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The scientific value of UNESCO biosphere reserves

The United Nations Educational, Scientific and Cultural Organization (UNESCO) launched its Man and the Biosphere (MAB) Programme in 1971, with its 'biosphere reserve' concept instituted 5 years thereafter. The aim of the MAB Programme is to improve the relationship between people and their natural environment, and provides an explicitly people-centred conservation approach that emphasises the synergies and trade-offs between environmental 'preservation' and environmental 'use'. These synergies, i.e. linking people and nature in pursuit of development goals, are being executed in landscapes designated as biosphere reserves. Sites are listed in the World Network of Biosphere Reserves (WNBR) and organised into regional networks in order to improve networking and collaboration. South Africa is a member of AfriMAB (regional MAB network for sub-Saharan Africa) and is the current coordinator of the southern Africa sub-regional network.

The WNBR currently numbers 701 in 124 countries. All sites enable three complementary functions: conservation (of landscapes, ecosystems, species and genetic variation), sustainable development (fostering economic development which is ecologically and socio-culturally sustainable), and logistic support (promoting research, monitoring, education and training), achieved through a graduated spatial zonation of permissible use (Figure 1). Biosphere reserves have been established across a wide range of landscapes and habitats, from the largest, North-east Greenland Biosphere Reserve of 97 200 000 ha, to the diminutive 905 ha coverage of And Atoll Biosphere Reserve, part of the Federated States of Micronesia. Despite differing in size and location, all sites are operationalised according to UNESCO's global policy objectives, and therefore constitute a very valuable resource of similarly managed sites that can be used to conduct scientific research.

The Director-General of UNESCO, Audrey Azoulay, recently noted:

The vitality of the WNBR gives us cause for hope. Each UNESCO biosphere reserve is an open sky laboratory for sustainable development, for concrete and lasting solutions, for innovation and good practices.

Her statement underscores the value of the international biosphere reserve network, especially in places where sustainability science could be practised and showcased.

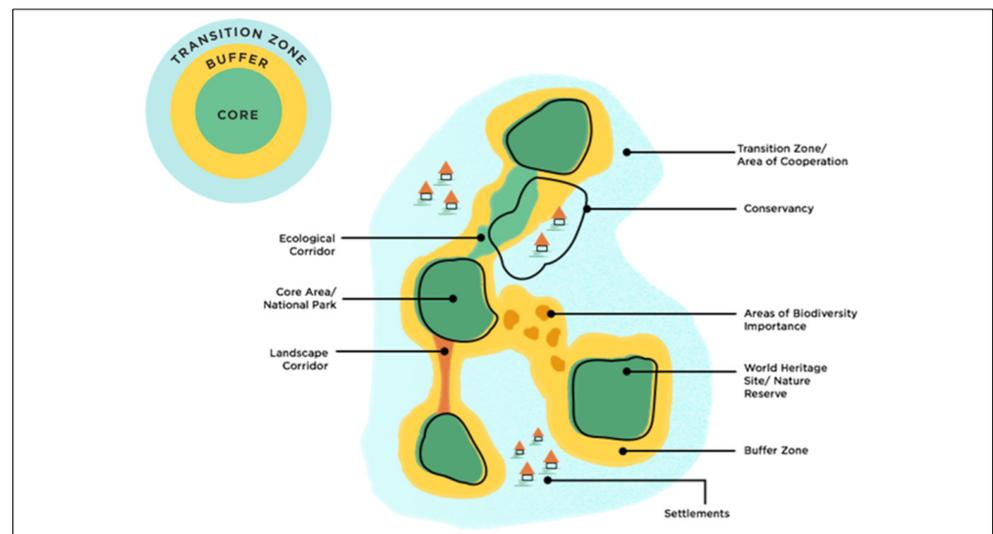


Figure 1: Schematic spatial layout of a typical biosphere reserve

UNESCO Guidelines for biosphere reserves

All biosphere reserves are directed by dedicated UNESCO guidelines, the first of which was the Seville Strategy and Statutory Framework of the WNBR in 1996.¹ New guidelines were released in 2017, namely the new global MAB Strategy and associated Lima Action Plan (LAP).² With the LAP's entry into MAB's policy space, the contribution of biosphere reserves to implementing the global Sustainable Development Goals (SDGs) as well as other multilateral environmental agreements including the Aichi Biodiversity Targets, was emphasised. Specifically, MAB's mission highlights the role of research

to help member states to urgently meet the SDGs through experiences from the WNBR, in particular through exploring and testing policies, technologies and innovations for the sustainable management of biodiversity [...] and adaptation to climate change.^{2(p.16)}

In line with Strategic Objective 3 of the global MAB Strategy, each biosphere reserve is expected to have an active research programme based on sustainability science,^{2(p.19)} and in the LAP, member states and individual biosphere reserves are encouraged to use the sites as observatories for climate change research, monitoring, mitigation and adaptation. Specific mention is made of research in terms of biosphere reserves as social-ecological systems. Action A1.6 of the LAP specifically notes that member states should 'undertake research and ensure the long-term conservation of the socio-ecological systems of biosphere reserves'^{2(p.36)}. Research to support the

management of biosphere reserves is addressed in detail in Outcome A4 and emphasises good practices for sustainable development and partnerships with tertiary institutions.^{2(p.38)} Joint research agendas and collaborative research in general is mentioned as actions of regional networks such as AfriMAB.

Clearly, research and innovation is required in order to assist countries in meeting the requirements of the SDGs. However, Nakamura et al.'s³ recent analysis of research activities related to the SDGs indicates that Africa is a small participant in SDG-related research, despite the fact that achieving the SDGs is of critical concern on the continent. Biosphere reserves specifically contribute towards SDGs 1 (No Poverty), 4 (Quality Education), 5 (Gender Equality), 8 (Decent Work and Economic Growth), 10 (Reduced Inequality), 13 (Climate Action) and 15 (Life on Land). This suggests a pressing research opportunity across the AfriMAB network to contribute to sustainability science as per requirements of the global MAB Strategy.

South African biosphere reserves

South Africa has 10 designated biosphere reserves (Kogelberg, Cape West Coast, Waterberg, Kruger to Canyons, Cape Winelands, Vhembe, Gouritz Cluster, Magaliesberg, Garden Route and Marico), with the first designated in 1998 and the most recent in 2018 (Table 1). They are located in six of South Africa's provinces (Limpopo, Mpumalanga, Gauteng, North West, Eastern Cape and Western Cape) and collectively cover 115 732 km², approximately 9.5% of South Africa's total land area. Although this figure includes statutory conservation areas as biosphere reserve core areas, it is clearly not insignificant in the greater national system of landscape protection.

Table 1: Biosphere reserves of South Africa

Biosphere reserve	Province(s)	Year of designation	Total size (ha)
Kogelberg	Western Cape	December 1998	103 629
Cape West Coast	Western Cape	November 2000	387 000
Waterberg	Limpopo	March 2001	417 406
Kruger to Canyons	Limpopo and Mpumalanga	September 2001	2 608 000
Cape Winelands	Western Cape	September 2007	322 032
Vhembe	Limpopo	May 2009	3 044 163
Gouritz Cluster	Western and Eastern Cape	June 2015	3 187 893
Magaliesberg	North West and Gauteng	June 2015	357 437
Garden Route	Western Cape and Eastern Cape	June 2017	698 363
Marico	North West	July 2018	447 269

Unlike statutory protected areas, biosphere reserves in South Africa are not enforced through legislation, but instead implemented in a 'soft law' spirit through collaboration between the biosphere reserve management entities and major stakeholders and role players.⁴ By establishing these relationships, biosphere reserves enable more defensible socio-political decision-making. In a country where the concept of 'conservation' is often associated with enduring resentment due to a socio-political history of marginalisation, exclusion, and ethical injustices,⁵ the MAB model's values of collaborative thinking and decentralised decision-making have additional relevance.

South Africa's biosphere reserves are currently guided by the Strategy for the Biosphere Reserve Programme (2016–2020).⁶ This specifically notes the value of partnerships at multiple scales, as the strength of a biosphere reserve lies in its ability to interact with local actors – of which research institutions are considered key – around a shared vision for landscape

management. The Implementation Plan and Monitoring and Evaluation Framework associated with the Strategy, list specific criteria for the designation and evaluation of biosphere reserves that inter alia refer to the value of having biosphere reserves, especially core areas, listed as long-term study sites for climate change research and monitoring.⁷ The Strategy also emphasises the general research role of biosphere reserves and the value of joint research agendas with tertiary institutions. The intention is that, coordinated effectively, biosphere reserves have the potential to assist the country towards meeting its international commitments in terms of the SDGs and the Aichi Biodiversity Targets, as well as the implementation of national priorities such as the National Development Plan.

Scientific value of biosphere reserves

People's lives are intertwined with natural ecosystems and this interconnectedness plays out in landscapes realised as social-ecological systems. The complex dynamics between humans and environmental systems are studied in the relatively new field of sustainability science.^{8,9} However, the MAB Programme has been the embodiment of sustainability science from the onset,¹⁰ arguably decades before this discipline gained prominence in the academic scholarship. One of the founding directions noted by the Seville Strategy was to 'reinforce scientific research in biosphere reserves'^{11(p.5)}. With time, the WNBR became a global network for interdisciplinary research – one that is albeit still underutilised – and thereby in effect, became the test case for applying sustainability science in different contexts.¹⁰ Biosphere reserves by their nature are multi-use landscapes, managed as complex adaptive social-ecological systems.^{4,11} They were initially positioned as a research network of permanent field sites¹² – sites at which the impacts of cross-scale social, economic and ecological interactions, and the consequences of ecological, social and political legacies of the broader landscapes can be assessed¹¹.

A literature review on research related to biosphere reserves¹³ indicates a steady increase in scientific output since the mid-2000s. Although most of these research outputs took place in biosphere reserves, they were 'not about biosphere reserves'^{13(p.46)}. Pool-Stanvliet and Coetzer⁴ identified two types of research relating to South African biosphere reserves, namely focused research on the implementation of the MAB Programme, and then research on a very wide range of topics for which biosphere reserves are used as study sites. The strengthening of different forms of research, including empirical research on the MAB Programme in itself, is important within the network of biosphere reserves.

A few attempts have been initiated as platforms for exchanging biosphere reserve research and as a home for knowledge on research conducted in biosphere reserves, e.g. BiosphereSmart, an online, global observatory created to share ideas and knowledge; the Biosphere Research Platform facilitated by C-BRA¹⁴; BRInfo, the Biosphere Reserve Information-sharing Portal; the database hosted by the *International Journal of UNESCO Biosphere Reserves*; and the Western Cape UNESCO Biosphere Reserves Research Portal. However, these platforms have yet to gain widespread traction as knowledge-sharing implements. Regardless, these attempts are in line with Strategic Action Area D of the LAP which emphasises transparent information and data sharing.

To illustrate the scientific value of South African biosphere reserves, we present two examples: Kruger to Canyons Biosphere Region and Vhembe Biosphere Reserve.

Kruger to Canyons Biosphere Region

Kruger to Canyons Biosphere Region (K2C) straddles Limpopo and Mpumalanga Provinces, covers 2 608 000 ha and was designated by UNESCO MAB in 2001. Scientific research is embedded in K2C, with the inclusion of the SAEON Ndlovu node that focuses on the Savanna Biome. The K2C team has identified 'sound research' as one of the responsibilities of the biosphere reserve. The Board of Directors is supported by a Representatives Council that hosts, amongst others, a task team on research.

A basic literature search for published papers specifically mentioning K2C as a study site reveals a long list of tertiary institutions from numerous countries, including (but not limited to) Australia, Canada, France,



Germany, Hungary, South Africa, the United Kingdom, and the United States of America. The fields of research are broad and cover climate change, biodiversity, and ecosystems, to social systems and resilience.

Being active in the research field, K2C has numerous connections to tertiary institutions and it benefits greatly from these collaborations through being exposed to alternative funding sources. Postgraduate students produce research that could be used to inform adaptive management in the K2C to improve effectiveness of the biosphere reserve.

Vhembe Biosphere Reserve

Vhembe Biosphere Reserve (VBR) in Limpopo Province comprises 3 044 163 ha and was designated in 2009. VBR is a vibrant landscape for scientific research and hosts a number of private research centres as well as the University of Venda.

The University of Venda is home to the South African Research Chair on Biodiversity Value and Change in the Vhembe Biosphere Reserve, and provides scientific support to administrators, politicians and biosphere reserve managers through applied research related to the challenges facing the biosphere reserve. The Research Chair is co-hosted by the Centre for Invasion Biology at Stellenbosch University which is a hub for biodiversity science, training and conservation application in the Southern African Development Community.

Work of the Research Chair contributed *inter alia* towards an effective environmental management plan for VBR. Collaborations of the Research Chair with VBR and the Limpopo Department of Economic Development, Environment and Tourism, have ensured that biodiversity and its ecosystem services have been adequately mapped and integrated into conservation planning at local and provincial levels.

Here, a basic literature search for published papers specifically mentioning VBR as a study site revealed an equally long list of tertiary institutions being involved with scientific research. Similarly, the fields of research were very broad, including insects, spiders, mammals, vegetation, conservation planning and social studies.

VBR reaps benefits from these valuable collaborations. Research outputs increase the visibility of the biosphere reserve and also contribute to greater awareness of the VBR and its work within the respective social-ecological landscape.

Other South African biosphere reserves

All South African biosphere reserves support and promote scientific and transdisciplinary research collaborations with tertiary institutions. The Gouritz Cluster Biosphere Reserve (GCBR) in the Western Cape Province is another example. The collaborative Jobs for Carbon project (J4C) is an innovative, flagship initiative combining job creation with biodiversity conservation. J4C has been included as a case study in a paper on climate change mitigation and ecosystem restoration.¹⁵ GCBR greatly benefits from exposure through the J4C. The project is resulting in job creation, skills development, landscape restoration, alternative funding streams and an increase in the quality of life of local communities. Toerien¹⁶ uses the GCBR as a case study that, for the first time in South Africa, has provided a quantitative picture of enterprise development and dynamics in a biosphere reserve.

Garden Route Biosphere Reserve (GRBR) in the southern Cape straddles the Western Cape and Eastern Cape Provinces. The George Campus of the Nelson Mandela University is located within the biosphere reserve. GRBR is being studied as a complex social-ecological system and used as a site for sustainability research, driven by the Sustainability Research Unit. This unit has conducted considerable research on topics such as biodiversity inventories, ecosystem services, management regime shifts, resource governance, stewardship and systemic change, to name but a few.

Conclusion

From the time of its inception, scientific research has been intrinsic to the MAB Programme. Biosphere reserves have a responsibility to promote and support interdisciplinary and transdisciplinary research

that is relevant to society. The complex interaction between people and the natural environment is embedded in biosphere reserves and it is this interconnectedness that drives sustainability science. Biosphere reserves are therefore ideal, scientifically sound platforms that can be used for understanding social-ecological systems,¹⁷ with Strategic Action Area A of the LAP placing biosphere reserves firmly at the interface between science, policy and society.

Biosphere reserves are 'learning sites for sustainable development', where the security associated with the UNESCO designation and the domestic political support that accompanies a nomination is of considerable importance.¹⁸ The LAP specifically acknowledges the WNBR as 'an integrated global network of learning and demonstration sites for innovation in sustainable development'^{20,22}. Yet despite this acknowledgement, biosphere reserves are still very much underutilised as global transdisciplinary study sites.

Critically important to biosphere reserves is the international affiliation with UNESCO. Being part of the WNBR carries a wealth of international recognition and access to expertise, thereby facilitating the process of requesting funding from international institutions. Given the increased competition for an increasingly limited number of research grants,¹⁹ such endorsement from UNESCO, *and* the public-private partnerships that the biosphere reserves management entities curate, has considerable added value.

We have presented a brief overview of South African biosphere reserves, emphasising their value as scientific research arenas. They are ecological and cultural depositories where the interconnectedness between humans and the natural environment is evident, and where scientific research focusing on this human-environment interface should be promoted and supported.^{10,20}

We foresee a future where biosphere reserves individually and the WNBR collectively would be fully utilised as a valuable platform for interdisciplinary and transdisciplinary research. Doing so would contribute to realising the vision of UNESCO's Director-General that they be acknowledged as open sky laboratories for sustainable development.

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