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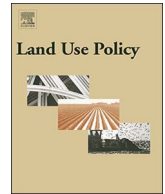Some of the authors of this publication are also working on these related projects:

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Criteria for selection and evaluation of biosphere reserves in support of the UNESCO MAB programme in South Africa

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ARTICLE INFO

ABSTRACT

The biosphere reserve model is a global designation in accordance with UNESCO's Man and the Biosphere Programme. Biosphere reserves are required to fulfil three functions as prescribed by UNESCO, namely conservation, sustainable development and logistic support. Worldwide, the 669 biosphere reserves in 120 countries are experiencing different degrees of effectiveness in fulfilling these functions.

This paper investigates trends in the selection of sites for new biosphere reserves and puts forward a set of criteria for the establishment of future biosphere reserves in South Africa, in order to capitalize on the potential of the MAB Programme. Given the country's limited natural, economic and social resources, there is a need to prioritize where these resources could best be allocated. Presently, new sites for biosphere reserves in South Africa are randomly nominated, resulting in biosphere reserves that are not always optimally located. The proposed suite of biosphere reserve criteria for South Africa has the potential to be of valuable assistance in selection processes for future effective and efficient biosphere reserves that will proudly earn their rightful place in the South African landscape. The criteria are structured according to four subsections, namely a general section that addresses national matters of general concern to the MAB Programme, and three sections covering the three biosphere reserve functions.

These criteria also have the potential to be adapted to the needs of other developing countries in support of the effective implementation of the MAB Programme.

1. Introduction

The UNESCO Man and the Biosphere (MAB) Programme finds spatial expression in sites designated as biosphere reserves. These sites are nominated by national governments and, subsequent to a review process, are designated by UNESCO. Biosphere reserves must meet a minimal set of criteria and conditions to be designated, subsequently forming part of the World Network of Biosphere Reserves (WNBR), currently comprising 669 biosphere reserves in 120 countries. The WNBR is one of only four global networks that include designated protected areas (Price et al., 2010). Consequently, biosphere reserves provide an expansive network of similarly defined sites around the world. Biosphere reserves are widely recognized as an excellent landscape management option through which to showcase sustainable development in action (Bridgewater, 2002, 2016; Edge and McAllister, 2008; Pool-Stanvliet and Giliomee, 2013), and are ideally positioned to assist countries in meeting the sustainable development goals (SDGs), adopted by the United Nations in September 2015. The fourth World Congress of Biosphere Reserves, held in Lima, Peru in March 2016, endorsed the Lima Action Plan (LAP), which was subsequently adopted by the MAB International Coordinating Council. The first action of the LAP specifically states that biosphere reserves are models contributing to the implementation of the SDGs (UNESCO, 2017).

A biosphere reserve encompasses three elements: core area(s) that are statutory protected, buffer zone(s) adjoining or surrounding the core areas, and a transition area. Given the required status of the core areas, biosphere reserves typically incorporate sites (as part of the core areas) that are listed in accordance with IUCN's Protected Area Management Categories, and which are therefore protected under national legislation. However, the entire conservation estate included in buffer and transition zones, does not necessarily have formal IUCN listing. Furthermore, biosphere reserves are not spatially exclusive and often include land parcels designated in accordance with other international designations such as World Heritage sites and Ramsar sites (Price et al., 2010; Schaaf and Clamote Rodrigues, 2016).

The government of South Africa strives to find the much needed

Box 1
Criteria as listed in Article 4 of the Statutory Framework of the World Network of Biosphere Reserves

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General criteria for an area to be qualified for designation as a biosphere reserve:

1. It should encompass a mosaic of ecological systems representative of major biogeographic regions, including a gradation of human interventions.

2. It should be of significance for biological diversity conservation.

3. It should provide an opportunity to explore and demonstrate approaches to sustainable development on a regional scale.

4. It should have an appropriate size to serve the three functions of biosphere reserves.

5. It should include these functions, through appropriate zonation, recognizing:

   (a) a legally constituted core area or areas devoted to long-term protection, according to the conservation objectives of the biosphere reserve, and of sufficient size to meet these objectives;

   (b) a buffer zone or zones clearly identified and surrounding or contiguous to the core area or areas, where only activities compatible with the conservation objectives can take place;

   (c) an outer transition area where sustainable resource management practices are promoted and developed.

6. Organizational arrangements should be provided for the involvement and participation of a suitable range of inter alia public authorities, local communities and private interests in the design and carrying out the functions of a biosphere reserve.

7. In addition, provisions should be made for:

   (a) mechanisms to manage human use and activities in the buffer zone or zones;

   (b) a management policy or plan for the area as a biosphere reserve;

   (c) a designated authority or mechanism to implement this policy or plan;

   (d) programmes for research, monitoring, education and training.

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balance between economic growth, social development and environmental sustainability, while dealing with a number of critical challenges, including poverty, unemployment and inequality (DEA, 2017; DSD, 2017). In addition to these social issues, the critical challenge of climate change impacts on environmental, social and economic systems. The new MAB Strategy and accompanying LAP encourage countries to use biosphere reserves towards fostering sustainable development and to 'contribute to sustainable, healthy, and equitable societies, economies and thriving human settlements' (UNESCO, 2017). These inherent attributes of the MAB Programme put biosphere reserves in a position to assist national government in finding landscape-based solutions to South Africa's pressing challenges.

The official UNESCO criteria for designation as a biosphere reserve are set out in Article 4 of the Statutory Framework of the World Network of Biosphere Reserves (Box 1 – UNESCO, 1996). The first two criteria address biodiversity significance and specify that a new biosphere reserve needs to be representative of a biogeographic region. The trait of representativeness is crucial where it refers to representation of important biological diversity at a specific scale and could refer to various units, such as biogeographical provinces (Udvardy, 1975), ecoregions (Olson and Dinerstein, 2002), biomes (Margules and Pressey, 2000), bioregions (Brunckhorst, 2000; Rutherford et al., 2006), vegetation types, ecosystems or habitat types (Margules and Pressey, 2000). The aim would be to cover the full range of the selected unit in a national network of biosphere reserves.

The question therefore arises: which process is most applicable to the selection of sites for new biosphere reserves that could form a well-designed network of social-ecological systems in a specific country. In the past, spatial selection of protected areas was based mostly on opportunism (Pressey and Taffs, 2001). In some cases, selection of sites was done in an ad hoc way, based on the availability of land, most of which have been land that are not commercially valuable or relatively rugged (Pressey et al., 1993; Pressey, 1994; Cowling et al., 1999; Margules and Pressey, 2000; Pressey and Taffs, 2001; Rodriques et al., 2004; Knight and Cowling, 2007). Other reasons for selecting protected areas included spectacular scenery (Terborgh and Winter, 1983), tourist revenue (Huntley, 1978) and water catchments (Rebelo and Siegfried, 1992). These methods result in protected areas not always being selected in a systematic manner. This is a practice which should be prevented in the selection of future biosphere reserves, given that biosphere reserves include protected areas as part of their core areas.

A recent multicase study on biosphere reserves in South Africa indicated that not all biosphere reserves are equally effective in their implementation of the three functions of (i) conservation (contributing to the conservation of landscapes, ecosystems, species and genetic variation); (ii) sustainable development (fostering economic and human development which is socio-culturally and ecologically sustainable); and (iii) logistic support (supporting demonstration projects, environmental education, training, research and monitoring), and that all biosphere reserves in the country face an uncertain future due to pressing challenges (Pool-Stanvliet, 2014). Despite these findings, and due to the socially-inclusive nature of biosphere reserves, the concept is particularly favoured in developing countries (Coetzer et al., 2013). The South African government supports the MAB concept as a framework to re-coordinate different programmes and projects within a certain area with a focus on sustainable development. This recognition is demonstrated through the growing number of biosphere reserves, endorsed by national government for UNESCO designation (Table 1).

At present, all of the nine South African biosphere reserves, as well as the one currently on review, are being managed through non-profit companies (Table 1). This is similar to Canadian biosphere reserves where activities are also coordinated by community-based structures, and biosphere reserves do not have legal jurisdiction over land, waters and resources (Reed, 2016). The non-profit management entities comprise representatives of a wide range of stakeholders, including communities, conservation agencies and government departments. Nonetheless, most of their accomplishments are being sustained by volunteer involvement. This is contrary to the findings of Schultz et al. (2011) where it was indicated that volunteer contributions should only complement formal, funded management of biosphere reserves. However, due to the virtual absence of government funding for biosphere reserves in South Africa, the fundraising abilities of volunteers contribute greatly towards ensuring financial sustainability of the respective biosphere reserves.

Biosphere reserves need to be optimally located in order to secure long-term persistence, efficiency and effectiveness. These sites need to be representative of biodiversity, efficiently managed, and persistent in the long run. Presently in South Africa, national government submits nominations of new biosphere reserves to UNESCO in an ad hoc manner, generally in response to requests by interested community groups, though with support from the relevant provincial government (Pool-Stanvliet, 2014). Although these nominations are supported by

Table 1
South African Biosphere Reserves.

BIOSPHERE RESERVE	PROVINCE	YEAR OF DESIGNATION	TOTAL SIZE	MANAGEMENT ENTITY
Kogelberg	Western Cape	1998	103 629 ha	Non-profit Company
Cape West Coast	Western Cape	2000	387 000 ha	Non-profit Company
Kruger to Canyons	Limpopo and Mpumalanga	2001	2 608 000 ha	Non-profit Company
Waterberg	Limpopo	2001	417 406 ha	Non-profit Company
Cape Winelands	Western Cape	2007	322 032 ha	Non-profit Company
Vhembe	Limpopo	2009	3 070 100 ha	Non-profit Company
Gouritz Cluster	Western Cape	2015	3 187 893 ha	Non-profit Company
Magaliesberg	Gauteng and North-West	2015	364 704 ha	Non-profit Company
Garden Route	Western Cape and Eastern Cape	2017	698 363 ha	Non-profit Company
Marico	North West	On review	447 268 ha	Non-profit Company

national government, the locations of the sites have not been systematically selected. In order to safeguard and enhance the quality of biosphere reserves, and to ensure support from responsible partners for the maintenance and development of these sites, the need was identified to devise a suite of biosphere reserve criteria for South Africa. Such criteria would be useful in the selection of new biosphere reserves, but could also be implemented in evaluating the effectiveness of existing sites. Therefore the focus of this research is to provide a suite of criteria applicable at national, provincial and local scales that would contribute to the selection process of future biosphere reserves.

2. Background to biosphere reserve criteria

South Africa has limited natural, economic and social resources. It is thus a given that these resources should be used wisely. The locations of new biosphere reserves must therefore be selected discerningly in a spatially-explicit manner, so as to ensure that they would offer a long-term landscape management opportunity towards the showcasing of sustainable development practices.

In the Statutory Framework of the WNBR it was noted that: "*States are encouraged to elaborate and implement national criteria for biosphere reserves which take into account the special conditions of the State concerned*" (UNESCO, 1996: 16). Although the Seville Strategy has been succeeded by the LAP (UNESCO, 2017), compliance with the Seville Strategy and the Statutory Framework has been incorporated in Strategic Action Area A of the LAP. Designing suites of national criteria is not an easy process and has not been attempted by many countries. Although much has been published on aspects that need to be addressed for biosphere reserves to have a positive influence in the landscape (Matysek, 2009; Schultz et al., 2011; Pool-Stanvliet and Giliomee, 2013; Reed, 2016; Cuong et al., 2017a, 2017b; Köck and Arnberger, 2017) little work has been done on criteria for the optimal location of biosphere reserves.

The biosphere reserve model could be regarded as a coupled social-ecological system with a strong multi-disciplinary basis (Matysek, 2009; Makeddah, 2010). In these social-ecological systems, ecological, social and economic information need to be taken into account during selection processes. Knight et al. (2010) noted the importance of taking social factors into account to ensure on-the-ground implementation of spatial prioritizations.

The science of selecting priority areas for biodiversity conservation is relatively new and is generally referred to as 'spatial prioritization' (Downsborough et al., 2011; Knight et al., 2010, 2011). It incorporates conservation planning processes and is widely used in selecting new protected areas. When we relate the criteria for selecting protected areas to the identification of sites for biosphere reserves, it is clear that the latter would need to include much more than only criteria towards the conservation of biodiversity. The process of selecting future biosphere reserves is comparable to a spatial prioritization process, but in addition it needs to take social views and needs into account. To our knowledge, a spatial prioritization approach with the specific aim of

designating biosphere reserves has only been done once and on a very small scale on the island of Bioko, Equatorial Guinea (Zafra-Calvo et al., 2010). This research resulted in the island being divided into three zones according to the MAB design and, as of 2018, biosphere reserve status is being pursued.

Taking all the above complexities into account, it is clear that a broad approach is needed to ensure long-term effective biosphere reserve implementation and that this should be based on careful selection of sites. All noted aspects should be considered in the process of identifying criteria that will be used for site selection towards the optimal location of future biosphere reserves. Such a process will ensure an effective national network that aligns with the vision of the Department of Environmental Affairs "*A prosperous and equitable society living in harmony with our natural resources*" (DEA, 2017: 10).

3. Methods

The applied social science methods used to obtain relevant information, included literature reviews, a national questionnaire, and focus group sessions (Frankfort-Nachmias and Nachmias, 1992; Margoluis and Salafsky, 1998; Longhurst, 2003; Ritchie et al., 2003; Stewart et al., 2009).

3.1. Literature reviews

Information was gathered from available literature to inform the drafting of a suite of biosphere reserve criteria for South Africa. A formal literature review was conducted on global biosphere reserve criteria. Because of the multidisciplinary, flexible and sometimes erratic nature of the biosphere reserve model, the review touched on relevant topics, including landscape-scale conservation, spatial prioritization, protected area selection processes and social-ecological systems. As a first step, the entire body of UNESCO MAB literature, where it relates to criteria for selecting and evaluating biosphere reserves, was reviewed. Publications on the UNESCO MAB web site (UNESCO, 2012) were searched with the Keywords: criteria. Out of a total of 202 records (search performed in May 2012), only 11 documents were of relevance.

The second step comprised a search of the global peer-reviewed literature through the application of a systematic review methodology (CEBC, 2010). The databases Scirus and Scopus were used to select a list of papers from international journals with respect to biosphere reserve criteria. Key words were combined using Boolean logical operators and are given in Table 2 (CEBC, 2010). Subsequent to applying a selection filter through reading titles and abstracts, the list included 102 relevant papers.

3.2. National questionnaire

The national Department of Environmental Affairs manages an electronic list of members of the National MAB Committee that gets updated annually. This list was used to distribute a national

Table 2
Key words used in the literature review.

Databases: Scopus and Scirus (search performed in April 2012)			
Keywords	*Confined to Subject Areas*	*Phrases used to refine*	*# Papers*
(criteria OR guidelines) AND biosphere	Environmental Science; Agricultural and Biological Sciences; Earth and Planetary Sciences; Social Sciences	biosphere reserve; criteria	40
select* AND biosphere reserve; criteria AND biosphere AND (select* OR evaluat*)	Environmental Science; Agricultural and Biological Sciences; Earth and Planetary Sciences; Social Sciences	biosphere reserve	19
(conservation planning OR spatial prioritization) AND selection AND protected	Environmental Science; Agricultural and Biological Sciences; Earth and Planetary Sciences; Social Sciences	reserve selection; systematic conservation planning	43
			102

Table 3
Suites of criteria derived from the literature review.

	Criterion Suite	Detailed Criteria
1	**Ecological/ Biological**	Representativeness (biogeographical regions/ ecoregions/habitats/vegetation types/etc.)
		Replication; Vegetation type
		Biological significance; Species diversity; Ecosystem diversity; Habitat diversity; Refugia for rare/endemic species
		Ecological connectivity
		Size (total and individual zones)
		Threats to loss of biodiversity
		Ecological resilience
		Availability of ecological data
		Land cover; Land use
		Naturalness
2	**Social**	Stakeholder support/attitudes
		Recreation value
		Total population; Demography
		Scenic quality; Aesthetic appeal
		Human alteration (present and future); Existing settlements
		Provision of ecosystem services
		Educational value
3	**Economic**	Sustainable financing
		Tourism opportunities
		Establishment costs
		Contribution of protection to maintaining economic value
		Operational costs
4	**Political**	Level of political support/acceptability
		Enforceability
		National/international importance
		Political visibility; Degree of political exposure
		Integration in land-use planning
		Political resilience
		Local conflict
		Need for conservation action
5	**Governance/ Management**	Persistency
		Legal implications
		Management plan/framework
		Logistics of management
		Site spatial design/zonation (core, buffer, transition)
		Compatibility with existing uses
		Institutional collaboration
		Organization; Manageability
6	**Scientific**	Presence of current research projects
		Potential/value for scientific research

questionnaire to solicit opinions on biosphere reserve criteria for South Africa. The questionnaire was based on the literature reviews and reflected six specific themes, namely ecological/biological, social, economic, political, governance, and scientific (see Table 3). A total of 51 questionnaires was distributed to members of the National MAB Committee that consisted of representatives of relevant national government departments (Environmental Affairs; Science and Technology; Basic Education: International Relations and Cooperation), the National Commission for UNESCO, all listed and proposed biosphere reserves,

and relevant provincial governments (Western Cape; Eastern Cape; Gauteng; Mpumalanga; Limpopo; North West).

3.3. Focus group sessions

Focus groups were shown to be an effective social research tool that facilitates communication and the exchange of views between participants concerning a specific topic (Longhurst, 2003; Ritchie et al., 2003; Stewart et al., 2009). The focus group method is sometimes also referred to as group interviewing or in-depth discussion groups (Ritchie et al., 2003; Hickey et al., 2013). In the case of this research, focus groups were particularly useful to explore the knowledge, insight and experiences of people closely involved with biosphere reserve management (Longhurst, 2003).

The network of people directly involved with South African biosphere reserves is relatively small and a total of four focus group sessions were held, attended by three, eight, 11 and 17 people respectively, representing all existing and proposed biosphere reserves at the time. The attendees were involved with the day-to-day management of biosphere reserves and differed largely from the respondents to the national questionnaire (of the 39 attendees, 8 were also members of the National MAB Committee at the time). The groups were all 'naturally occurring' (Stewart et al., 2009), in other words they have known each other personally, were used to working together, and had in-depth knowledge of the implementation of the MAB Programme in their respective biosphere reserves. As focus groups need to have a clear focus on a specific topic of interest (Stewart et al., 2009), an agenda focusing on national biosphere reserve criteria was set by the moderator.

4. Results

4.1. Literature reviews

Information obtained through reviews of the UNESCO MAB and peer reviewed scientific literature proved to be informative. The Lima Action Plan provides guidance towards ensuring that the World Network of Biosphere Reserves consists of effectively functioning models for sustainable development (UNESCO, 2017). In order to be effective, biosphere reserves need to be selected discerningly with regards to their spatial location.

The Seville +5 document noted that UNESCO's biosphere reserve periodic review process should facilitate the drafting of country specific guidelines for selection of new biosphere reserves (UNESCO, 2001). More recently, Stoll-Kleemann and O'Riordan (2017) noted that there would be a need for new criteria to inform the establishment of biosphere reserves and to assist these sites in becoming showcases of the SDGs.

The 1984 Action Plan for Biosphere Reserves, adopted by the International Coordinating Council of the MAB Programme (UNESCO, 1984; Batisse, 1985) called on countries to assist in improving and expanding the international biosphere reserve network. Conforming to this request, the National MAB Committee of Germany made a

Table 4
Description of criteria for selection and evaluation of South African biosphere reserves.

	GENERAL	Mandatory (M) Evaluation (E)
1	**Meet requirements of Seville Strategy and Article 4 of the Statutory Framework of the World Network of Biosphere Reserves**	**M**
	The biosphere reserves must address the 3 complementary functions within a 3-tiered zonation system of core, buffer and transition areas as described in the Seville Strategy, as well as conform to all 7 criteria as listed in Article 4 of the Statutory Framework of the WNBR. This information is needed to complete the prescribed UNESCO MAB nomination form.	
2	**Committed to sustainable development practices**	**M**
	The biosphere reserve management entity needs to make a statement related to their commitment to promote and support sustainable development practices.	
3	**Contribute towards conservation of biological and cultural diversity**	**M**
	The biosphere reserves needs to make a defined contribution to at least one aspect of biological or cultural diversity which is not sufficiently represented in South African biosphere reserves.	
4	**Proof of majority stakeholder support for the establishment of biosphere reserve**	**M**
	The biosphere reserve management entity needs to supply the results of a survey addressed to all major stakeholders, indicating majority support for the establishment of the biosphere reserve.	
5	**Legal enforcement of the biosphere reserve**	E
	Explore all legislative means and options to secure the enforcement of the biosphere reserve model and describe how these will be used and enforced.	
6	**Proof of networking endeavours at all scales**	E
	The biosphere reserve management entity has to provide proof in the form of agendas, attendance lists and minutes of networking opportunities with all major stakeholders, specifically including government departments, land administrators, NGOs, large businesses and community groupings.	
7	**Implement MAB Programme in accordance with national and provincial legislation**	E
	Depiction of the legal means that will be used to implement the biosphere reserve, such as protected area legislation, local authority by-laws and spatial planning processes.	
8	**Respect for rights and uses of land owners and traditional communities**	E
	Respect indicated in accordance with the Constitution of the Republic of South Africa, No. 108 of 1996, specifically chapter 1 (Founding Provisions), chapter 2 (Bill of Rights) and chapter 12 (Traditional Leaders).	

	CONSERVATION	Mandatory (M) Evaluation (E)
1	**Representative of a specific bioregion (subdivisions of biomes)**	**M**
	The biosphere reserve needs to represent a specific bioregion in the national system of biosphere reserves, taking the location of other biosphere reserves into account.	
2	**Proof of biological significance**	**M**
	The biosphere reserve needs to be of specific significance in the conservation of biodiversity, such as the presence of transitional vegetation types, rare and threatened species, endangered habitat types, species of special concern.	
3	**Long-term persistence of biosphere reserve/chances of success**	**M**
	As assessment is required of the chances that the biosphere reserve will be implemented successfully, efficiently and effectively over the long-term. Buy-in from stakeholders, integration into policies and land-use planning processes, support from local communities, financial soundness, amongst others could be used to verify chances of success.	
4	**Need to contain some element of uniqueness/characteristic natural feature (geography, altitudinal corridor)**	**M**
	The biosphere reserve needs to make a contribution in terms of a unique element contained in the functional space of the biosphere reserve that is not present in another South African biosphere reserve.	
5	**Ideally a biosphere reserve should encompass an integrated range of ecosystems**	E
	The biosphere reserve should represent an ecosystems or unique ecosystem complexes that form the basis of the demarcation of the outer boundary of the biosphere reserve.	
6	**Fine-scale spatial plan indicating priority areas in need of conservation**	E
	An indication of commitment to draft a fine-scale spatial plan for the entire biosphere reserve that would inform management practices.	
7	**Core areas listed as Long-Term Ecological Research (LTER) sites for climate change research and monitoring**	E
	An indication of commitment to investigate the potential of biosphere reserve core areas as an integral part of the South African long-term environmental observation network.	

	SUSTAINABLE DEVELOPMENT	Mandatory (M) Evaluation (E)
1	**Delimitation into core, buffer and transition areas/zones with use and development guidelines for each zone**	**M**
	Provide a map of the detailed zonation of the biosphere reserve, including guidelines for the use and potential future development of each zone.	
2	**Core areas long-term legally protected in terms of the National Environmental Management: Protected Areas Act**	**M**
	All core areas must be formally protected with an allocated legal status in terms of the NEM:PAA.	
3	**Contribute to the provision of landscape functions**	**M**
	The biosphere reserves needs to be specific about the landscape functions to be provided, such as conservation of water catchments, unpolluted air, recreational spaces, sustainable utilization of specific natural resources, and natural sources of energy.	
4	**Buffer zone functions specified (e.g. connectivity, buffering the core, cultural diversity)**	**M**
	Buffer zones are generally the most important functional spaces of biosphere reserves and the functions of the specific buffer zones need to be specified, amongst others connectivity, buffering the core, and cultural diversity.	
5	**Proof of consultations with buffer zone land owners**	**M**
	All buffer zone land owners must be consulted and proof of their consent to their land forming part of the biosphere reserve buffer zone need to be submitted.	
6	**Transition zone with meaningful boundaries, specified through consultation. Outer boundary should be demarcated primarily according to natural boundaries and secondly according to cadastral units**	**M**
	Transition zones need to have been demarcated with meaningful boundaries, preferably according to natural boundaries, additionally by means of cadastral boundaries. Provide proof of consultation processes with relevant land owners and administrations.	
7	**Sufficient size of all zones to fulfil required functions**	**M**
	An indication of why specific sizes have been allocated to zones is required. Minimum size of a biosphere reserve should ideally not be less than 50 000 ha.	

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Table 4 (*continued*)

	SUSTAINABLE DEVELOPMENT	Mandatory (M) Evaluation (E)
8	**Approved management framework with clearly defined vision and objectives and consideration of manageability of biosphere reserve**	M
	Submission of a management plan or management framework that provides directional guidance to the future of the biosphere reserve. A clearly defined vision and objectives that have been approved and adopted by all major stakeholders. The management plan needs to be specific about how the biosphere reserve will be collectively managed by all relevant role-players.	
9	**Presence of human communities within the biosphere reserve**	M
	A biosphere reserve is about 'man' and its interaction with the 'biosphere' therefore there needs to be interaction with human communities within the area of influence of the biosphere reserve.	
10	**Cooperative conservation and development strategies (e.g. connectivity, integrated planning)**	E
	Proof of strategies with collaborators such as plans to manage corridors for biodiversity connectivity, integrated planning processes, stewardship agreements, amongst others.	
11	**Established Biosphere Reserve Demonstration Projects**	E
	Plans are required that would set up demonstration projects to showcase sustainable development practices and provide benefits to local inhabitants, with a specific focus on co-managed communal areas under traditional authority ruling, and with the objective to form an integral part of the biosphere reserve.	
12	**Promote alternative, sustainable livelihoods**	E
	Commitment by the biosphere reserve management entity to support and promote alternative livelihoods such as use of renewable energy, wise water use, water purification, recycling ventures, use of indigenous vegetation in gardening and beautification.	
13	**Proof of sustainable land-use practices/strategies/initiatives**	E
	Commitment by biosphere reserve management entity to work with land owners to promote sustainable land-use practices and initiatives.	
14	**Address large population numbers and resultant challenges such as land restitution, unsustainable use of natural resources**	E
	Provide innovative ideas on how to address ever growing population numbers, changing consumption patterns and resultant strain on natural resources. If relevant, provide commitment to address land restitution challenges and plans on collaboration with new land owners with a focus on co-management practices.	

	LOGISTIC SUPPORT	Mandatory (M) Evaluation (E)
1	**Proof of stakeholder support through participatory processes, specifically targeting local and traditional communities**	M
	The biosphere reserve management entity needs to provide proof of collaboration with local and traditional communities and some proof of support by them for the establishment of the biosphere reserve.	
2	**Proof of political support through agreements with government departments, active involvement of politicians including mayors**	M
	The biosphere reserve management entity needs to provide proof of political support through signed Memorandums of Understanding with relevant departments and administrations.	
3	**Dedicated champion, support group and additional staff, office space**	M
	The biosphere reserves needs to have at least one dedicated person that acts as the spokesperson for the biosphere reserve. In addition, proof of a support group needs to be provided as well as an indication of available office space.	
4	**Proof of financial support for salaries and operational costs for at least 3 years, approved budget**	M
	Submit an approved budget with sufficient financial resources to cover the salary of one person and basic operational costs of the biosphere reserve for at least 3 years.	
5	**Designated representative (disciplines, authorities, gender and race) and transparent management entity with approved responsibilities**	M
	Details of the biosphere reserve management entity with representation across disciplines, authorities, gender and race. A clear indication of responsibilities of each representative on the management entity should be provided.	
6	**Proof of independency of management entity from government and political influences**	M
	Biosphere reserves are non-political entities and proof of independency needs to be submitted.	
7	**Institutional collaboration**	M
	Proof of the biosphere reserve management entity's collaboration with all major institutions, administrations and government departments in order to secure collaborative management of the biosphere reserve.	
8	**Educational value**	M
	An indication of how the biosphere reserve will be utilized to improve the educational impact within its boundaries and even beyond.	
9	**Ensure relevance of biosphere reserve's existence through relationship building, provide benefits to local communities and stakeholders such as job creation**	E
	Commitment to spend much time in building relationships with local inhabitants, especially the less advantaged sections of society. Provide an indication of how the biosphere reserve will provide benefits to local communities and stakeholders with the view to making a difference to people's lives.	
10	**Proof of awareness programmes**	E
	Creating awareness about the MAB Programme is crucial to the existence of a biosphere reserve therefore proof of awareness programmes with a range of community groupings need to be provided.	
11	**Perform a research and monitoring role, established links with educational institutions**	E
	Biosphere reserves need to be involved in research and monitoring projects and programmes. Provide commitment to secure research links with educational institutions, specifically universities, in the vicinity of the biosphere reserve.	
12	**Improve capacity through stakeholder empowerment**	E
	Stakeholders in general do not have sufficient knowledge about the MAB Programme and the biosphere reserve model. Indicate commitment to improve capacity of stakeholders through learning seminars and knowledge exchange opportunities.	
13	**Integration with relevant urban areas and urban authorities**	E
	Where relevant, urban authorities need to be secured as collaborative partners with the view to integrate the benefits of the biosphere reserve into urban areas.	
14	**Play a role in corporate social responsibility schemes**	E
	Local government has a social responsibility towards their constituent but does not always have the necessary in-house skills and expertise. Biosphere reserves could step into this void through acting as an implementing agent for governmental projects towards their social responsibility mandate and measures to this effect need to be provided. This could ensure that biosphere reserves would be recognized as valuable partners by provincial and local government.	
15	**Use the biosphere reserve brand in partnerships**	E
	The branding of the name of the biosphere reserve could be utilized to showcase sustainable development practices. If relevant, the biosphere reserve logo could be registered as a trade mark and used as a marketing and awareness building tool.	

deliberate effort to prepare a much detailed suite of criteria with which to review new biosphere reserve applications and to evaluate existing sites. The criteria were approved in January 1996 and comprise a two-tiered system of ten exclusion and 29 evaluation criteria, divided into structural and functional criteria (German MAB National Committee, 1996; UNESCO MAB, 1996; German Commission for UNESCO, 2007). Much alike the German system, Switzerland drafted a system of ten mandatory and eight assessing criteria for the selection and evaluation of their biosphere reserves, as noted in the Seville +5 document (Ruoss, 2001). In 1996 Austria similarly compiled a system of 38 biosphere reserve criteria, consisting of obligatory and evaluation criteria (Austrian MAB Committee, 2006).

A substantial body of literature exists on the selection of areas for biodiversity protection and the design of conservation area networks. A wealth of approaches, tools, strategies and frameworks are available on how exactly to conduct such a selection and network design. Most of these concur on the fact that the starting point is to develop a vision and objectives for a proposed network (Kelleher and Kenchington, 1993; Rawinski and Price, 1994; Hockey and Branch, 1997; McGregor, 2003; Didier et al., 2009; Makeddah, 2010). Apart from biodiversity aspects, the process of selecting new biosphere reserves would need to also include social and economic issues. Some of the lead authors within the discipline of landscape ecology agree that the lack of interaction between ecology and social-economic issues is indeed a weakness (after Calder, 2007).

Specific themes seem to be repeated throughout the reviewed global literature on conservation planning and biosphere reserve criteria. These are grouped into six main subsections as listed in Table 3.

4.2. National questionnaire

Of the 51 questionnaires distributed to members of the National MAB Committee, a total of 18 completed questionnaires were received, which represents 35% of the recipients. The main objective of the questionnaire was to solicit opinions on the need for South African biosphere reserve criteria (which was supported by 14 of the respondents), as well as to obtain inputs on a range of possible criteria. Reflections on possible criteria were tested with a rating of significance where the number 1 indicated a low significance; the number 2 indicated moderate significance and the number 3, high significance. The highest support (allocated a 3 by 12 or more of the 18 respondents) were indicated for criteria reflecting the following issues: dedicated staff; integration in land use planning; biological significance; provisioning of ecosystem services; educational value; sustainable financing mechanisms including the availability of operational costs; extensive stakeholder support; sustainable land use practices; high level political support; and the possibility of long-term persistence of the biosphere reserve. The case of biological representativeness has been given a rating of high significance by only ten respondents, whereas seven respondents rated it as moderate significance. This is in line with the findings of Reed (2016, 453) where it was noted that, in Canada, *"the goal of selecting representative ecosystems as sites for biosphere reserves no longer prevails"*. However, this issue has been incorporated into the final set of criteria (see Table 4 below) in accordance with the criteria listed in Article 4 of the Statutory Framework of the World Network of Biosphere Reserves (UNESCO, 1996, 16), to ensure a *"mosaic of ecological systems representative of major biogeographic regions"* with the national network of biosphere reserves.

The question of size for individual biosphere reserves is often discussed, especially in documents originating from UNESCO. The question was asked to the respondents whether there should be a size limit for future South African biosphere reserves. Two of South Africa's biosphere reserves are very large indeed − 3 070 000 ha and 3 187 893 ha respectively. Respondents involved in these two biosphere reserves suggested maximum sizes of between 1 and 2 million hectares. Suggestions of minimum sizes varied between 10 000 ha and 250

000 ha, but the main proposals were in support of biosphere reserves that are ecologically viable as land management units, and for the use of natural demarcations, such as watersheds, as outer boundaries.

4.3. Focus group sessions

Considering the limited network of people associated with South African biosphere reserves, the four focus group sessions were organized regionally to allow for easy commuting by the attendees who were all closely involved with a specific biosphere reserve. This arrangement ensured representation of all South Africa's biosphere reserves. These sessions, moderated in accordance with an agenda, lasted for one to two hours each and all observations were recorded. The members of the focus groups interacted informally, but were kept to the topic by the facilitator. It was agreed by all focus group members that the setting of criteria for selecting future biosphere reserves is a necessary, although not simplistic task. Some notable suggestions were made by the focus group members which were all incorporated into the final criteria.

A specific proposal by the group was to categorize the criteria according to the three biosphere reserve functions, with specific emphasis on sustainable development criteria. It was noted that a biosphere reserve must contain some element of uniqueness or a characteristic natural feature. In addition it was agreed that representativeness of a biogeographical area is important in the South African context of a network of biosphere reserves.

Ideally, a biosphere reserve should encapsulate an integrated range of ecosystems, but is was noted that size should not be a determining factor (although a biosphere reserve could be too small in terms of ecosystem functioning). The possibility of corridor establishment, specifically altitudinal corridors, should be present when selecting a biosphere reserve site. Although the three-fold zonation defined in the Statutory Framework should be in place, a process of spatial sensitivity mapping, using data on biodiversity, heritage and the physical environment as the main source of information, could add value with regards to prioritization and decision-making within a biosphere reserve.

In terms of boundaries, it was agreed that the focus should be on natural boundaries such as watersheds, and the presence of human communities is a non-negotiable requirement in the case of a biosphere reserve. A biosphere reserve is about '(hu)man and the biosphere', therefore an interaction between core conservation sites and communities should be showcased through implementing actions such as the so-called Demonstration Projects that were mentioned in the Madrid Action Plan, and subsequently included in Actions A1.5 and A4.5 of the LAP as initiatives and projects to inform sustainable development (UNESCO, 2017). The majority of role-players (including local authorities) should indicate support for the biosphere reserve model to ensure the chances of long-term success. This could be addressed through public participation processes, awareness programmes, and indicated through a survey amongst most role-players and stakeholders.

In support of the national education system in South Africa, it was agreed that biosphere reserves should fulfil an environmental education role, specifically aimed at rural areas. It is also crucial for a biosphere reserve to have a champion who is supported by a civil society group that is passionately pursuing the ideal of the biosphere reserve. Lastly, the need for proof of sustainable funding sources was emphasized.

5. Discussion

Information obtained through the methods discussed, all have a bearing on setting biosphere reserve criteria for South Africa. Although little work has been done globally on criteria for selecting the optimal location of biosphere reserves, a substantive body of literature reflects on factors pertaining to the success or failure of biosphere reserves, some of which could be translated into potential criteria. Specific

factors as listed by Stoll-Kleemann (2007) and reiterated through the focus group sessions, include: legislation and enforcement of the biosphere reserve model; community involvement and participation; environmental education; qualified staff; political support; appropriate funding; institutional responsibilities and accountability; management structure and capacity; research and monitoring needs; exploitation of natural resources; poverty and population growth. These factors reflect the four requirements for biosphere reserves as described by Price (2017), namely effective communication of the biosphere reserve concept, involvement of diverse stakeholders, participatory management structure and adequate financial resources.

Within this context the Governance of Biodiversity (GoBi) project has done extensive research on biosphere reserves and governance, from which valuable information could be extrapolated. From 2004–2007 the GoBi project was coordinated by the Humboldt University of Berlin. This project was about assessing successes and failures of governance and management approaches used in biosphere reserves all over the world (Hirschnitz-Garbers and Stoll-Kleemann, 2011). As noted above, much could be learned from the results of the GoBi project in terms of aspects that need to be addressed in the selection and evaluation of biosphere reserves in order to ensure the long-term effectiveness of these sites (Stoll-Kleemann, 2007).

When drafting a set of biosphere reserve criteria, the context and scale of the matter need to be taken into account. In addressing the context, UNESCO's guidelines as well as the country's specific legislation and statutory provisions come into play. With regards to the scale, this research attempted to draft criteria that would be applied at the national scale, whilst also considering the provincial and local context.

The proposal is to structure criteria for South African biosphere reserves into four subsections, namely a general section that addresses national matters of interest to the MAB Programme, and three sections covering the three biosphere reserve functions. In addition, Mandatory and Evaluation criteria are indicated in order to distinguish between criteria that biosphere reserves need to fully conform to before the nomination is submitted (Mandatory), and criteria that could be addressed after designation towards the evaluation and sustaining of existing biosphere reserves (Evaluation). The final suite includes 44 criteria, divided into 25 Mandatory and 19 Evaluation criteria.

The general subsection covers areas such as the Seville Strategy and Statutory Framework, as well as issues such as sustainability, human rights, stakeholder support and legal compliance.

The conservation subsection covers representativeness, biodiversity importance, persistence, uniqueness and climate change research. Representativeness of biological diversity could refer to various entities, including biomes that are divided into bioregions (Rutherford et al., 2006). Bioregions are natural landscapes that could be subdivided into sub-regions which could be used as regional land-use planning units. As landscapes are the scale at which humans interact with the environment (Brunckhorst, 2001) and the biosphere reserve model is a landscape management tool with which to facilitate sustainable integrated resource management (Brunckhorst, 2001; Edge and McAllister, 2008; Pool-Stanvliet and Giliomee, 2013), we propose the use of bioregions as a biodiversity surrogate in the process of selecting sites for biosphere reserves. This is congruent with national planning methodologies that recognise bioregions as planning units aimed at achieving sustainable development.

The subsection on sustainable development covers zonation, landscape functions, specific traits of the zones, size, management framework and cooperative strategies. It is proposed that Biosphere Demonstration Projects should become a concept in South African biosphere reserves as it will assist in making biosphere reserves relevant to sustainable development practices. In the South African context, demonstration projects comprise a collaboration between biosphere reserve management entities and local communities, such as the Jobs for Carbon project of the Gouritz Cluster Biosphere Reserve (GCBR, 2014). This embodies the vision for South African biosphere reserves as

drafted by the SA Biosphere Reserve Working Group in 2008: "*South African Biospheres are special landscapes where socio-ecological land management is practiced towards a more sustainable future for all.*"

The logistic support section covers a wide range of aspects, including stakeholder participation, political support, community awareness, management entities, financial security, education, empowerment and social responsibility. In addition to the need to address political agendas, it is quite clear that biosphere reserves need to engage people as well. In fulfilling this quest, stakeholder participation and support, community awareness and empowerment all are vital aspects of ensuring the involvement of local people. Traditional authorities and their leaders, where relevant, must be targeted and accommodated within their specific sphere of self-governance.

In the light of all available knowledge, information and opinions by well-informed persons connected to, and associated with South African biosphere reserves, a suite of criteria for South African biosphere reserves has been devised. Although this research was conducted in 2014, it is significant to note that the final set of criteria reflects all eleven factors subsequently identified by Cuong et al. (2017a) as playing a role in effecting biosphere reserve management. Mandatory and Evaluation criteria with detailed descriptions of all criteria are listed in Table 4.

Within the South African context the MAB Programme has the potential to play a much more prominent role in current government strategies related to poverty alleviation, environmental sustainability, social upliftment, transformation and economic development. In addition, the MAB Programme is supporting the country's contribution towards achieving the 17 Sustainable Development Goals (also known as the Global Goals) and the 20 Aichi Biodiversity Targets (Government of South Africa, 2015; UNESCO, 2017). The biosphere reserve model should be realized as a valuable land management tool with which to integrate people and the environment in a manner that supports the country's natural and cultural conservation and sustainable development objectives while improving human well-being.

6. Conclusion

The suggested suite of biosphere reserve criteria for South Africa was based on inputs, proposals and recommendations by focus group members, as well as information obtained through a national questionnaire and relevant literature. The criteria have now been incorporated into the South African Strategy for the Biosphere Reserve Programme, as adopted by the Department of Environmental Affairs in 2016 (Government of South Africa, 2015). The criteria are suitable towards selection of future effective and efficient biosphere reserves, as well as for evaluating existing biosphere reserves towards long-term persistency. It should therefore be of valuable assistance to ensure that biosphere reserves could proudly earn their place in the South African landscape as 'special places for people and nature' (Bridgewater, 2002; UNESCO, 2002).

Chief Seattle's widely used quotation 'all things are connected' dates back to 1854. In our view, this is reflected by the basic aim of UNESCO's MAB Programme, namely to improve the relationship between humans and the natural environment. However, the interchange between these two domains tend to be a much debated topic. Due to the social-ecological nature of the MAB Programme, biosphere reserves are well positioned to bridge this gap in support of true living landscapes (Knight et al., 2003). Based on sound natural science, biosphere reserves provide an innovative way in which to showcase sustainable living practices through implementing the crossover to social sciences.

It has been documented that the MAB Programme is playing an important role in respect of the science-policy interface through delivering outcomes for both science and society (Bridgewater, 2016). Nevertheless, there is still a challenge with translating scientific knowledge into action − the gap between knowing but not doing (Knight et al., 2008; Reyers et al., 2010). The submitted criteria have the ability to connect knowledge and practice through a closer

relationship between practitioners and decision-makers. In light of recent references to challenges facing the effective implementation of biosphere reserves (Coetzer et al., 2013; Bridgewater, 2016; Köck and Arnberger, 2017; Stoll-Kleemann and O'Riordan, 2017), it is imperative to demonstrate effective, well-managed and just social-ecological landscapes. With careful decision-making on future sites through execution of the criteria, South Africa has the opportunity to make a difference through a dynamic, effective national network of biosphere reserves. With time, this could set an example for other developing countries in support of the effective implementation of the MAB Programme.

Statement on conflicts of interest

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