least 5,000 hectares. One of its key efforts is in Spain, where over 5,000 hectares of degraded land and are being reforested to combat desertification, restore biodiversity, and sequester carbon. The project focuses on engaging communities in tree planting, promoting climate resilience, and enhancing local biodiversity. Costs include land preparation, tree planting, and long-term maintenance, while benefits include ecosystem restoration and carbon sequestration[63]. This is a useful example of a NBS.

The following Table 3 summarizes these issues, presenting the outcomes of different combinations of climate action and biodiversity conservation, and emphasizing the importance of nature-based solutions and holistic planning to address both crises [64, 65, 66].

Table 3: Nexus Thinking Applied to Urban and Rural Nature Based Solutions

Solution	Scale	Focus	Climate Impact	Biodiversity Impact	Key Benefits
Green Roofs	Urban	Heat island mitigation, biodiversity	Reduces urban heat island effect, improves air quality	Increases urban biodiversity (pollinators, birds)	Regulates urban temperature, provides habitat for species, reduces energy consumption, manages stormwater runoff
Urban Parks & Green Corridors	Urban	Green spaces for recreation, heat mitigation	Reduces temperatures, sequesters carbon	Provides habitat for urban species	Mitigates urban heat, increases resilience to heatwaves, connects fragmented habitats
Large Landscape Projects (5,000 ha)	Landscape (rural)	Reforestation, water retention, resilience	Increases carbon sequestration, enhances water retention during droughts	Restores ecosystems, supports wildlife corridors	Builds ecosystem resilience, reduces drought impact, promotes species adaptation to climate changes
Reforestation Projects	Large landscape (rural)	Restoring native forests	Sequesters carbon, improves regional climate regulation	Restores habitats for endangered species	Enhances ecosystem services, mitigates soil erosion, improves local climate stability

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Conclusion

This paper highlights the need for a paradigm shift in how we address the interconnected crises of climate change and biodiversity loss. The evidence presented underscores that isolated interventions in either domain are insufficient, as the feedback loops between climate and ecosystems intensify the challenges. Nature-based solutions (NBS) emerge as a strategy for mitigating both climate change and biodiversity loss, offering pathways for resilience, adaptation, and carbon sequestration. However, these solutions must be implemented at a larger scale and with greater coordination across policy, finance, and corporate sectors to be transformative.

Corporate initiatives such as Science-Based Targets (SBTs) and Science-Based Targets for Nature (SBTN) are expected to drive further integration of climate and biodiversity efforts, as companies increasingly set measurable goals for reducing their environmental impacts. By aligning corporate strategies with both climate and biodiversity objectives, SBT frameworks could create a natural demand for NBS, particularly for projects like reforestation, ecosystem restoration, and sustainable agriculture. As more businesses adopt these targets, the implementation of NBS at both urban and landscape levels will likely accelerate, fostering broader ecosystem resilience.

NBS can also serve as a buffer against tipping points while promoting both biodiversity conservation and climate adaptation. The looming threat of climatic tipping points, such as the potential collapse of the Atlantic Meridional Overturning Circulation (AMOC), further reinforces the need for immediate, coordinated efforts. The AMOC plays a crucial role in regulating global climate systems, and its potential collapse mid-century could lead to severe disruptions, including extreme winters in Europe, altered monsoon systems, and ecosystem destabilization. Such a scenario would exacerbate both biodiversity loss and climate change, making large-scale nature-based interventions critical for mitigating cascading environmental risks.

The integration of frameworks such as the SBTN and global initiatives like the EU Green Deal demonstrates growing recognition of the climate-biodiversity nexus. Yet, significant gaps remain in translating these initiatives into on-the-ground action, especially in regions most vulnerable to environmental degradation. The findings of this paper suggest that future research and policy must focus on scaling nature-based solutions and ensuring they account for local ecological contexts while addressing global challenges. Addressing the trade-offs and ensuring synergies between climate action and biodiversity protection will be essential in shaping a resilient future.

Disclaimer

The contents of this research article are not meant to recommend courses of actions or investment decisions on the basis of the issues identified and analyzed. The contents are intended to inform you as a reader, and to identify research and policy gaps for further work. Any financial gain or loss incurred by a reader because of this article will result from decisions taken by the reader as an individual. The opinions expressed in this research article are my own as an individual, and do not reflect the opinions of my current employer.

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