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Contribution of Key Biodiversity Areas to Societal Challenges through Nature-based Solutions

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ABSTRACT

This research was conducted to determine how Key Biodiversity Areas (KBAs), areas that make a critical contribution to global biodiversity conservation, can contribute to solving societal challenges through Nature-based Solutions (NbS). To this end, a total of 21 documents, including international academic journals and institutional reports, were analyzed. Cases were classified and organized according to the seven major types of societal challenges defined by the International Union for Conservation of Nature NbS Global Standard. The analysis revealed that KBA-based NbS contributes most extensively in the 'environmental degradation and biodiversity loss' domain, aligning with the fundamental purpose of KBAs being biodiversity conservation. This was followed by contributions to water security, climate change mitigation and adaptation, and economic and social development. Conversely, case accumulation was limited in some areas, such as human health and food security, likely due to the relatively recent establishment of KBA standards. In terms of research scale, most studies were conducted at a global scale, while regionally, the most active NbS application was reported in Asia and Africa. This research demonstrates that KBAs can function as core spatial platforms for NbS implementation beyond simple protected areas. It also suggests that KBAs hold significant strategic value for achieving international environmental goals, such as the Kunming-Montreal Global Biodiversity Framework and the Sustainable Development Goals.

Keywords: Biodiversity conservation, Climate change, Key Biodiversity Areas, Nature-based Solutions, Societal and environmental challenges

Introduction

Climate change is having various impacts globally across society, including rising temperatures, sea level rise, more frequent and severe torrential rains, changes in precipitation patterns, and alterations in ocean currents. These changes significantly affect diverse sectors such as agriculture, public health, water use, energy production, and biodiversity (Rawat *et al*., 2024). Measures are needed to adapt to climate change and mitigate greenhouse gas emissions in order to reduce the damage caused by these changes and to positively impact health, biodiversity, food security, and other areas (Korea Meteorological Administration, 2024).

Nature-based Solutions (NbS) are gaining attention as an integrated solution to address complex environmental crises such as biodiversity loss and increased disasters. NbS are actions to protect, sustainably manage, and restore natural and modified ecosystems in ways that effectively and adaptively address societal challenges, providing both human well-being and biodiversity benefits (International

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Union for Conservation of Nature [IUCN], 2020). The recognized scope of societal challenges currently includes climate change (adaptation and mitigation), disaster risk reduction, ecosystem degradation and biodiversity loss, food security, human health, social and economic development, and water security. Importantly, while one or more societal challenges can be the entry point for NbS, the priority is to leverage the potential of NbS to provide multiple benefits, whereby one intervention addresses several challenges (IUCN, 2020).

Protected Areas can play an important role in climate change adaptation as NbS (Lipka *et al*., 2023). For example, Forests work to increase the minimum river low flow during droughts and to decrease the magnitude and pace of floods (Lipka *et al*., 2023). From this perspective, Key Biodiversity Areas (KBAs)—regions scientifically proven to hold high ecological value for biodiversity conservation—can be viewed as more than mere conservation zones. They serve as foundational areas for providing diverse ecosystem services such as carbon sequestration and disaster mitigation. Thus, KBAs represent crucial spatial units capable of maximizing the practical effectiveness of NbS.

KBA is a region that contributes significantly to the global conservation of biodiversity (Ahn & Kang, 2024), and the KBA standards were approved by the IUCN Council and launched at the 2016 World Conservation Congress in Hawaii (IUCN, 2022). As of 2025, 16,602 KBAs are registered worldwide (KBA homepage, 2025; November 1st), demonstrating their potential as a strategic foundation for applying NbS.

Additionally, NbS and KBA serve as indicators for fulfilling international commitments. NbS is utilized as a means to achieve Kunming-Montreal Global Biodiversity Framework (KMGBF) targets 8 (Minimize the Impacts of Climate Change on Biodiversity and Build Resilience) and 11 (Restore, Maintain and Enhance Nature's Contributions to People). Meanwhile, KBAs are also used as indicators for KMGBF 3 (Conserve 30% of Land, Waters and Seas), as well as indicators for UN Sustainable Development Goals (SDGs) 15 (Life on land). Thus, KBAs transcend simple conservation areas; they represent spatial units that can contribute to the implementation of various international environmental goals through the strategic application of NbS. However, to maximize the strategic value of KBA, it is necessary to conceptually clarify the mechanism by which KBA—as sites critical for global biodiversity conservation—translate their intrinsic ecological value into practical contributions across the seven major societal and environmental challenges addressed by NbS.

This relationship forms the core of the research question: In what ways does the established function of KBAs as sites of critical importance for global biodiversity contribute to solving the diverse societal challenges prioritised by the NbS framework? This research analyzes existing literature and case studies to examine how NbS implemented in KBAs can contribute to solving specific social challenges, thereby identifying the multidimensional value of KBAs.

Materials and Methods

Literature review

To ensure the relevance and specificity of the analyzed literature to the research's core objective (Contribution of KBAs to Societal Challenges through NbS), inclusion criteria were applied:

(1) Topical relevance: The document must explicitly discuss NbS and their contribution to at least one of the seven major societal challenges identified by the IUCN Global Standard

(2) Geographic/scope relevance: The document must explicitly address the implementation or contribution of NbS within a KBAs. Studies focusing only on general protected areas or non-KBA sites were excluded.

(3) Content focus: The document must present empirical data, case studies, or analytical assessments of the NbS contribution.

(4) The collected data from the identified literature were organized and analyzed based on the seven types of major societal challenges addressed by NbS. The seven major societal and environmental challenges identified in the IUCN Global Standard are: Climate change mitigation and adaptation; disaster risk reduction; economic and social development; human health; food security; water security; and environmental degradation and biodiversity loss (IUCN, 2020) (Table 1).

Results

Analysis of the 21 selected studies indicates that the societal challenge to which KBAs most frequently contribute is environmental degradation and biodiversity loss (Table 2) (Baumbach *et al*., 2023; Dong *et al*., 2024; Eken *et al*., 2004; Gacheru *et al*., 2023; Goyal *et al*., 2025; Kullberg *et al*., 2019; Lansley *et al*., 2025; Larsen *et al*., 2012; Máiz-Tomé *et al*., 2017; Mehlomakhulu & Buschke, 2023; Neugarten *et al*., 2014; 2018; Plumptre *et al*., 2019; 2024; 2025; Shrestha *et al*., 2021; Sun *et al*., 2022; Tognelli *et al*., 2017; Trew *et al*., 2024; Visconti *et al*., 2019; World Wide Fund for Nature, 2024). The next most frequently addressed areas are water security, followed by climate change mitigation and adaptation, economic and social development, disaster risk reduction, human health, and food security. Overall, these findings demonstrate that KBAs can function not only as sites for biodiversity conservation but also as strategic spatial units capable of contributing to the resolution of a wide range of major

Table 1. IUCN NbS Global Standard: seven major societal challenges

Major societal challenges	Role of NbS in addressing the challenge
1. Climate change mitigation and adaptation	Utilizing NbS to address climate change through three core functions: Ecosystem-based Mitigation by preventing the degradation and loss of natural ecosystems to avoid emissions; functioning as a 'natural carbon sink' through the conservation and restoration of forests, wetlands, and oceans; and enabling Ecosystem-based Adaptation and Ecosystem-based DRR (Eco-DRR) to help vulnerable communities increase their resilience to adverse climate effects
2. Disaster risk reduction (DRR)	Utilizing the regulatory role of ecosystem services (e.g., wetlands, forests, coastal systems) to cost-effectively reduce risks from natural hazards. NbS serves as protective barriers or buffers to decrease physical exposure, protect infrastructure, and support quicker livelihood recovery, forming the basis of the Eco-DRR approach
3. Economic and social development	Utilizing NbS to promote sustainable economic growth and social well-being by supporting nature-based livelihoods, job creation, and inclusive local development. NbS enhances community resilience and long-term socio-economic stability through the sustainable management of ecosystem services
4. Human health	Recognizing the natural environment's role as a determinant of human health, well-being, and social cohesion. NbS aims to utilize nature's benefits—such as improving environmental quality (heat, noise), promoting physical and social activity, and providing sources of medicines—to enhance physical and mental health outcomes
5. Food security	Achieving sustainable food systems through an ecosystem-aware approach. This involves leveraging NbS to protect wild genetic resources, manage wild species, and utilize stable ecosystem services to stabilize food availability and access during periods of environmental or political stress
6. Water security	Utilizing water-related services provided by 'natural infrastructure' (such as forests, wetlands, and floodplains) to address exacerbated water crises. The goal is to achieve sufficient and safe water management and preserve ecosystem function simultaneously
7. Environmental degradation and biodiversity loss	Utilizing conservation through protection, restoration, and sustainable use to maintain or enhance biodiversity, serving as a critical input to NbS, thereby reversing ecosystem degradation and biodiversity loss while providing simultaneous benefits to human well-being

IUCN, International Union for Conservation of Nature; NbS, Nature-based Solutions.

societal challenges.

The literature analysis indicates that most of the selected studies were conducted at a global scale (Eken *et al*., 2004; Kullberg *et al*., 2019; Lansley *et al*., 2025; Larsen *et al*., 2012; Neugarten *et al*., 2018; Plumptre *et al*., 2025; 2024; Sun *et al*., 2022; Trew *et al*., 2024; Visconti *et al*., 2019), followed by Africa (Gacheru *et al*., 2023; Mehlomakhulu & Buschke, 2023; Neugarten *et al*., 2018; Plumptre *et al*., 2019; World Wide Fund for Nature, 2024), Asia (Dong *et al*., 2024; Goyal *et al*., 2025; Shrestha *et al*., 2021), Europe (Máiz-Tomé *et al*., 2017), North America (Tognelli *et al*., 2017), and Central America (Baumbach *et al*., 2023).

Discussion

This research demonstrates that KBAs contribute to a wide range of societal and environmental challenges addressed through NbS, suggesting that KBAs have the capacity to function as strategic spatial units beyond their role in biodiversity conservation. The contributions observed in the environmental degradation and biodiversity loss reflect the fundamental ecological role of KBAs in sustaining species and habitats. As evidenced by Eken *et al*. (2004), Kullberg *et al*. (2019), and Plumptre *et al*. (2024), identifying and protecting KBAs represents one of the most effective approaches to preventing global biodiversity loss. For example, Baumbach *et al*. (2023) quantitatively demonstrated that protected areas within KBAs maintain higher biome stability than unprotected areas KBAs. These findings suggest that substantial policy-driven conservation efforts must accompany the identification process to effectively mitigate environmental degradation and biodiversity loss.

Table 2. Key contributions of NbS within KBAs to societal challenges

No	References	Key contribution	Seven major societal challenges						
			CC	DRR	ESD	HH	FS	WS	EDBL
1	Eken *et al*., 2004	KBAs as a means to reduce global biodiversity loss							O
2	Larsen *et al*., 2012	Substantial human well-being benefits from safeguarding KBAs	O		O			O	
3	Neugarten *et al*., 2014	Assessment of the ecosystem service values of KBAs in Madagascar	O	O	O	O	O	O	O
4	Máiz-Tomé *et al*., 2017	Freshwater KBAs for water and ecosystems in North-Western Mediterranean sub-region						O	O
5	Tognelli *et al*., 2017	Freshwater KBAs for water and ecosystems in Canada						O	O
6	Neugarten *et al*., 2018	Ecosystem service modeling in protected areas (incl. KBAs)	O	O					O
7	Kullberg *et al*., 2019	KBA protection increasing threatened species coverage							O
8	Plumptre *et al*., 2019	Mapping KBAs and critical conservation sites in Uganda							O
9	Visconti *et al*., 2019	Utilizing KBAs for conservation outcomes							O
10	Shrestha *et al*., 2021	KBAs provide a high degree of ecosystem services in Chindwin River Basin, Myanmar	O					O	
11	Sun *et al*., 2022	Global trade analysis for KBA and global biodiversity integrity							O
12	Baumbach *et al*., 2023	Protected KBAs have higher ecosystem stability							O
13	Gacheru *et al*., 2023	Status of Kenya's KBA and recommendations for enhancing various ecosystem services		O	O			O	O
14	Mehlomakhulu & Buschke, 2023	Built & natural capital in South African KBA tourism			O				
15	Dong *et al*., 2024	KBA conservation as a win-win for biodiversity and climate goals in China	O						O
16	Plumptre *et al*., 2024	Using KBAs to halt biodiversity loss & meet GBF goals							O
17	Trew *et al*., 2024	Tropical KBAs acting as climate refugia	O						O
18	World Wide Fund for Nature, 2024	How the Kenyan banking sector can protect KBAs			O				
19	Goyal *et al*., 2025	GIS mapping of ecosystem services and threats provides a scientific basis for conservation planning			O			O	O
20	Lansley *et al*., 2025	Bird sites offer co-benefits for other species and humans							O
21	Plumptre *et al*., 2025	KBA & systematic conservation planning-guided expansion achieves KMGBF Target 1 and halts biodiversity loss							O

NbS, Nature-based Solutions; KBAs, Key Biodiversity Areas; CC, climate change mitigation and adaptation; DRR, disaster risk reduction; ESD, economic and social development; HH, human health; FS, food security; WS, water security; EDBL, environmental degradation and biodiversity loss; GBF, Global Biodiversity Framework.

Protecting areas of high biodiversity, including KBAs, contributes to climate change mitigation by reducing CO_2 emissions through carbon storage and sequestration, while also supporting climate change adaptation (Gacheru *et al*., 2023; Larsen *et al*., 2012; Neugarten *et al*., 2018). In particular, Trew *et al*. (2024) show that tropical KBAs can function as climate refugia under changing temperature regimes. In addition, evidence from some KBAs demonstrates their contribution to disaster risk reduction through ecosystem functions such as flood regulation (Neugarten *et al*., 2018).

Beyond environmental benefits, KBAs have also been shown to support economic and social development, for example through ecotourism opportunities (Neugarten *et al*., 2018) and contributions to the maintenance of human cultural diversity (Larsen *et al*., 2012). Furthermore, studies on freshwater KBAs in the Mediterranean (Máiz-Tomé *et al*., 2017) and Canada (Tognelli *et al*., 2017) underscore the importance of defining geographic priorities for freshwater biodiversity conservation and managing these areas to secure adequate environmental flows necessary to sustain vulnerable freshwater ecosystems, thereby enhancing water security.

Case studies demonstrating the contribution of NbS within KBAs to addressing societal challenges were most frequently conducted at the global scale. However, when examined by region, a relatively larger number of studies were identified in Asia and Africa. This pattern may reflect the fact that KBA-related research has been particularly active in these regions, as well as that Asia and Africa contain extensive areas of high ecological value while simultaneously experiencing strong anthropogenic pressures such as development and land-use change (Goyal *et al*., 2025; Neugarten *et al*., 2018; Plumptre *et al*., 2019). Consequently, the need for NbS that can simultaneously support biodiversity conservation and address societal and environmental challenges may be especially pronounced in these regions.

This research has several limitations. First, the relatively small sample size (n=21) of the analyzed literature may limit the generalizability of the findings. In particular, contributions to human health and food security were not identified, with the exception of an analysis in Madagascar (Neugarten *et al*., 2018). This is likely due to the limited accumulation of research, given that the KBA standard was established relatively recently in 2016. Second, the literature selection criteria were restricted to documents explicitly mentioning 'KBA' and the 'seven major societal challenges' defined by the NbS Global Standard. Consequently, related studies using similar concepts or terminologies, such as 'green infrastructure' or 'ecosystem-based adaptation,' may have been excluded.

Despite these limitations, this research supports the hypothesis that KBAs provide a foundation for the application of NbS. Specifically, it suggests that KBAs can generate a wide range of societal benefits beyond conservation objectives and hold significant strategic value for advancing international environmental targets, including the KMGBF and the SDGs. To fully realize this potential, future research should quantitatively assess the multiple values of KBAs and strengthen their integration into policy frameworks and decision-making processes.

Author Contributions

Conceptualization: NA, SRK. Data curation: NA, YS. Formal analysis: NA. Funding acquisition: SRK. Investigation: NA, SC, BRK. Methodology: NA, SC, YS. Project administration: NA. Resources: NA, SC, BRK. Supervision: SRK. Writing – original draft: NA, SRK. Writing – review & editing: NA, SRK.

Conflict of Interest

The authors declare that they have no competing interests.

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