

Review Article

# FROM COEXISTENCE TO MUTUALISM: MAINSTREAMING BIODIVERSITY IN THE SUSTAINABLE DEVELOPMENT GOALS

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## ARTICLE HIGHLIGHTS

- Mutualism paradigm aligns biodiversity with sustainable development.
- Biodiversity acts as a driver for prosperity rather than a constraint.
- Integrated policy mixes unlock powerful synergies for global goals.
- Reciprocal benefits are vital to moving beyond mere coexistence.

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## ABSTRACT

Mainstreaming biodiversity into the Sustainable Development Goals (SDGs) is currently hampered by a prevailing “coexistence” paradigm, which treats conservation and economic development as separate, often conflicting domains. This fragmentation leads to persistent policy silos and unresolved trade-offs, undermining long-term sustainability. This study aimed to critically diagnose the structural limitations of this approach and proposes a transition toward “mutualism”—a framework where biodiversity and development objectives are mutually reinforcing. Adopting a critical review methodology, we synthesized evidence from policy, economic, and scientific sectors. We analyzed specific instruments, such as Nature-based Solutions (NbS) and Payments for Ecosystem Services (PES), to identify the institutional, financial, and social barriers currently constraining their effectiveness. The novelty of this paper lies in the conceptualization of ‘mutualism’ not merely as an ecological metaphor, but as an operational framework for the SDGs that moves beyond the traditional “do no harm” principle to actively engineering reciprocal benefits. We concluded that while existing instruments show promise, they fail to achieve systemic change due to a lack of strategic alignment. To operationalize mutualism, we recommend a strategic shift focusing on three pillars: implementing coherent policy mixes that integrate regulatory and fiscal instruments, establishing inclusive governance to manage trade-offs, and mobilizing finance that rewards verifiable ecological and social synergies.

**Keywords:** biodiversity, mainstreaming, mutualism, policy integration, sustainable development goals (SDGs)

## INTRODUCTION

The global consensus embodied in the Sustainable Development Goals (SDGs) and international biodiversity targets underscores the urgency of aligning human well-being with the preservation of the biosphere. This effort has recently been crystallized in the landmark Kunming-Montreal Global Biodiversity Framework adopted in 2022, which serves as the new global roadmap to ‘live in harmony with nature’. Biodiversity is not merely an environmental amenity but an

essential foundation supporting vital systems for civilization, including food security, public health, and economic stability. Nevertheless, efforts to mainstream biodiversity conservation into the broader development agenda have yielded limited progress.

The fundamental problem lies in the dominant paradigm, which operates at the level of coexistence a framework wherein nature protection and economic development are treated as separate and often antagonistic pursuits. Consequently, short-term economic gains are systematically prioritized over

long-term ecological sustainability. This fragmented approach has led to specific implementation failures within the SDG framework. For instance, the pursuit of food security (SDG 2) often drives agricultural expansion that directly degrades natural habitats (SDG 15), creating a “policy incoherence” where the achievement of one goal undermines another. Similarly, economic decision-making frequently relies on cost-benefit analyses that fail to account for long-term societal interests, thereby exacerbating poverty and social inequality for communities dependent on natural resources from protected areas. This practice, ironically, exacerbates social inequality, food insecurity, and poverty, particularly for communities whose livelihoods are directly dependent on natural resources from protected areas (Frank & Schäffler 2019; Cléménçon 2021).

This insufficient integration stems from a series of complex structural barriers. First, an excessive prioritization of economics in decision-making means that the valuation of ecosystem services through cost-benefit analysis often fails to accommodate long-term societal interests (Cléménçon 2021). Second, weaknesses at the level of policy and governance are manifested in non-binding legal regulations and a multiplication of overlapping and ineffective policy instruments (Thool 2022; Azizi *et al.* 2019). Third, the presence of vague and conflicting goals, such as the tension between agricultural expansion for food security and the imperative to protect natural habitats, highlights a deficit in policy coherence (Chahar *et al.* 2016). This gap is compounded by a disconnect between public perception which tends to equate sustainable development with conservation and a policy discourse that still largely interprets it as conventional economic growth (Cléménçon 2021). Furthermore, fragmented, sectoral approaches that address biodiversity and climate change as separate issues ignore the fundamental and interdependent nature of these two global crises (Kearney 2022; Pettorelli *et al.* 2021).

This review aimed to critically analyze the existing literature to diagnose the structural weaknesses of the current “coexistence” approach and to propose a conceptual framework for a transition toward mutualism. By synthesizing evidence from various policy, economic, and scientific sectors, this review examined the barriers that perpetuate the disconnect between conservation and development agendas. The central argument advanced is that to holistically achieve the SDGs, a

fundamental paradigm shift is required from mere coexistence to a mutualistic relationship. Within this framework, biodiversity is no longer viewed as a constraint or a burden but as a prerequisite and an active driver that generates reciprocal benefits with development objectives. In essence, investing in ecosystem health will inherently strengthen the achievement of socio-economic targets, and vice versa.

To construct this argument, the article first provides an in-depth analysis of the limitations of the “coexistence” model. It then elaborates on the concept of “mutualism” as a superior alternative paradigm capable of creating synergies between conservation and other development sectors, such as agriculture (Mamabolo *et al.* 2020). Finally, the article outlines strategic pathways to facilitate this transition, focusing on three key pillars: coherent policy integration, mobilization of public support, and an integrated research agenda.

The central argument advanced is that to holistically achieve the SDGs, a fundamental paradigm shift is required from mere coexistence to a mutualistic relationship. While previous reviews have cataloged the barriers to mainstreaming biodiversity, this paper offers a novel conceptual contribution by proposing ‘mutualism’ as an operational framework. We argue that this paradigm shift is not just a semantic change but a necessary strategic pivot to unlock powerful synergies previously constrained by a ‘coexistence’ mindset. This review synthesizes evidence from policy, economic, and scientific sectors to construct this argument, ultimately outlining strategic pathways to facilitate this critical transition.

## REVIEW

### Conceptual Framework: From Coexistence to Mutualism

The central argument of this review hinges on the critical distinction between two paradigms for integrating biodiversity and development: coexistence and mutualism. Coexistence, in the context of the Sustainable Development Goals (SDGs), describes a state where different entities, such as human communities and wildlife, exist together with interactions managed primarily to minimize conflict (Gao & Clark 2023; Petitpierre-Sauvain 2008). This approach often frames biodiversity and development as separate domains that must be carefully balanced to prevent negative interference. In contrast, mutualism proposes a

more deeply integrated relationship, drawing from its ecological origins to describe interactions that produce net positive benefits for all parties involved (Fox *et al.* 2020). Applied to the SDGs, a mutualistic framework actively seeks to create systems where environmental protection and socio-economic progress are not merely compatible but mutually reinforcing, shifting the goal from avoiding harm to actively creating synergistic value (Lydgate 2012).

The imperative to transition from coexistence to mutualism is rooted in the indivisible and interconnected nature of the SDGs themselves. While coexistence can prevent conflict, it is insufficient to drive the transformative progress required. A mutualistic framework is superior because it fosters synergistic benefits that are essential for accelerating progress across the interconnected goals (Fenner 2022; Leal Filho *et al.* 2024). By leveraging the strengths of multiple stakeholders, it spurs innovation and creates positive feedback loops where advancing one goal supports another (Sharma & Sharma 2024). A coexistence model, however, often leads to fragmented efforts and untapped potential (McGowan *et al.* 2019; Basheer *et al.* 2025).

Furthermore, a mutualistic approach inherently demands integrated strategies that minimize the trade-offs often seen between competing objectives, such as economic growth and ecosystem protection (Fader *et al.* 2018; Obersteiner *et al.* 2016). It forces a holistic perspective that redesigns systems to align these goals. This approach also promotes the deep, multi-stakeholder cooperation needed to tackle complex global challenges by creating shared benefits, which provides a powerful incentive for long-term commitment (Kloke-Lesch 2021; King 2025).

### **Current Status of Biodiversity Integration in the SDGs**

An analysis of biodiversity mainstreaming within the Sustainable Development Goals (SDGs) to date reveals a complex picture, marked by commendable progress alongside persistent gaps. At the planning level, biodiversity is explicitly recognized as fundamental to achieving various SDGs, particularly those related to poverty eradication, food security, and environmental sustainability (Lucas *et al.* 2014; Ament *et al.* 2019). This recognition is institutionalized through SDG 14 (Life Below Water) and SDG 15 (Life on Land), which directly target conservation and sustainable

use (Khan & Shehzad 2025; Lernborg & Atallah 2025). Furthermore, the Kunming-Montreal Global Biodiversity Framework reinforces this through its 23 targets for 2030, especially Target 14, which mandates that parties ensure biodiversity values are fully integrated into policies and regulations at all levels of government. At the implementation level, various innovative models have demonstrated the potential for synergy, such as Integrated Conservation and Development Projects (ICDPs), Nature-Based Solutions (NBS), and regenerative agriculture practices, all of which link conservation with socio-economic development (Ernoul & Mesleard 2008; Gómez Martín *et al.* 2020; Himshikha *et al.* 2024). In financing, mechanisms like Payment for Ecosystem Services (PES) have been identified as effective tools, although these efforts are still hampered by a significant funding gap to reverse biodiversity loss (Lernborg & Atallah 2025; Wei *et al.* 2021).

However, despite these efforts, the current state of integration more closely reflects a paradigm of coexistence rather than true mutualism. Significant gaps remain, hindering the realization of a mutually beneficial relationship. Key challenges include insufficiently robust policy frameworks, inadequate biodiversity monitoring indicators at the country level, and a limited diversity of funding channels (Ogwu *et al.* 2025; Dickens *et al.* 2020; Wei *et al.* 2021). The disconnect between public perception, which favors conservation, and policy implementation, which often prioritizes other goals, also presents a major barrier (Cléménçon 2021). These gaps are not merely technical issues but are symptomatic of deeper, interconnected, fundamental barriers.

To transition toward a mutualistic relationship, it is crucial to understand the barriers that perpetuate the status quo. The literature identifies several key categories. Policy and institutional barriers such as imperfect regulations, conflicting policies, and a lack of inter-agency cooperation directly explain why on-the-ground implementation is often ineffective and fragmented (Wang *et al.* 2022; Domenech *et al.* 2019; Davis *et al.* 2022; Szymańska *et al.* 2023). Financially, the aforementioned funding gap is exacerbated by weak economic incentives and a lack of sustainable financial support to foster mutualistic practices (Domenech *et al.* 2019; Andrei *et al.* 2019).

Perhaps the most fundamental are the social and environmental barriers. Cultural resistance

to cooperation often rooted in historical contexts along with power asymmetries and the risk of exploitation in partnerships, creates a climate of distrust that impedes genuine collaboration (Andrei *et al.* 2019; Powell & Maoz 2014; Egger & Hibbett 2004; Duchenne *et al.* 2023). Furthermore, environmental conditions themselves, such as resource availability and climate variability, can affect the stability of mutualistic relationships (Grman *et al.* 2012; Dunkley *et al.* 2020). Thus, the journey from coexistence to mutualism demands a systemic approach that not only focuses on individual projects but also strategically dismantles these interconnected policy, institutional, financial, and social barriers.

### **Mechanisms and Strategies Toward Mutualism**

Transitioning from a paradigm of coexistence to one of mutualism requires the application of policy instruments and practical approaches that actively create synergies between biodiversity conservation and development objectives. A review of the literature identifies several promising pathways, which are supported by lessons learned from various case studies around the world. This section outlines these instruments and distills critical lessons from both the successes and failures of their implementation.

The literature highlights several key instruments as effective in fostering mutualistic relationships. Nature-based Solutions (NbS) are recognized for their significant potential to simultaneously address climate, biodiversity, and disaster risk challenges. Although their implementation faces constraints such as a lack of expertise and stakeholder conflicts, studies demonstrate that NbS like forest landscape restoration can yield significant positive economic impacts, particularly in water flow regulation (Scolobig *et al.* 2024; Restrepo *et al.* 2024). Overcoming these barriers requires legally binding policy instruments, mobilization of public and private finance, and enhanced capacity building (Scolobig *et al.* 2024).

Another effective instrument is Payments for Ecosystem Services (PES), which establishes a direct mutualistic link by integrating the economic valuation of ecosystem services into land-use planning. By providing direct financial incentives, PES transforms stakeholders from passive residents into active partners in conservation, creating a relationship where maintaining and enhancing ecosystem services generates tangible

economic benefits (Restrepo *et al.* 2024).

More broadly, the development and updating of National Biodiversity Strategies and Action Plans (NBSAPs) now serve as the primary policy mechanism for countries to translate GBF targets including those focused on mutualism into national action. Furthermore, the literature emphasizes the importance of Policy Mixes the combination of various instruments such as taxes, tradable permits, and command-and-control regulations.

This approach has proven more effective at addressing multiple market failures and enhancing policy synergy, fostering a comprehensive governance structure that supports mutualistic outcomes (Persson 2006; Ji *et al.* 2022; Dalhammar *et al.* 2018). Market-based instruments like carbon pricing also effectively promote eco-innovation, though they often require supplementation with stringent controls to drive more radical change (Sánchez & Deza 2015).

The real-world application of these mutualistic approaches provides valuable lessons. Successful case studies reveal common key factors in the finance realm, innovations such as 'biodiversity credits' and nature-linked green bonds are being explored as ways to scale up private sector investment. These instruments are designed to create a mutualistic link where financial returns are directly tied to verifiable ecological outcomes, aligning with the goal of increasing transparency and accountability in biodiversity finance.

For instance, successful cross-border cooperation between Cieszyn (Poland) and Cesky Tesin (Czech Republic) was driven by clear goals, diverse stakeholder involvement, and guaranteed mutual benefits (Kurowska-Pysz *et al.* 2018). Similarly, successful Public-Private Partnerships (PPPs) in developing countries and a university-city partnership in Malmö, Sweden, underscore the importance of strategic alignment, transparent and participatory governance, and mutual learning processes (Tanveer *et al.* 2025; Stauffacher *et al.* 2008).

Conversely, cases of failure offer critical insights. One international alliance failed due to a high dependency on single-project success and the difficulty for small companies to lead independently, highlighting structural challenges for smaller actors (Hollins 2006). Another example of a lack of mutualism in a production relationship between Finland and Somalia showed that without an equitable distribution of benefits and

production capacity, such relationships become unsustainable (Fox *et al.* 2020).

From these cases, several universal lessons can be drawn. First, inclusivity and stakeholder engagement are fundamental prerequisites; all parties must have ownership and derive benefits. Second, success hinges on clear objectives and strategic alignment from the outset. Third, transparent and collaborative governance is crucial for building trust and ensuring accountability. Finally, a mutualistic approach must consciously address power and capacity imbalances, especially in international collaborations, to ensure equitable and sustainable relationships. Therefore, the application of appropriate policy instruments must be accompanied by careful and adaptive partnership design based on these lessons.

### **Navigating Synergies and Trade-offs within the SDG Framework**

The shift from a paradigm of coexistence to one of mutualism demands a nuanced understanding of how biodiversity conservation efforts interact with the broader Sustainable Development Goals (SDGs). These interactions manifest as both mutually reinforcing synergies and conflict-laden trade-offs. This section reviews the most significant synergies, analyzes the primary areas of conflict, and outlines strategies for their management based on findings from the extant literature.

Biodiversity conservation efforts demonstrate powerful synergies with the achievement of several key SDGs. Most prominently, this is visible with SDG 2 (Zero Hunger), where ecosystem services such as pollination, natural pest control, and soil fertility all of which are underpinned by biodiversity are crucial for enhancing agricultural productivity and resilience (Yang *et al.* 2020; Makwinja *et al.* 2022; Hu *et al.* 2022). Ecosystem restoration programs have also been shown to synergistically advance SDG 2 (Yao *et al.* 2021). An equally strong synergy exists with SDG 6 (Clean Water and Sanitation), as healthy ecosystems act as natural water filters and protect watersheds, which is essential for maintaining water quality and availability (Yang *et al.* 2020; Yao *et al.* 2021; Gómez Martín *et al.* 2020). Furthermore, conservation is a core component of SDG 13 (Climate Action), given that biodiversity-rich ecosystems like forests and wetlands are vital for carbon sequestration and climate regulation (Yang *et al.* 2020; Hu *et al.* 2022; Gómez Martín *et al.* 2020). The synergies also extend to goals such as SDG 1 (No Poverty),

where ecosystem services support local livelihoods through fisheries, forestry, and tourism, thereby offering pathways for poverty alleviation (Yang *et al.* 2020; Gatiso *et al.* 2022; Ingram 2012).

Despite these powerful synergies, conflicts between conservation and development objectives are unavoidable. The most acute trade-offs often emerge at the nexus of economic development and conservation. Agricultural expansion to meet food demands and the extraction of natural resources like oil, gas, and minerals frequently occur in areas of high biodiversity, creating direct conflicts (Grigg 2005; Chahar *et al.* 2016). Similarly, infrastructure development, including urbanization and port expansion, leads to habitat fragmentation and loss (Chahar *et al.* 2016; Rajvanshi *et al.* 2009). Conflicts are also common within protected area management, where divergent stakeholder interests can impede the simultaneous achievement of social and environmental goals (Fisher *et al.* 2023).

The literature suggests several strategies to navigate these complex trade-offs. First, inclusive stakeholder engagement is critical for minimizing conflict and ensuring equitable outcomes, even if it is resource-intensive (Fisher *et al.* 2023; Broussard *et al.* 2023). Second, analytical tools like Multi-Criteria Decision Analysis (MCDA) can help formally and transparently assess trade-offs between ecological and socio-economic goals (Drechsler 2004). Third, the economic valuation of ecosystem services can build a compelling financial case for conservation, particularly for the finance sector (Grigg 2005). Fourth, policy coherence between global biodiversity regimes and national policies, supported by a strong science-policy interface, is essential (Kedia & Anand 2021). Finally, adaptive management approaches that embrace flexibility and a broader ethical-cultural discourse on the value of biodiversity can help manage uncertainty and align public perception with policy objectives (Young *et al.* 2010; Cléménçon 2021). By employing these strategies, it is possible to balance competing demands and steer interactions away from mere coexistence and toward genuine mutualism.

The shift from a paradigm of coexistence to one of mutualism demands a nuanced understanding of how biodiversity conservation efforts interact with the broader Sustainable Development Goals (SDGs). These interactions manifest as both mutually reinforcing synergies and conflict-laden trade-offs. On one hand, conservation efforts demonstrate powerful synergies with key goals,

including SDG 2 (Zero Hunger), SDG 6 (Clean Water and Sanitation), and SDG 13 (Climate Action), where healthy ecosystems provide foundational services. Conversely, the most acute trade-offs often emerge at the nexus of conservation and economic development objectives, such as those outlined in SDG 8 (Decent Work and Economic Growth) and SDG 9 (Industry, Innovation, and Infrastructure). Navigating this complex landscape thus requires strategic management to mitigate negative impacts and foster mutually beneficial outcomes. The following Table 1 synthesizes these key interactions, illustrating the primary synergies, most common trade-offs, and proposed mutualistic management strategies for select, representative SDGs.

## CONCLUSION

This review concludes that the prevailing coexistence paradigm for mainstreaming biodiversity is insufficient to achieve the 2030

Agenda, making a fundamental shift toward mutualism an urgent necessity. The current separation of conservation and development perpetuates policy incoherence and unresolved trade-offs, undermining long-term ecological and social well-being. While progress is evident through innovative models like Nature-based Solutions and Payments for Ecosystem Services, their impact is constrained by deep-seated financial, institutional, and social barriers. To overcome these obstacles and harness the powerful synergies between biodiversity and key SDGs, a systemic approach is required, centered on integrated policy mixes, inclusive governance, and equitable partnerships that actively generate shared value. Ultimately, embedding this mutualistic ethos into all development planning is not merely an ecological ideal but a pragmatic and essential strategy for building resilient, equitable societies and realizing a future where human prosperity and a thriving biosphere are understood to be inseparably linked.

Table 1 Matrix of synergies, trade-offs, and management strategies for biodiversity-SDG interactions

| Relevant SDG                                                                                              | Primary synergy with biodiversity conservation                                                                                                          | Primary trade-off with biodiversity conservation                                                                                                  | Mutualistic management and mitigation strategy                                                                                                                         |
|-----------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>SDG 1</b> (No Poverty)                                                                                 | Ecosystem services support local livelihoods through fisheries, forestry, and tourism, providing pathways for poverty alleviation.                      | Access restrictions to resources in protected areas can adversely affect resource-dependent communities.                                          | Implement inclusive stakeholder engagement and establish equitable benefit-sharing schemes.                                                                            |
| <b>SDG 2</b> (Zero Hunger)                                                                                | Ecosystem services such as pollination, natural pest control, and soil fertility are crucial for enhancing agricultural productivity and resilience.    | Agricultural expansion to achieve food security objectives often leads to habitat loss and deforestation in areas of high biodiversity.           | Adopt regenerative agriculture and agroforestry practices; integrate the economic valuation of ecosystem services into land use planning.                              |
| <b>SDG 6</b> (Clean Water and Sanitation)                                                                 | Healthy ecosystems function as natural water purifiers and protect water catchments, which is essential for maintaining water quality and availability. | The development of water infrastructure, such as dams, can alter river flows and degrade aquatic habitats.                                        | Employ Nature-based Solutions (NbS) for water management; utilize Multi-Criteria Decision Analysis (MCDA) to assess trade-offs.                                        |
| <b>SDG 8</b> (Decent Work and Economic Growth) and <b>SDG 9</b> (Industry, Innovation and Infrastructure) | Ecotourism and other nature-based industries create novel economic opportunities.                                                                       | Infrastructure development (e.g., urbanization, ports) and resource extraction (e.g., mining, oil, gas) result in habitat fragmentation and loss. | Enforce stringent biodiversity offset policies; utilize integrated spatial planning; ensure early and inclusive stakeholder engagement to minimize conflicts.          |
| <b>SDG 13</b> (Climate Action)                                                                            | Carbon-rich ecosystems, such as forests and wetlands, are vital for carbon sequestration and enhancing resilience to climate impacts.                   | Certain energy solutions, such as large-scale bioenergy production, may compete for land with natural habitats.                                   | Integrate NbS into National Climate Action Plans and align Nationally Determined Contributions (NDCs) with National Biodiversity Strategies and Action Plans (NBSAPs). |

## Policy Implications and Future Directions

The transition toward mutualism requires concrete actions. For policymakers, this review highlights the need to move beyond fragmented, single-issue regulations toward integrated policy mixes that reward the generation of reciprocal benefits. This includes designing financial mechanisms like PES and green bonds that not only fund conservation but also create measurable value for development actors. Furthermore, establishing transparent and inclusive governance platforms is essential to manage trade-offs and build the trust necessary for multi-stakeholder partnerships to succeed.

For future research, several gaps need to be addressed. First, there is a pressing need for robust, standardized metrics to quantify ‘mutualism’ in practice—how can we measure the reciprocal benefits between development projects and ecosystem health? Second, more longitudinal case studies are required to track the socio-economic and ecological outcomes of projects that explicitly adopt a mutualistic framework. Finally, research should explore the cultural and social barriers to mutualism, such as power imbalances and historical distrust, and identify strategies to foster a collaborative ethos essential for sustainable development. Addressing these research questions will be vital to operationalize the mutualistic paradigm and accelerate progress toward the 2030 Agenda.

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