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Review

Unlocking the potential of biosphere reserves: a review of structural, institutional, and ideational challenges to transformational learning

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Addressing the intertwined challenges of biodiversity loss and climate change requires rapid, intentional societal shifts. UNESCO Biosphere Reserves (BRs), established as interdisciplinary learning hubs for sustainable development, offer significant potential to bridge global commitments and local action. However, their effectiveness is hampered by structural, institutional, and perceptional/ideational challenges. This review identifies and categorizes these challenges, highlighting issues such as socioeconomic inequalities, governance constraints, and narrative complexities. Our analysis of 42 recent studies reveals that while BRs could serve as 'living labs' for transformative change, their impact is limited by these challenges. There are numerous indications that the development of BRs is at a critical juncture. If the identified challenges are not addressed, there is a risk that the role of BRs will be marginalized in the future, rather than evolving into key arenas that contribute to the transformative change we urgently need.

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Introduction

It is imperative that humanity undergoes swift and intentional changes in all societal spheres to tackle the interconnected challenges of biodiversity loss and climate change [1,2]. These changes put exceptional pressures on national and subnational political institutions, frequently casting doubts on their robustness [3]. It has prompted calls for innovative approaches and solutions but also for investigating how to make better use of already-existing governance frameworks [4], such as UNESCO Biosphere Reserves (BRs), to successfully translate policies into action on the ground and bring about the necessary societal changes.

Established in 1971, BRs aim to enhance the relationship between people and their environment by promoting sustainable development, conservation of biodiversity, and socioecological research through an interdisciplinary and intergovernmental approach. Designated as learning places for sustainable development, BRs are explicitly committed to sustainability. The Lima Action Plan of 2016, soon to be replaced by the Hangzhou Strategy and Action Plan (2026–2035), emphasizes their role as model regions for advancing the United Nations Sustainable Development Goals (SDGs) [5]. Today, the network of 727 sites across 131 countries includes territories co-managed by local and Indigenous communities, highlighting their potential for localizing global sustainability efforts through learning and innovation [6].

It is thus assumed that strengthening BRs could further improve the implementation of climate as well as conservation policies, effectively bridging global commitments with local development [7,8]. Given that they are provided greater support to fulfill their role as learning hubs and to develop new tools and more strategic approaches, BRs have the potential to become 'living labs' for co-producing knowledge with transformative potential [9–11].

To gather insights on this potential, we conducted a literature review to explore the challenges that may contribute to or hinder the ability of BRs to meet their objectives in conservation, development/innovation, and education. We focus specifically on the role of learning and how management can experiment with different approaches to achieve transformational change.

The literature review focusing on the last 2 years was conducted following best practices in the field [12]. The search included the academic databases Web of Science,

Scopus, along with Google Scholar. Keywords included 'UNESCO Biosphere Reserves', 'learning', 'living labs', and combinations of these. The searches were conducted in June 2023, yielding a total of 270 studies. In the second step, one author reviewed the titles, keywords, and abstracts to eliminate duplicates and studies that did not directly address the targeted topic, resulting in a refined sample of studies. Further refinement occurred in the third step, where a thorough analysis of the full text of each publication was conducted to exclude documents that did not address the topic. In parallel, a set of inclusion and exclusion criteria concerning aspects of learning associated with the potential for transformative change was developed to guide the review process. These included, for example, inclusion of studies that explicitly engage with learning concepts (e.g. critical reflection, perspective transformation); provide empirical evidence of learning outcomes that result in shifts in practice, governance, or social-ecological relationships; and explore the use of living labs or similar concepts experimental spaces as settings for co-creation, real-world testing, and iterative learning in support of transformation. Studies were excluded if they conceptualized learning solely as knowledge transfer or technical training; lacked attention to reflexivity, dialog, or the affective dimensions of learning; or mentioned living labs or the like without discussing their role as learning environments or catalysts for transformation. Additionally, relevant cited papers were included in the sample. Following these four steps, a total of 42 papers were deemed suitable for the analysis, and three main challenges were identified: (1) structural, (2) institutional, and (3) perceptual/ideational challenges, each one impacting learning and effective management in different ways. In the following section, these three challenges are presented in more detail.

Review

Structural challenges

Our review identified three key structural challenges that may impact learning and management toward transformative change: (a) socioeconomic inequalities, (b) geopolitical, and (c) demographic challenges.

Studies on BRs in different contexts show that the often-assumed win–win outcomes in biodiversity protection and socioeconomic development cannot always be guaranteed. On the contrary, studies of BRs in Latin America as well as a review of BRs in Southeast Asia show that existing socioeconomic gaps may even be reinforced and widened in BRs through limiting access to resources and hindering effective participation and collaboration. Additionally, communities facing economic difficulties may prioritize immediate survival needs over long-term environmental goals, making it challenging to engage in sustainable practices [13,14]. Social divides, such as those based on class, ethnicity, or education, can further split communities, hindering collective action, undermining trust and shared understanding needed for societal transformation [15].

Geopolitical factors, such as national versus regional or urban versus rural competition for power, may reduce BRs to mere political and economic tools departing substantially from the ideals of sustainable development outlined in the UNESCO MAB program [16,17]. Federal/national versus regional power struggles may lead to BRs being leveraged for political gains, where economic priorities overshadow ecological and social goals [18]. Additionally, urban–rural dynamics can create conflicts over land use and resource allocation, with urban interests often dominating at the expense of rural communities [19]. Hence, there is a need to employ policy instruments or develop innovative measures to take this into account to be able to promote sustainable development, enhance social equity, and ensure the effective management of natural resources through, for example, agroecology, responsible tourism or payment for ecosystem services [20,21].

Demographic factors present another structural challenge, particularly when involving marginalized groups, such as youth. Despite that several studies show successful cases where young people enjoyed participating and were well received in BRs [22], had a strong grasp of environmental governance issues, and preferred to contribute actively to conservation and development [23,24], youth representation in decision-making bodies remains limited. This risks youth exclusion and potential brain drain from BRs territories. Hence, greater youth integration into governance is crucial for addressing these challenges [11].

Depopulation is another recurrent demographic factor in the literature that may contribute to land use change due to, for example, a decline in traditional management systems and by extension less resilient ecosystems [13,19,23]. Neither National Parks nor BR designations seem to have been able to slow down this phenomenon. Revitalizing these systems requires locally tailored approaches, integrated planning, and active community involvement and learning, with a focus on engaging youth and women [23,25].

Institutional challenges

Key institutional challenges that hinder learning as well as effective management of BRs include weaknesses in governance framework design, including BRs' role as either a neutral platform or a normative arena for transformative change. These challenges tend to affect participation, which is compounded by issues related to property rights, influencing land use and planning processes.

Our review shows that BRs face numerous challenges in their effort to balance human welfare and conservation due to their governance structures, which often combine formal structures with informal networks [26]. On a horizontal level that includes collaboration between entities on the same level of government. The establishment of BRs is often impacted by legacy effects from past governance, particularly under corporatist or colonial systems, influenced by political and socioeconomic histories and dominant stakeholder networks [27]. Consequently, there is a need for stronger government commitments and proactive support to help facilitate equal involvement among different right- and stakeholders, which at the moment are hindered by, for example, under-resourcing [11,28].

In their role as regional actors, BRs often contribute to new institutional entities such as steering committees, intermunicipal assemblies, and task force groups which in turn develop internal organizational and external communication structures. In doing so, they help to consolidate vertical governance, that is, coordination and collaboration between different levels of government [20]. However, studies have called attention to, on the one hand, lack of integration in national political structures [29] and, on the other hand, the risk that the BRs might develop into "mini public authorities" on a regional level with responsibility over specific tasks such as land use planning, but without decision-making rights [10].

Another challenge for BRs lies in balancing their dual objectives. Although BRs are formally committed to integrating social and cultural aspects of sustainable development, our review shows that they tend to focus primarily on nature conservation [30–33]. This gap between UNESCO's human-centered goals and the actual practice within BRs is well documented, with ecological priorities often overshadowing cultural and developmental aims. There is therefore an ongoing debate within the research community whether BRs can or even should continue to be neutral arenas, as illustrated in the establishment of the Isle of Man BR. Some scholars as well as officials contend that for BRs to truly drive sustainable and equitable futures, they must move beyond their supposed neutrality and actively engage in sociopolitical change [34]. This involves including collective action that does not seek to resolve tensions or achieve consensus but rather aims to learn to navigate the complexities and discomforts of differing perspectives. It is assumed that through this process, new possibilities for collective action and innovative methods for transformation can emerge [35].

Another key component in the governance of BRs is stakeholder participation. While BRs hold potential for fostering dialog and collaboration in natural resource management, active participation is often hindered by individual resource constraints and conflicts of interest, influenced by historical relationships, perceptions of nature protection, and attitudes toward economic gain [36,37]. Other studies show that community engagement with BRs is often low due to top-down management, financial challenges, weak collaborative governance frameworks, and limited knowledge about BRs [15,38,39]. Due to the struggle with limited stakeholder engagement in many BRs, participation often involves only a small although very committed group [18]. Effective BR governance must overcome these barriers to strengthen community involvement and collaboration. Enhanced education and communication about BRs' roles and benefits could shift these perceptions and boost community engagement, as well as supportive community organizations and local governments in fostering collaborative networks and sustainable land use policies [8,40].

Another institutional challenge affecting learning, and the effective management of BRs is the variation in property rights and land ownership, across countries and regions around the globe. In some countries, like China, where land is state owned, community participation in BR management is limited because local stakeholders lack control over land use decisions due to, for example, history of land disenfranchisement that historically has been associated with conservation [15]. This contrasts with many Western countries, where private land ownership allows individuals and organizations more freedom to engage in land management. Despite this freedom, several studies indicate challenges to engage landowners due to fear of losing control over their land [10]. This global variation, from state control to private ownership, poses challenges for effective BR governance and collaboration, as different systems shape how communities contribute to conservation efforts.

Discursive ideational aspects

A key aspect associated with ideational and perceptional challenges can be found in the debate surrounding the concept of BRs. The word 'reserves' versus, for example, National Parks reveal significant differences in how these areas are perceived and communicated to the public. National Parks benefit from a well-established and powerful narrative that aligns with the human-nature dichotomy, identifying them as places where nature can recover from human influence. This narrative helps National Parks gain recognition and support, leveraging landscape stereotypes to attract, for example, tourism and public interest [41].

In contrast, BRs struggle with a more complex narrative due to their dual objectives of development and conservation. Unlike the straightforward narrative of National Parks, BRs aim to bridge the human-nature divide through a participatory approach to sustainable

development. This duality creates conflicting messages and complicates their communication, hindering public understanding and making it challenging to mobilize stakeholders and the public [6,41].

This challenge is reflected in the lack of recognition for BRs within global conservation frameworks. Unlike National Parks, BRs are not included in the protected area categories defined by the International Union for Conservation of Nature or in the Other Effective Area-Based Conservation Measures classifications. This lack of recognition diminishes their visibility and importance in global biodiversity agreements. Scholars argue that BRs should be recognized alongside other conservation measures to strengthen their role in promoting sustainable development and integrating into existing protected area categories rather than creating new ones. This would enhance the legitimacy of BRs and fit well into the new global biodiversity framework [6,42]. Others contend that BRs need a clear, cohesive narrative that effectively communicates their practical, local solutions, and overall value to both the public and policymakers; this could include alternative labels like 'biosphere landscape' or 'sustainable region' [16,43].

Discussion

How then can BRs address these challenges? Studies emphasize the need to develop the periodic reviews of BRs to become more effective learning tools [9,38,44,45]. Such systematic learning, monitoring, and reflection are crucial for developing adaptation strategies and informing planning at multiple levels.

While institutional aspects often are the focus in these reviews, our work also suggests that the identified structural and ideational, and perceptual challenges should be considered in a more strategic way to ensure that these are properly addressed. Structural challenges, which involve socioeconomic structures that shape individual as well as organizational behavior, may initially seem beyond the scope of individual BRs to manage. Nonetheless, socioeconomic, geopolitical, and demographic challenges may also serve as catalysts for social change. Therefore, including structural aspects in evaluations is essential for identifying key drivers of conflict that may hamper learning and ensuring that socioeconomic development, or the lack thereof, is carefully considered when setting objectives and strategies to avoid exacerbating existing inequalities.

Moreover, when it comes to institutional challenges, there remains a need to establish governance frameworks that, on the one hand, maintain independence, and on the other, are sufficiently integrated — horizontally and vertically — into existing governance structures to gain legitimacy. As mentioned above, BRs often struggle with their dual objectives, particularly the apparent bias toward ecological goals over social and cultural ones. Here, it is probably necessary to rethink and innovate to being able to address the intertwined crises of climate change and biodiversity loss while taking social and cultural aspects into account. This also touches upon the identified narrative challenges since the adoption of the Lima Action Plan of 2016, which emphasizes BRs' role in advancing SDGs, is a normative agenda in itself challenging the supposed neutrality of BRs. However, the focus on SDGs within BRs also warrants critical examination. Critics argue that these concepts often emphasize economic growth while overlooking cultural alternatives. To foster more context-specific and transformative practices, it might be beneficial to explore alternative approaches such as 'Buen Vivir', 'Ubuntu', 'Swaraj', and degrowth, which prioritize social and environmental well-being over economic expansion [1].

While BRs hold significant potential as learning hubs or 'living labs' for transformative change a recent analysis of sustainability innovations in BRs show that these innovations had limited transformative potential due to the lack of amplifying strategies [46]. This can also be understood in relation to the challenges identified in this review. Given the global challenges, there are numerous indications that the development of BRs is at a critical juncture. If the identified challenges are not addressed, there is a risk that the role of BRs will be marginalized in the future, rather than evolving into key arenas that contribute to the transformative change we urgently need.

Conclusion

The findings of this review underscore that for BR to meaningfully contribute to sustainability transformation, several entrenched challenges, structural, institutional, and ideational, must be actively approached. These are not just operational obstacles but reflect deeper tensions in how BRs are conceptualized and implemented in different socioecological contexts. Addressing these challenges demands more than incremental improvements; it calls for the adoption of transformative approaches such as the living lab concept [47,48], co-productive agility [35,49], and the development of evaluative frameworks [50]. These tools are essential not only for fostering learning at the local level and innovation but also for critically assessing the broader transformative potential of BR initiatives.

Incorporating these aspects into the periodic reviews of the BRs but also in research could enhance their capacity to engage with the complexities of social change. In this light, BRs must be seen not merely as protected areas or

experimental zones but as evolving platforms for where new strategies and institutional arrangements can be tested and scaled. Their legitimacy and effectiveness as models for sustainable development will increasingly depend on their ability to navigate complexity, embrace reflexivity and support systemic transformation.

Data Availability

No data were used for the research described in the article.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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