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Reviewing Biosphere Reserves globally: effective conservation action or bureaucratic label?

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ABSTRACT

The Biosphere Reserve (BR) model of UNESCO's Man and the Biosphere Programme reflects a shift towards more accountable conservation. Biosphere Reserves attempt to reconcile environmental protection with sustainable development; they explicitly acknowledge humans, and human interests in the conservation landscape while still maintaining the ecological values of existing protected areas. Conceptually, this model is attractive, with 610 sites currently designated globally. Yet the practical reality of implementing dual 'conservation' and 'development' goals is challenging, with few examples successfully conforming to the model's full criteria.

Here, we review the history of Biosphere Reserves from first inception in 1974 to the current *status quo*, and examine the suitability of the designation as an effective conservation model. We track the spatial expansion of Biosphere Reserves globally, assessing the influence of the Statutory Framework of the World Network of Biosphere Reserves and Seville strategy in 1995, when the BR concept refocused its core objectives on sustainable development. We use a comprehensive range of case studies to discuss conformity to the Programme, the social and ecological consequences associated with implementation of the designation, and challenges in aligning conservation and development. Given that the 'Biosphere Reserve' label is a relatively unknown designation in the public arena, this review also provides details on popularising the Biosphere Reserve brand, as well as prospects for further research, currently unexploited, but implicit in the designation.

Key words: biodiversity conservation, Man and the Biosphere Programme (MAB), interdisciplinary science, protected areas, socio-ecological systems, spatial zonation, sustainable development, trade-offs, UNESCO.

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I. INTRODUCTION: THE BIOSPHERE RESERVE (BR) CONCEPT

The Biosphere Reserve (BR) model of UNESCO's Man and the Biosphere Programme (MAB) represents a shift towards people-centred conservation, explicitly acknowledging humans, and human-interests, in the conservation landscape. Through the establishment of BRs, MAB sets a basis for improving the relationships between people and their environment, a long-term approach that increases people's ability to manage environmental resources sustainably into the future (UNESCO, 1996). Theoretically, where individual BRs contain more than one protected area, they may also fulfil the spatial obligations for more effective protected area system under global-change scenarios, translating the management of isolated 'island' protected areas into regional co-operation, i.e. a regional meta-reserve system that includes matrix areas and enhances connectivity across the BR landscape.

Conceptually the BR model is attractive, yet the practical reality is likely to be challenging, particularly given the history of disappointments of traditional Integrated Conservation and Development Projects (ICDPs; Brandon & Wells, 1992; Neumann, 1997; Wells & McShane, 2004; Blom, Sunderland & Murdiyarso, 2010). Additionally, given that each BR remains under the sovereignty and legislation of the country in which it is found, the BR designation does not guarantee the effective implementation of the concept (Walker & Solecki, 1999). This may be especially true for developing countries where the need for socio-economic development and poverty alleviation is prioritised over nature conservation. Thus, a 'Biosphere Reserve' may remain only a bureaucratic label, with little resemblance to the model envisioned by UNESCO and MAB; the requirements of the designation can be ignored by the State and management objectives of the individual protected areas contained within the BR. As a result, the BR often has a theoretic character (Nolte, 2008), with a considerable gap between the BR concept and the reality worldwide (Price, 2002).

Herein we discuss the history of the Biosphere Reserve concept, and its evolution and expansion across the globe. We assess the extent of the BR concept-reality gap using the status of existing BRs worldwide, and examine the factors that contribute to failures and successes. We examine the suitability of the designation as an effective conservation model, exploring the conservation-development link that is central to the BR concept, and discuss the applicability of the model for developing nations, using the Kruger to Canyons (K2C) BR in South Africa as a case study.

II. BACKGROUND TO THE BIOSPHERE RESERVE CONCEPT

The Biosphere Reserve concept was launched almost four decades ago, in 1974, with the first official international 'Biosphere Reserve' designated two years later. In 1976, some 58 BRs were recognised worldwide (IUCN, 1980). By 2012, this had increased to 610 reserves in 117 countries (Fig. 1; also see Section IV.1 and Fig. 4 for spatial distribution globally).

The Man and the Biosphere Programme (MAB) was launched in 1971 (Dyer & Holland, 1988), after the 1968 'Conference on the Rational Use and Conservation of the Resources of the Biosphere' (Batisse, 1986), as a progression from the International Biological Program (IBP; Di Castro, 1976). While this 1968 conference is referred to as the 'Biosphere Conference' (UNESCO, 1993), there was no reference to 'Biosphere Reserves' (Batisse, 1986), nor, had the notion of 'sustainable development' yet achieved widespread acceptance in the conservation literature (Batisse, 1997). However, this conference paved the way for MAB, emphasising the 'sustainable management of land resources', and prioritising 'the utilization and preservation of genetic resources'. A particular focus was the preservation of a 'representative sample of significant ecosystems, original habitats and remnant populations' (Batisse, 1986, p. 161), which even today is a compliance criterion of BRs (see UNESCO, 1996, p.16).

From the outset, MAB was intended as an interdisciplinary and international approach to resolve ecological and resource management problems (Di Castro, Hadley & Damlamian, 1981; Batisse, 1997), centred around three major themes: (*i*) conservation of genetic resources and biological diversity; (*ii*) international research and monitoring; and (*iii*) ecologically sustainable development (Batisse, 1986; Price, 2002). These themes translated into conservation, logistic and development roles, and BRs were, and continue to be, MAB's instrument to fulfil these roles.

Thus the BR designation was born as the mainstay of the MAB conservation approach (Dyer & Holland, 1988). Implemented through the World Network of Biosphere Reserves (WNBR; Price, 2002), BRs were established as a network of environmentally significant sites, selected for the conservation value of the one or many protected areas they contain, as well as their ability to provide relevant scientific research that would contribute to sustainable development (von Droste, 1987). They were intended as ecological baselines against which the consequences of human-driven modification and management interventions could

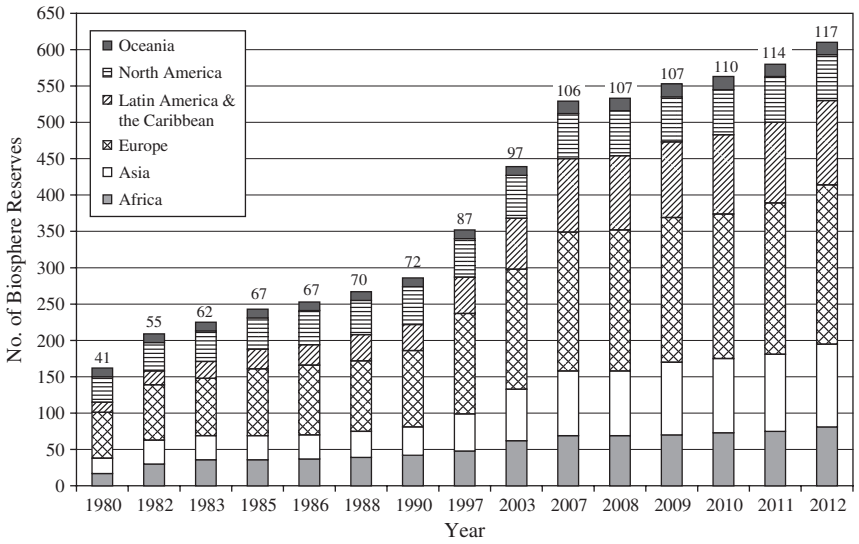

Fig. 1. Biosphere Reserves (BRs) by continent over time (1980–2012) including a country-count. Country counts (above bar) indicate countries as they existed at that date (prior to modern dissolution, secession or renaming. Data extracted from lists compiled by IUCN/UNEP and UNESCO's MAB Programme (1980–2012: (IUCN, 1980, 1982, 1983, 1986, 1988, 1990, 1998, 2003; UNESCO—MAB Secretariat, 2007, 2008, 2009, 2010, 2011, 2012)). Data presented are years for which official protected area lists were available.

be monitored (Di Castro, 1976). The data generated from research within individual BRs would have international applicability and wide-scale relevance (Dyer & Holland, 1988). At inception, BRs were thought to be invaluable in focusing interest and collaborative effort in this inter-governmental scientific endeavour—acting as regional and logistical 'base stations' for any proposed conservation and research plans (Batisse, 1986).

More recently, the BR concept has evolved to represent an interdisciplinary philosophy to address the ecological, social and economic dimensions of biodiversity loss (www.unesco.org). The modern-day BR concept places more emphasis on the relationships between people and biodiversity (Price, 2002), and the protection of socio-ecological systems (SES). People and their activities are considered an integral part of the wider conservation landscape (Brunckhorst, 2001), where environmental protection need not be at the expense of socio-economic development.

Given that strict environmental protection and development are not usually mutually exclusive; BRs have a generalised spatial zonation of acceptable land uses relative to proximity to conservation areas. Different land uses fall into zones of permissible access and enforced controls. A 'core' zone(s) of priority conservation areas and strict formal protection is adjoined by a clearly delineated 'buffer' zone (originally 'inner buffer zone'). In the buffer zone only those activities and land-ownerships compatible with environmental protection can occur (e.g. other conservation designations without strict, statutory protection, ecotourism, recreation). A flexible 'transition' zone (originally 'outer buffer zone') or 'zone of cooperation' (see Price, Park & Bouamrane, 2010) adjoins this area; here, other more intensive land uses are allowed (e.g. human settlements, agricultural areas, traditional resource use) (Batisse, 1986; UNESCO, 1995).

This spatial zonation need not be concentric, and in reality the spatial arrangement of the zones will match existing land-use patterns and development potential in the region. Thus, the 'buffer' zone(s) is one end of the open-ended (and continuous) 'transition' zone (Brunckhorst, 2001), with decreasing intensity of land use and management interventions with proximity to the 'core' areas.

III. DO DESIGNATED BIOSPHERE RESERVES MEASURE UP?

When the first set of BRs was designated, the conservation role was prioritised. Development and logistic roles were overlooked, and links between environmental resource use and development were not addressed (Batisse, 1986). Despite an intervention in 1984 ('*The Action Plan for Biosphere Reserves*'; (Batisse, 1985)), by 1995, there were concerns about a widespread lack of conformity of established sites with the ideals of the BR concept. Only 50% of the 324 existing reserves consisted of a protected core area with additional buffer and/or transition zones, and there was little opportunity for local communities to become active stakeholders in the decision-making process (Price, 2002). As a result, for many sites, BRs were simply a misrepresentation of 'just another' conservation initiative that excluded community involvement; an alternative label for the 'strict protection' typical for legally protected reserves.

Recognising this divergence between the theoretical concept and the *in situ* reality, following the Seville

Conference in 1995 [which gave rise to two documents that remain at the centre of MAB's position on BRs: '*The Seville Strategy*' and '*The Statutory Framework of the World Network of Biosphere Reserves*' (hereafter 'the Statutory Framework'; UNESCO, 1996)], the periodic review process of existing BRs was initiated (Price, 2002; Price *et al.*, 2010). The period following the Seville conference reflects a shift in the manner in which BRs were defined—a shift in focus from individual protected areas linked to the three zones towards ecosystem/regional conservation with sustainable development as an overarching priority (Ishwaran, Persic & Tri, 2008). The Madrid Action Plan for Biosphere Reserves (2008–2013, MAP) is the current strategic document for existing BRs, building upon the Seville Strategy, with the goal to raise BRs to 'the principal internationally-designated areas dedicated to sustainable development in the 21st century' (UNESCO, 2008, p. 3).

(1) The Seville Strategy and Statutory Framework: conforming to new criteria

The Statutory Framework states that the review procedure should be conducted at 10-year intervals, i.e. on the 10-year anniversary of the designation date or subsequently submitted reviews (Price *et al.*, 2010). It evaluates compliance with the specific criteria (related to size, zonation, ecological characteristics, biodiversity importance, and regional sustainable development prospects; see Statutory Framework, Article 4; UNESCO, 1995) that allow individual BRs to meet the basic conservation, development and logistic roles expected of a 'site of excellence' (UNESCO, 1996, p. 16)' (Price *et al.*, 2010). Failure to fulfil these criteria may eventually lead to a site's UNESCO 'Biosphere Reserve' status being revoked.

Following review, seven countries have removed a total of 12 BRs from the WNBR (Table 1; also refer to Price *et al.*, 2010). All have been voluntary removals by member states, themselves recognising divergence between the status of the BR and the ideals of the BR concept. To date, UNESCO has never forced the withdrawal of a site, but rather recommends specific revisions to meet the criteria of the Statutory Framework. If the BR concerned still fails to comply within a 'reasonable period of time' following these recommendations, it could only then be formally removed from the WNBR (UNESCO, 1995: Article 9).

The Seville conference and its key outputs, the Seville Strategy and the Statutory Framework, represent a point of divergence in the MAB Programme, with a clear division between pre- and post-Seville sites. The majority of existing BRs remain pre-Seville sites (57% in 2010, 54% in 2011, 51% in 2012), with spatial biases in distribution across continents (Fig. 2). The predominance of pre-1995 sites is not unexpected given that the criteria for establishing a BR have become more rigorous over time, but of these pre-Seville sites, only 65% had undertaken a periodic review by 2010, and of these, half did not fulfil the current criteria (UNESCO, 2010*b*). By 2010, over 20% of countries had never addressed the periodic review process or submitted a periodic review report (Price *et al.*, 2010).

However by 2011, the number of sites submitting period reviews had improved, with 28 BRs submitting periodic review reports for the first time (32 submitted in total; UNESCO, 2011*b*). By 2012, a further 33 reviews were submitted, with only nine of these resubmissions by specific BRs, i.e. successive reports addressing recommendations issued by the MAB from previous reviews (UNESCO, 2012). However, the United States, which has more BRs than any other country (47 sites, all designated before 1995), has still not undertaken any official review of its existing reserves (Price *et al.*, 2010; UNESCO, 2010*b*), and few of these [e.g. Southern Appalachians, Champlain-Adirondack (McDonnell, 2005) and the New Jerseys Pinelands BRs (Walker & Solecki, 1999)], appear to have the required spatial zonation.

In this regard, for these sites and a number of others that are in the same situation, in 2011, at the 23rd session of the International Co-ordinating Council of MAB in Germany, members of the Advisory Committee requested that countries that had not submitted periodic reviews be formally withdrawn from the WNBR (UNESCO, 2011*b*). By the 24th session, there was a decision that the MAB-Secretariat would write to all countries concerned, requesting that MAB member states inform on the process of upgrading existing BRs, providing an indicative plan and/or a timeline for the upgrade to Statutory Framework criteria (UNESCO, 2012).The deadline for reply was December 2012.

There is some urgency in ensuring compliance of existing sites to the vision outlined in the Seville Strategy and Statutory Framework, particularly for 'first generation' sites listed during 1976–1984 (see Ishwaran *et al.*, 2008; UNESCO, 2012). The Madrid Action Plan (UNESCO, 2008), is a strategic document in this regard, setting a specific deadline for compliance to the requirements of the 'new' BR concept, i.e. the end of 2013.

(2) The Biosphere Reserve criteria and existing conservation designations: a conflict of interests?

On the basis of the periodic review reports submitted most recently to UNESCO (e.g. UNESCO, 2011*b*, 2012), recommendations made by UNESCO most frequently focus on *inter alia*: enhancing/establishing links between conservation and sustainable development functions, addressing concerns that the conservation function is being undermined by developments in the BR, addressing concerns related to the small spatial extent of a BR and its ability to fulfil function, issues linked to incomplete or ineffectual zonation, insufficient community involvement, and inadequate management plans for the BR.

This is certainly not an exhaustive list of reasons that may result in a site's eventual removal from the WNBR should they not be addressed, nor are they the only reasons that have historically led to a Member State's voluntary withdrawal of a BR from the WNBR. Yet, for those BRs that have been withdrawn from WNBR since the periodic

Table 1. Biosphere Reserves (BRs) removed from the World Network of Biosphere Reserves (WNBR) following review

Biosphere Reserve	Country	Year designated	Year delisted	Reasons for delisting
Northeast Svalbard	Norway	1973	1997	No resident human population within the BR (Price *et al.*, 2010).
St. Kilda	UK	1976	2002	Internationally important site with range of conservation designations, including World Heritage. Spatial restrictions on developing proper zonation, given strict 'Conservation' obligation of the site. Limited community engagement (Scottish Natural Heritage, 2000).
Rùm	UK	1976	2002	No zoning structure present [island managed purely for conservation purposes (Environmental Change Institute (ECI), 1998)]. Scope to introduce three zones severely limited. The majority of the island would require strict, formal protection for conservation purposes (Scottish Natural Heritage, 2000).
Claish Moss	UK	1976	2002	Limited stakeholder involvement; existing core area did not protect an adequate range of habitat types (Scottish Natural Heritage, 2000)
Caerlaverock	UK	1976	2002	Only fulfilled conservation function: small size, no defined buffer zone and limited human population (ECI, 1998). Stakeholder involvement severely limited. The expansion required to meet post-Seville criteria would encroach into priority conservation RAMSAR site where 'multi-use' requirements of zonation unacceptable (Scottish Natural Heritage, 2000).
Taynish	UK	1976	2010	Not possible for the site to meet the Statutory Framework criteria (Price *et al.*, 2010). Limited local population (ECI, 1998) with poor opportunities for stakeholder involvement. Problematic to develop the transition zone (Scottish Natural Heritage, 2000)
Moor House-Upper Teesdale	UK	1976	2012	Site does not meet Statutory Framework criteria UNESCO, 2012. It is comprised of two National Nature Reserves, and forms a broad partnership with the North Pennines Area of Outstanding Natural Beauty, the expansion required of the current core zone was deemed inappropriate (UK—MAB, 2012).
Maritchini Ezera	Bulgaria	1977	2002	Withdrawn by Bulgarian authorities; no review completed before delisting (Price *et al.*, 2010).
South West National Park	Australia	1977	2003	BR consists of only a core area, designated as a National Park and managed for conservation purposes. The protected area's existing National Park and World Heritage designations competed with the BR's 'multi-use' status (Matysek *et al.*, 2006).
Macquarie Island	Australia	1977	2011	No resident human population (Parks and Wildlife Service, 2006)
Bayerischer Wald	Germany	1979	2007	Required extension to meet post-Seville criteria. There was a lack of support from local communities and relevant institutions to be included within the 'new' BR boundaries (Price *et al.*, 2010; UNESCO, 2010*b*)
Lake Torne Area	Sweden	1986	2010	Lacked appropriate zoning (consisted of only a core area of National Parks) with no resident human population in surroundings areas (Thorell *et al.*, 2005).

review process was initiated, these sites have been removed around issues linked to zonation (i.e. only a core area with legal protection), the absence of permanent settlement and stakeholder involvement in the BR, and/or conflicts between conservation and development goals (Table 1). If these are reasons significant enough to result in formal withdrawal from the WNBR, then it appears that many more BRs than those currently listed in Table 1, or marked as 'under revision' by MAB, are also failing to meet the criteria. At least twenty-two sites currently designated by MAB have no permanent resident population, while more do not adhere to the spatial zonation outlined by the BR concept, with non-existent or incomplete zonation (Table 2).

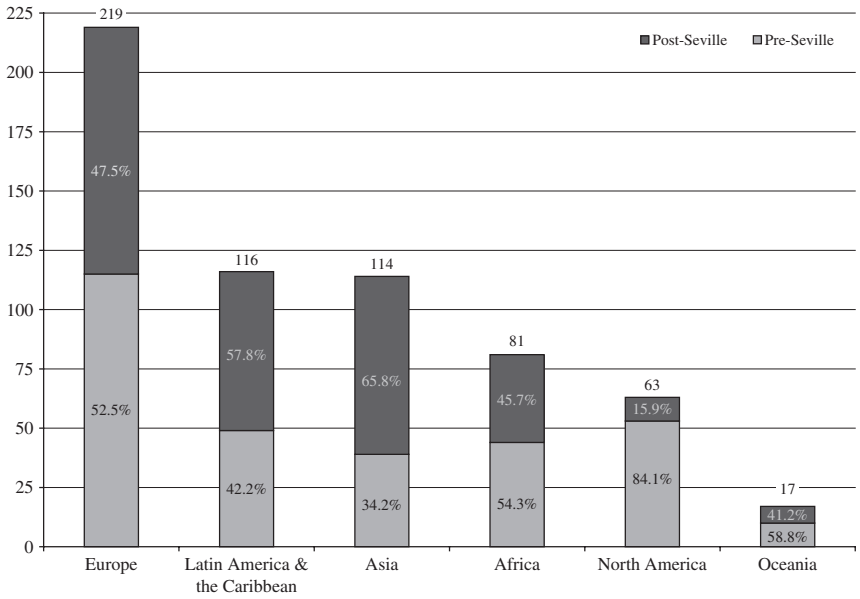

Fig. 2. Pre- and post-Seville differences in the number of Biosphere Reserves (BRs) in 2012 across continents (United Nations macro-geographical regions). Above-bar counts indicate number of BRs by macro-geographical region. Total BRs for 2012 = 610.

A study by Ishwaran (2012) has come to the same conclusion; stating that many existing BRs have been given the 'Biosphere Reserve' designation as simply an additional label to their existing conservation designation or research purpose.

For these BRs (i.e. examples listed in Table 2), park management authorities alone represent the resident human population, and environmental protection, research and tourism and/or nature appreciation is the only 'resource-use' ongoing within the BR's boundary. In these instances, the separate, and more specific, conservation designation that existed prior to the designation of the BR, may better fulfil the management requirements of these reserves than the multi-use landscape requirement of BRs.

The area recognised as a BR may well include multiple designations that appear to serve a degree of the same overarching cause, i.e. environmental protection and long-term sustainability (e.g. Biosphere Reserve, National Park, National Heritage, RAMSAR site, Transboundary Parks). Yet such coincidental designations do not necessarily ensure a cumulative protection effect, especially when strict protection must exist alongside multi-use, sustainable development priorities. Where the zonation structure is lacking, and the BR comprises only a nature reserve or national park with a conservation mandate, it is unlikely that these multiple objectives will coexist.

This was the case for Australia's Macquarie Island BR, which was withdrawn by the Australian authorities at the June/July 2011 meeting of MAB council in Germany, stating the absence of a permanent resident human population as grounds for removal (Table 1). This site had been part of the WNBR since 1977.

The island is listed as critical habitat for two vulnerable albatross species, and inscribed as a World Heritage Site in 1997 (Parks & Wildlife Service, 2006). Macquarie offers invaluable opportunities for scientific research on sub-Antarctic systems (see http://www.antarctica.gov.au/living-and-working/stations/macquarie-island), and given its significance for global geo-conservation and biological diversity, it has severe tourist restrictions in place to ensure minimum human impact on the environment. Tourist visits must be pre-approved, for educational purposes only, and even then, there are spatial and temporal limitations on access to the area (Parks & Wildlife Service, 2006). Given that the MAB approach encourages sustainable, multi-'use' of the landscape (synonymous with some form of resultant land-cover/land-use change), the BR designation seemed incompatible with the level of protection required for this island - particularly given required compliance with the post-Seville criteria, i.e. buffer and transition zones associated with a resident human population. Thus, the conservation of this sensitive environment was likely to be achieved better under its pre-existing, and strictly controlled, World Heritage, Australian Critical Habitat, National Estate and Nature Reserve listings (Parks & Wildlife Service, 2006), rather than one that encourages 'use' of this landscape. The MAB 'Biosphere Reserve' label, in this context, became unnecessary. The former St. Kilda BR, UK, presents a similar scenario (Table 1).

(3) Conforming to the Man and the Biosphere Programme (MAB) as an evolving concept

With the evolution of the BR concept, and the change in focus towards the relationship between conservation and development, it is reasonable that many of these BRs that were established early in the BR concept's history do not conform to contemporary criteria. However, the action

Table 2. Sample of existing Biosphere Reserves (BRs) that at present do not fulfill zonation, resident population, nor economic activities/opportunities criteria post-Seville. Original data obtained from the MAB WNBR directory[a] updated with 2012 withdrawals

Biosphere Reserve (country)	Year listed	Size (hectares)	Other designations	Zonation, with zone sizes (ha) indicated when present	Resident population	Management priorities/ongoing land use
Coram (USA)	1976	3019	National Wilderness	No zonation	None	Research: 'outdoor laboratory'
Three Sisters (USA)	1976	80900	National Wilderness	No zonation	None	Control site for research, recreation
*Circeo (Italy)	1977	8500	State Nature Reserve, Nomination World Heritage, RAMSAR site, Barcelona Convention Specially Protected Site	Core (3 200), buffer (~2800), transition (2500)	~50 inhabitants	Conservation, tourism
*Collemeluccio-Montedimezzo (Italy)	1977	637	European Biogenetic Reserve, State Nature Reserve (IUCN category V)	Core [550 (400 marine)], buffer (241)	None	Conservation, tourism
Iles Zembra et Zembretta (Tunisia)	1977	791	National Park, Specially Protected Area of Mediterranean Interest	Strictly protected (core)	~10 inhabitants	Conservation
Lobau (Austria)	1977	1037	Ramsar Site, Natura 2000, part of Donau-Auen National Park	Undefined	None	Research, education, recreation
Macchabee/Bel Ombre (Mauritius)	1977	3594	National Park	Undefined	None	Tourism, important conservation area, environmental education
North-East Greenland (Denmark)	1977	97200 000	National Park	Undefined	None	Important research site (International Tundra Experiment; www.geog.ubc.ca/itex)
Odzala (Congo)	1977	110000	National Park	Undefined	None	Conservation, tourism. Traditional subsistence agriculture adjacent to park
Mount Chatkal (Uzbekistan)	1978	57360	State Nature Reserve	Core (45160), buffer (12200)	None	Conservation, research
Torres del Paine (Chile)	1978	184414	National Park	Core only	None	Managed as a national park; tourism, research
Laguna San Rafael (Chile)	1979	1742 000	National Park	Undefined	None	Tourism, research
*Pietrosul Mare (Romania)	1979	46399	Scientific Reserve within Rodna Mountains National Park	Undefined until 2010; renaming and extension: core (8200), buffer (11800), transition (24000) (UNESCO, 2011*b*)	None	Conservation

Table 2. Continued

Biosphere Reserve (country)	Year listed	Size (hectares)	Other designations	Zonation, with zone sizes (ha) indicated when present	Resident population	Management priorities/ongoing land use
Gorge of Samaria (Greece)	1981	4850	National Park	Undefined	None	Restricted tourism
Mount Olympus (Greece)	1981	4000	National Park	Core and buffer only (zone sizes not specified)	None	Managed as a National Park; tourism (core); grazing, hunting, wood extraction (buffer)
Kronotskiy (Russian Fed.)	1984	1142134	State Reserve, World Heritage Site	Undefined (under revision)	None	Research, limited tourism
*Waddensea of Lower Saxony (Germany)	1992	240000	National Park, World Heritage Site	Core (130000), buffer (108000) [extended transition zone (2000) proposed]	One researcher	Conservation, tourism

*Indicates intent to adjust BR to meet criteria in near future (MAB-Italy, 2011; UNESCO, 2011*b*).
[a]http://www.unesco.org/new/en/natural-sciences/environment/ecological-sciences/biosphere-reserves/world-network-wnbr/wnbr/

required to reflect the requirements of post-Seville BRs may be beyond the capacities of BR managing authorities, or may not receive the appropriate stakeholder buy-in from surrounding communities.

In the case of Bayerischer Wald BR, Germany, which was removed from the WNBR in 2007 (Table 1), stakeholders in the area adjacent to the BR strongly opposed their inclusion into the redesigned BR. Enlargement of the site was opposed by the local community, and the BR was withdrawn from the WNBR as a result (Price *et al.*, 2010; UNESCO, 2010*b*). While the conservation-development model is attractive, and may offer local residents previously unavailable opportunities to benefit from conservation in the BR, the restrictions imposed on land uses within the BR boundaries may be unattractive compared to land uses found outside, making inclusion into the 'new' Reserve unappealing (see Section IV.2).

UNESCO (2010*b*) has also found that the costs associated with the review process are a limiting factor in the success of the transformation process, with one Australian signatory from Tasmania's Department of Primary Industries, Parks, Water & Environment, stating that the effort spent on developing reports for MAB could be better utilised on much needed conservation projects within the core zone's National Park (Price *et al.*, 2010; UNESCO, 2010*b*). This particular BR, Australia's South West National Park, was removed from the WNBR in 2003 (Table 1).

Price *et al.* (2010) quantified these costs into the thousands (US dollars). While the effort spent on preparing periodic review reports was not necessarily comparable across countries, costs ranged from \$2200 (Canada, where time was donated by national experts and only travel costs were measured) to \$43,000 (France).

However, regardless of the difficulties associated with review and the subsequent restructuring of non-conforming sites, the review process is currently the only mechanism that exists to assess the WNBR as individual sites and as the cumulative network. It is the only mechanism to gauge MAB's progress in reconciling biodiversity conservation and sustainable development (Price, 2002; Price *et al.*, 2010).

Some sites have been transformed effectively following review, and there are a number of success stories for transformation internationally (see UNESCO, 2010*b*, 2011*b*, 2012). In particular, Braunton Burrows BR, UK, now enlarged and renamed 'North Devon BR', after revision, became the UK's first 'new style' BR (Macleod & Price, 2012). It is considered to epitomize the model BR by many (Ishwaran *et al.*, 2008).

(4) UK-MAB: a success story for the review process

Following the success of the North Devon revision, UK-MAB invested further in ensuring compliance of their remaining BRs, all established in 1976, setting the precedent for the revision process in the other MAB member states.

In England, this process resulted in the withdrawal of one of its three BRs, Moor House-Upper Teesdale BR (Table 1). In Wales, the Dyfi Valley BR, the only BR designated here,

was enlarged and renamed (now *Biosffer Dyfi Biosphere)*; its boundaries extended beyond the National Nature Reserve that had previously accounted for the entire Biosphere region (www.unesco.org). With this revision, Biosffer Dyfi effectively became the UK's second 'new style' BR (Macleod & Price, 2012).

In Scotland (home to the remainder of the UK's BRs, as well as five BRs now withdrawn from the WNBR, Table 1), two of the original BRs (Cairnsmore of Fleet, and Merrick Kells-Silver Flowe) previously not fulfilling the Statutory Framework criteria individually, were included in a single, larger 'Galloway and Southern Ayrshire BR'. This extensive consultative process began in 2006 (see Wallace, 2011 for details), and following its renomination to UNESCO in 2011, this site was successfully added to the WNBR in July 2012 (http://www.unesco.org).

The Beinn Eighe BR, which failed the revised criteria due to insufficient human intervention and poor opportunities for sustainable development (Hambrey Consulting, 2009), would potentially conform if local communities living outside the BR allowed for expansion of reserve boundaries, i.e. beyond only the Beinn Eighe National Nature Reserve. The Wester Ross Alliance (http://www.wester-ross-alliance.co.uk) initiated dialogue with other regional stakeholders, with a proposal to create a large 'Wester Ross BR' with the current Beinn Eighe site as part of its core (Macleod & Price, 2012). The enlarged site would qualify under post-Seville criteria with little change to existing institutional structures and land management (Hambrey Consulting, 2009; Macleod & Price, 2012), making it an excellent candidate for reinstatement. However, the challenge for this particular BR, still in the proposal stage, is in acquiring commitment for the required financial investment/resources; the current economic climate may favour expenditure in the established conservation areas rather than newly designated sites (see Macleod & Price, 2012).

Given that a significant proportion of conservation initiatives in the UK are community led with voluntary organisations playing an important role in environmental protection [conservation authorities in the UK own only approximately 3% of their National Parks, with public bodies, charities and private alliances accounting for the remainder (Selman, 2009)], there is a history of sympathetic stakeholder involvement associated with conservation. This is likely to favour the discussions around the revision of the remaining BRs, and ultimately the sustainability and successful implementation of MAB in the UK long term.

IV. CONSERVATION AND SUSTAINABLE DEVELOPMENT

(1) Political buy-in: the attraction for developing country economies

Ultimately, the BRs fall under the jurisdiction of individual member countries, regardless that it is an international designation and a global collaboration. The individual protected areas within the BR may be afforded the protection of the state, but the region defined as the BR frequently does not have the same supporting legislation to ensure its persistence. Thus for the BR model to be successful long term, it requires political buy-in at the level of state/provincial or national government, and if popular political benefit is seen to be absent, it is unlikely that these governments will continue to support the ideals of the BR concept (J.D. Brown, 2002*a*).

Prior to the era of 'new conservation' (K. Brown, 2002*b*, 2003), protected areas, and their associated fortress conservation ethic, typically evoked negative social responses, with a narrative of displacement and/or expulsion, exclusion and resource restriction accompanying their creation (West, Igoe & Brockingham, 2006, for review; Hartter & Goldman, 2010). Parks were seen to be perpetuating the poverty cycle, further marginalising the already marginalised [e.g. the San and Bakgalagadi of Botswana's Central Kalahari Game Reserve (Hitchcock, 2002)], and establishing an enduring attitude of resentment towards conservation agencies (Brockington & Igoe, 2006; Rangarajan & Shahabuddin, 2006; West *et al.*, 2006; Hartter & Goldman, 2010). However, the widespread political acknowledgement for more accountable conservation decisions makes the people-centred conservation model more politically congruent, for both developed and developing country governments alike. Similarly, the awareness for 'sustainability' is rising and therewith so too is political interest around the concept.

The attraction of the BR concept is that it offers a mechanism for the traditionally protectionist conservation land use to 'work for the poor'. In a climate where social equality and economic upliftment is prioritised, it becomes politically dangerous to favour environmental protection over socio-economic development.

Since inception, the BR concept has been especially favourably received by developing country governments [approximating 'Emerging' and 'Developing economies', as categorised by the International Monetary Fund (2012) World Economic Outlook], with the average rate of 'buy-in' through the listing of new BRs each year exceeding that of developed countries ('Advanced economies'; IMF, 2012) pre- and post-1995 (Fig. 3). The difference in the total cumulative listings in each period is significant between developed and developing countries ($X^2 = 19.02$; d.f = 1; $P < 0.00001$; Fig. 3), becoming noticeably more pronounced in developing countries over time, i.e. when the Seville Strategy refocused the objectives of the BRs on sustainable development, and the rate of new listings increased accordingly. These differences may indicate the influence of different sets of stakeholder groups as instrumental in the decision-making process around BR proposal and eventual establishment, i.e. conservationists and scientists in developing countries, while citizen groups, local land-owners, social organisations and local councillors are frequently more prevalent in developed countries. Recognising that a BR's establishment may be motivated by different desires, values and/or expectations will be useful in future BR-stakeholder relations

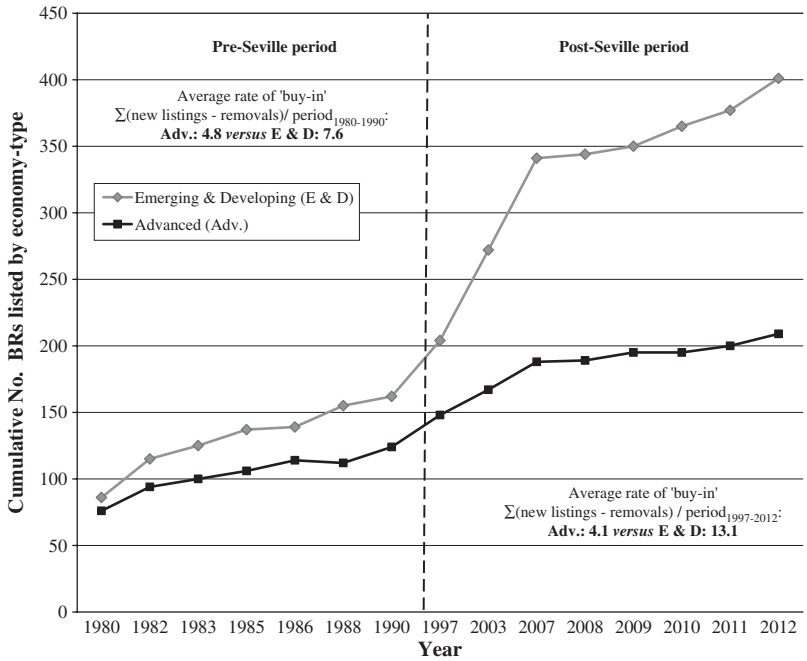

Fig. 3. Cumulative Biosphere Reserve (BR) listing pre- and post-Seville by economy-type. Data presented are years for which official protected area lists were avaliable (IUCN/UNEP and UNESCO's MAB Programme: 1980–2012). Data points in the trend line were calculated as the number of BR by economy type over time (a cumulative total of pre- and post-Seville, accounting for new listings and removals from the WNBR for each year); the average rate of 'buy-in' was calculated for periods: 1980–1990 and 1997–2012, where $t_0 = 1980$ for the pre-Seville, and $t_0 = 1997$ for the post-Seville period.

(see Bouamrane, 2007 for case studies across different socio-ecological contexts; see also Sections IV.2 and IV.3).

As of 2012, 65.7% of the listed BRs have been established in emerging and developing countries (Fig. 4). The remaining 34% of BRs are located in advanced-economy countries, with the majority (61.2%) of this portion established pre-Seville.

(2) Biosphere Reserves and links to Integrated Conservation and Development Projects

The linking of development with conservation is not unique to the BR concept. While the Seville Strategy may have reorganised the ideals of the MAB so that 'people-centred conservation and sustainable development' became a priority criterion, Integrated Conservation and Development Projects (ICDPs) had already begun to attempt this a decade previously.

The first ICDPs were launched in 1985 by the Wildlands and Human Needs Program (WWF) as a mechanism to integrate economic development with sustainable natural resource management, targeted specifically at the 'rural poor' (Hughes & Flintan, 2001). Today's working definition of these original ICDPs may have evolved somewhat, but contemporary versions (i.e. the 'new conservation') remain primarily biodiversity conservation projects that combine social development (and enhanced livelihood options) with environmental protection (Hughes & Flintan, 2001).

The history of ICDPs has been one of elusive success, with the literature indicating that they have failed their promise, i.e. 'conservation by distraction' (Ferraro & Simpson, 2000). Confusion over objectives, vague assumptions, naïve expectations and a failure to acknowledge trade-off between conservation and development priorities have led to significant criticism of the concept by social scientists and ecologists alike (reviewed in Hughes & Flintan, 2001; Robinson & Redford, 2004; McShane *et al.*, 2011). These criticisms include: (*i*) that projects act as population 'attractors', fuelling migration to project areas, and hence (*ii*) result in more rapid land-cover change around conservation areas; (*iii*) resource entitlements/restrictions as a result of projects shift resource exploitation to new areas; (*iv*) that projects are frequently linked to external donor funding cycles which raises issues for project sustainability; (*v*) projects result in biased and disproportionate benefits across communities; (*vi*) there is limited participation with decisions made by 'external' parties with little understanding of social and ecological context; and (*vii*) the mismatch between timeframes for economic and biodiversity outcomes prevent the successful integration of objectives.

As a result, resurgent protectionists have begun to advocate more strongly for the dissolution of coupled protected area-development initiatives, and the return to strict authoritarian enforcement in conservation areas (Sandker *et al.*, 2009; see Wilshusen *et al.*, 2002 for discussion of the 'resurgent protectionist' argument). There is also increasing support for the replacement of the traditional notion of ICDPs by 'landscape or ecosystem approaches' (Sayer *et al.*, 2006; Sayer, 2009; Axelsson *et al.*, 2011). Landscape approaches,

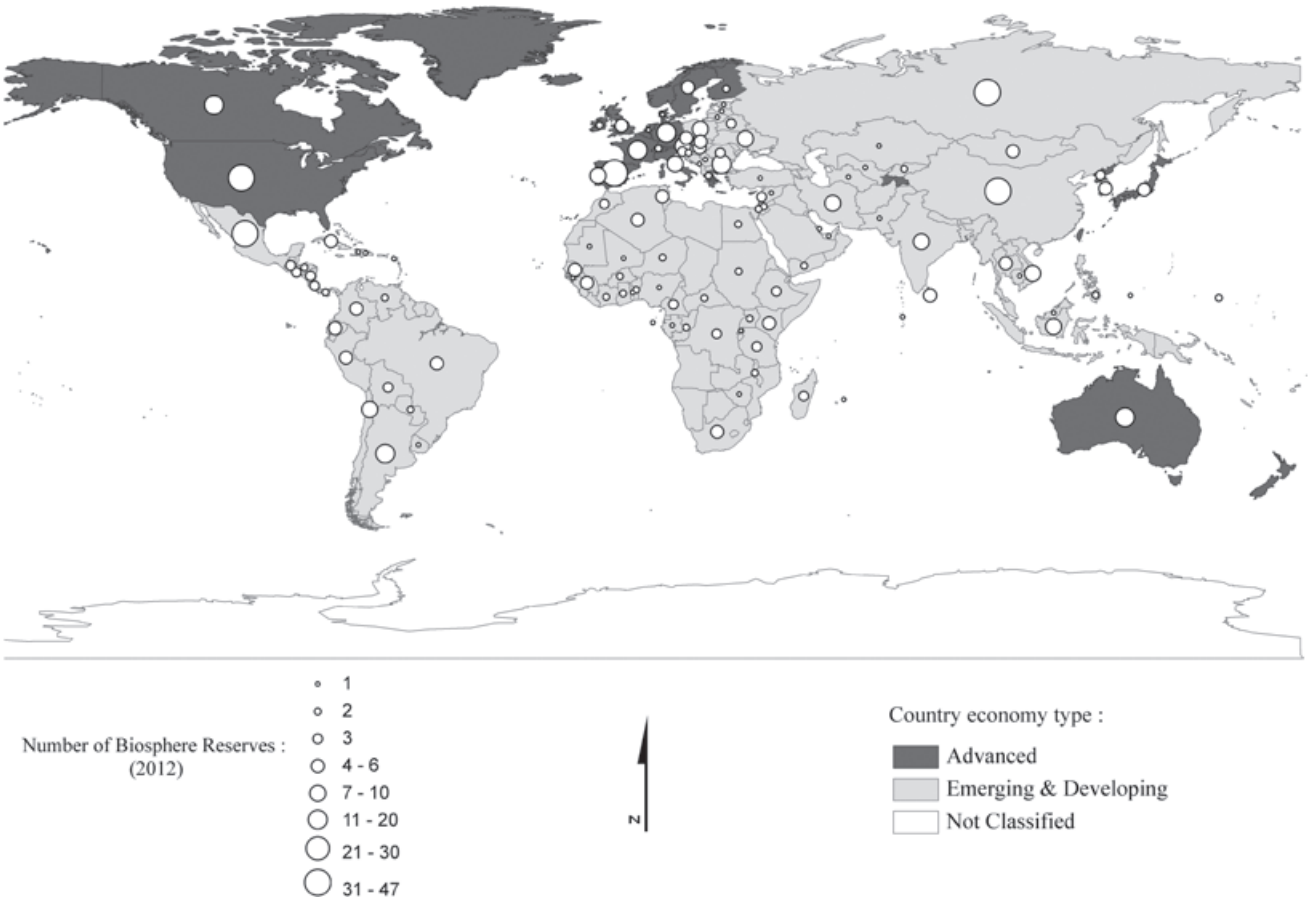

Fig. 4. Relative distribution of 2012 Biosphere Reserves (BRs) by country economy-type. The August 2011 and July 2012 additions included seven countries that had previously not been represented in the World Network of Biosphere Reserves (WNBR): St. Kitts & Nevis, Togo, the Maldives, Lithuania (2011) and Haiti, Kazakhstan, Sao Tome & Principe (2012). All of these are listed by the International Monetary Fund (IMF) as 'Emerging & Developing' economies. 'Economy-type' is defined as in the IMF's 2012 World Economic Outlook (WEO) classification system (International Monetary Fund, 2012; http://www.imf.org).

given their larger scale and explicit appreciation of a diverse landscape mosaic, are thought appropriate for resolving the trade-offs between economic, social and conservation objectives in complex socio-ecological systems. However, a landscape approach for reconciling development with conservation may present its own operational challenges.

As with ICDPs, there is little empirical evidence that a landscape approach is more effective than ICDPs in aligning environment-development objectives (Sayer *et al.*, 2006). Given that it is still largely untested and undocumented, and that it shows convergence with the ideals of the original ICDP approach, there is the potential that a landscape approach, by adding complexity to an already complex aspiration (e.g. aligning conservation and development for the benefit of both) may suffer the same limitations of the traditional ICDP.

In this regard, the BR designation may be especially useful. The development of the ecosystem approach was influenced by the systematic approach of UNESCO-MAB's implementation principles and designation requirements (Axelsson *et al.*, 2011). Given BRs prerequisite of larger size, prescription for co-management and multiple stakeholders in the designation of a site, opportunities for continuous review and interdisciplinary research, and potential for exploitation as 'natural experiments' at a global scale (see Section VII), BRs can provide the framework for action learning around win-win solutions, and ultimately contribute to sustainability in many scenarios.

Thus, the ICDP definition (and future evolution thereof) demonstrates substantial convergence with MAB's current aims and objectives. BRs provide an indirect linkage between livelihoods and conservation through substitute economic activities, provided by the BR authorities in return for compliance with the spatial restrictions on resource use (Salafsky & Wollenberg, 2000). Such development initiatives are as diverse as they are abundant, and examples are included in Table 3.

Many of Table 3's projects remain in their infancy, i.e. Cape West Coast, or have only been implemented as 'pilot projects' thus far, i.e. Kruger to Canyons, Yayu, Lake Vanern BRs, but these economic interventions may help secure confidence in the BR model, and increase

Table 3. Economic development initiatives implemented within selected Biosphere Reserves (BRs)

Biosphere Reserve	Economic development and welfare upliftment initiative
Giam-Siak Kecil—Bukit Batu BR (Indonesia)	Establishment of acacia plantations as a community development initiative (UNESCO, 2010*a*) and to target illegal logging of natural forest; pilot program to initiate bio-village [Asia Pulp & Paper (APP), 2011].
Yayu BR (Ethiopia)	Sustainable agriculture initiatives targeted at coffee production linking local coffee production to organic and free-trade markets (through training, and assistance with coffee value additions, i.e. harvesting, processing, certification and marketing procedures). Agriculture initiatives aimed at honey and fruit production are in the planning and fundraising stages. Renewable energy initiatives (from coffee-waste, small-scale hydro- and solar power) will drive further local development (Deprez, 2011*a*, *b*, *c*)
Yancheng BR (China)	Programs to expand cultivable land area through the construction of aquaculture ponds, reed lands and salt pans in the tidal areas on the eastern side of the BR (Ma *et al.*, 1998). While this expansion guaranteed habitat transformation, the activities remained tolerable for the vast resident waterbird population while food and water remained in adequate supply. Protecting the bird species population is the BR's main objective.
Bia BR (Ghana)	Local villages have been allocated harvesting licenses for African giant snail (*Acantina acatina*) found in abundance in the BR. Income obtained from this is partially utilised for conservation purposes, with the remainder returned to the villages for use in community-based projects, such as for water pumps and improvements to schools (Schaaf, 2009).
Nanda Devi BR (India)	Afforestation projects and the provision of mechanical soil conservation measures, solar power, improved beehive and spinning devices at subsidised prices. Government support for establishing vermicompost and the use of biofertilisers—in anticipation of increased demands for organic crops grown in the BR (Saxena *et al.*, 2010).
Sierra Gorda BR (Mexico)	Establishment of one of the first (social) carbon projects developed by the Grupo Ecologico Sierra Gorda operating within the carbon market's 'very voluntary' arena (i.e. no third-party certification). Offers institutions the option of offsetting carbon emissions by giving financial compensation to farm-holders who pledge reforestation and environmental conservation (Deprez, 2011*d*). Project has direct benefits (education, training, payments for ecosystem services and conservation of private lands, water storage works) for >200 communities in the BR, with conservation benefits of >13 000 hectares returned to natural forested state (http://www.carbonneutralplanet.org/basket.pdf). Other sustainable agriculture initiatives successfully established value-added products: e.g. *Sierra Country Products* (intensive management and sale of livestock products), aquaculture products, *Pure Life Foods* (organic fruits and vegetables), *Green Gold Certified Oregano* and *Honey of Tancoyol* (Deprez, 2011*e*).
Entlebuch BR (Switzerland)	Development of the BR-linked label, '*Echt Entlebuch*' (genuine Entlebuch), identifying high-quality products (e.g. cheese, ham) manufactured within the BR. The Swiss National Tourist Office has awarded three of these products the prestigious ' NaturPur' label. Local restaurateurs (>300) bear the 'Gastropartner' label awarded by the BR; this label identifies local establishments partnering, and utilising Entlebuch Biosphere products (UNESCO Biosphere Entlebuch, 2007; Schaaf, 2009).
Lake Vanern (Sweden)	Projects to link recreational fishing more closely with *in situ* fish sales and more efficient, more holistic processing methods. Currently recreational fishing extracts a comparable volume of fish to commercial fishing from the lake. The pilot project aims to enhance sustainability of the lake's fisheries use by *inter alia* linking food to the BR region, allowing local use of ecosystem services, and improving the lake's management practices (UNESCO, 2011*a*; www.euromab2011.se).
Kruger to Canyons BR (K2C) (South Africa)	Established natural-resource-use projects centred on environmental access rights (www.kruger2canyons.org/projects.html). These projects include a successful *Bio-cultural Protocol* project implemented through traditional health practitioners which outlines the traditional practitioners' role in the community and the challenges they face. Bio-cultural protocols assist in protecting traditional knowledge and traditionally used resources, and help practitioners acquire access to areas that are unavailable for harvesting. This project is closely linked to a community-based carbon-trading project (*Voluntary Carbon Offset Programme*), where carbon is sequestered through the planting and growing of important medicinal plant resources. This helps to address resource availability issues due to over-harvesting or lack of access. The *Environmental Monitor Project*, implemented under National Government's Extended Public Works Programme employs previously unemployed community members from within K2C; specifically to assist with the monitoring function of the BR. K2C also conducted a feasibility study for a hydro project (*Blyde Hydro Project*) as a direct result of collaboration with the Rhön BR in Germany. The project proposes the development of a hydro station on an already established dam wall. However, due to the potential financial rewards and political challenges, this project was taken over by the Provincial authority, with K2C committed to the final decision. The Kruger National Park (KNP) has also implemented its own community-targeted development projects in the BR: a pepperbark *Warburgia salutaris* (IUCN: Endangered) harvesting and propagation (Scheepers *et al.*, 2011), a thatch harvesting (Zambatis, 2011), and a mopane worm harvesting project (Swemmer *et al.*, 2011), allowing approved access to the resources in the National Park.

Table 3. Continued

Biosphere Reserve	Economic development and welfare upliftment initiative
Cape West Coast BR (South Africa)	Education outreach and scholarship programmes. These include youth schools environmental education, scholarships to study at the South African Wildlife College and bursaries for tertiary education. The BR also has begun negotiation of a major industrial corridor through the subregion, and assisted local government with geographic information system GIS projects (du Toit, 2011).

support for community inclusion into the BR. Some projects, for example the original agricultural expansions in Yancheng BR, the initiatives in Entlebuch BR and the carbon project in Mexico's Sierra Gorda BR, have already had successful outcomes (Table 3; Hughes & Flintan, 2001; http://www.carbonneutralplanet.org/basket.pdf), with these development initiatives having positive impacts on poverty while environmental integrity was unaffected or even slightly enhanced.

However, BRs fall within the theoretical arena of 'win-win' conservation and development solutions; true win-win outcomes are rare, with trade-offs between competing objectives likely (reviewed by McShane *et al.*, 2011). Where conservation initiatives inflate community expectations, without being explicit about potential, and possibly disproportionate, livelihood losses and restrictions on resource use, the discord between community members and conservation agencies is likely to be substantial. Wells & McShane (2004) refer to this as a cycle of 'optimism and disenchantment', which, if unresolved, will have long-lasting consequences for future conservation initiatives in the area.

In some instances the potential benefits of these projects are viewed as inferior to the livelihood losses incurred due to spatial restrictions on use, e.g. Nanda Devi (Maikhuri *et al.*, 2001; Saxena *et al.*, 2010) and Bayerischer Wald BRs (Table 1; Price *et al.*, 2010; UNESCO, 2010*b*). This is particularly true when benefit-sharing is viewed, rightly or wrongly, as inequitable across stakeholders, i.e. biased towards a select few in the community (e.g. individuals qualifying for participation in pilot projects). Many of those who may benefit from conservation-linked development opportunities, e.g. ecotourism initiatives, may not be the ones who are adversely affected by the change in resource access rights, while those who suffer the costs may not be sufficiently reimbursed for their sacrifices (Fuentes-Quezada, Sekhran & Kunte-Pant, 2000; Fu *et al.*, 2004).

For example, local farmers in the Wolong BR, South Western China bore the conservation costs of restricted land use, with their traditional resource use impaired by the spatial regulations of the reserve (Fu *et al.*, 2004). They received no tangible economic rewards from the eco-tourism initiatives implemented within the BR, nor were able to afford the hydro-powered electricity offered as an alternative source of energy to the now restricted fuelwood harvests. For this portion of the community, the establishment of the BR further undermined their already fragile socio-economic circumstances, offering no opportunities for improvement of livelihood options.

When the Maya Biosphere Reserve, Guatemala, was established in 1990, the initial eviction and subsequent resettlement of the original residents from the National Park to government-established agricultural properties *('fincas')* was generally well accepted. This resettlement mainly involved the *Comunidades Población en Resistencia* (CPR), a faction opposing the Guatemalan government during the 36 year civil war, who had sought refuge in the National Park. However, the relationship between Maya BR and new colonists moving into the reserve from other regions of Guatemala continues to be fraught with difficulty. The ongoing displacement of the new colonists and residents from the core zones, and limitations on access elsewhere in the 'multi-use' zones, has led to repeated illegal re-colonisation of the core zones, and ecological sabotage, such as setting fire to the BR to make conservation pointless (McNab & Ramos, 2007). Further compounding the lack of regard for the Maya BR designation is the government's inability to police and evict the wealthy landowners from the BR, which has precipitated a wider disregard for the Maya BR's rules and regulations in general. As a result, stakeholders of the BR have suggested *inter alia*, that the BR be de-proclaimed/eliminated, or that the core area's restrictions on access be reassessed, with the core zones re-designated as forest concessions (McNab & Ramos, 2007).

In the Changbai Mountain BR, China, until new legislation and a more effective management organisation prohibited such activities in 2006, reserve authorities supplemented their limited salaries by offering entrepreneurial activities, issuing collection contracts to private individuals for forest resources (e.g. pine nuts). These contracts generated significant resentment towards both the contractors and reserve authorities, and provided local residents with the motivation to continue with their own exploitation of the forest, regardless of the restrictions in place (see Yuan, Dai & Wang, 2008, for details).

The examples listed here are not representative of all the stakeholder-management relations found across the WNBR. It is certainly not the case for those BRs that have undergone review and subsequent transformation successfully; for example, the UK examples in Section III.4, the examples Reed & Egunyu (2013) discuss from Canada, or in the Kristianstad Vattenrike Biosphere Reserve, Sweden, where extensive research in co-management has been undertaken

to improve the 'fit' of social institutions and the natural environment (see Olsson *et al.*, 2007). Yet these examples illustrate the fragile relationship between BR managers, local government and resident communities, and the problems that may arise if managers treat BR residents as a homogenous entity, or enforce decisions without appropriate participation.

Results from ICDPs have shown that projects that fail to address equity issues (i.e. gender issues, economic discrimination) and social organisation, particularly local decision-making hierarchies (i.e. family hierarchies, traditional authorities, such as chiefs and councils) have had reduced success, especially in terms of project longevity (reviewed in Hughes & Flintan, 2001). These same cautions must apply to BR management. In the case of the Maya BR example, the modern BR may need to re-evaluate access rights to generate support around the designation (McNab & Ramos, 2007) which raises challenges for what appears to be already weak or discriminatory governance.

(3) Local stakeholder buy-in

Thus, BRs that fail to address participation effectively will undermine long-term sustainability, as shown by Stoll-Kleeman & Welp (2008). In a survey of 213 BRs, increased participation resulted in increased social acceptance of the BR which, in turn, resulted in more effective conservation. BR managers cannot neglect appropriate and unbiased community engagement, regardless of the complexities that may be involved with the participatory process, e.g. the large numbers of stakeholders involved in decision-making and the opportunities for conflict in the management process. In this regard, the BR concept has provided a systematic approach to achieving effective stakeholder-manager dialogue, using detailed examples of the consultation and co-decision process in selected BRs (reviewed in Bouamrane, 2007).

However, in this era of people-centred conservation, BRs may also find invaluable insights from tools that are traditionally linked to the marketing and product development arena given that conservation has moved beyond biogeographical problems, to include sociological issues central to success. In this context, programs like Future Search (http://www.futuresearch.net/), Open Space (http://www.openspaceworld.com/users_guide.htm), and World Café (http://www.theworldcafe.com/) have merit for participatory management (reviewed in Stoll-Kleeman & Welp, 2008) with the Open Space method already used by UNESCO Venice with some success. Other methods that may offer insight to the relationship between communities and their BR, include focus groups [see Stoll-Kleeman & Welp (2008) for explanation], key informant interviews, and participatory geographic information system (GIS) approaches [e.g. for discourse around resource allocation in BRs; see Kwaku Kyem (2004) for review of participatory GIS applications].

V. CAUTIONS FOR BIOSPHERE RESERVES: CHALLENGES IN ALIGNING CONSERVATION AND DEVELOPMENT

BRs may offer prospects for socio-economic development as an incentive to the BR stakeholders, yet development delivers its own challenges for these conservation areas. Encouraging development in sensitive environments may have negative consequences not only for ecological integrity and conservation values but also for economic activities that depend on an appreciation of an 'unspoiled' environment and the notion of 'wild nature', i.e. for recreational purposes.

(1) Consequences for ecological integrity

In Wolong BR the presence of a road system allowed residents to access biodiversity resources a distance away from their villages (Fu *et al.*, 2004), exploiting areas that were previously inaccessible to residents, and fuelling more rapid land-cover change across the landscape. Once intact habitat is lost from the landscape on a large-scale, e.g. due to development initiatives, the cycle is frequently self-propagating involving land-cover change trajectories of increasing transformation with further development (Brady *et al.*, 2009). While the notion of development itself is not problematic, unregulated and indiscriminate development agendas will compromise the BR long term, particularly at the level of spatial zonation (see Section VI.2).

In Yancheng BR initial development programs expanding cultivable land area did not negatively affect biodiversity (Ma *et al.*, 1998; Table 3). However, this success led to further development projects, effectively intensifying development activities in the BR, yet assuming the same negligible environmental impacts as the first project. Conservationists foresaw local species extinctions as a result (i.e. river deer *Hydropotes inermis*), and the forced migration of the waterbird population as the wetland ecosystem was irrevocably changed (Ma *et al.*, 1998). The new development permissions allowing for over-development of the BR (Ma *et al.*, 2009) resulted in economic rewards for the local BR human population. Yet, these new permissions had serious consequences for the environmental integrity of remnant wetland habitat, and the priority BR species (Table 3), the endangered red-crowned crane (*Grus japonensis*), now only survives in artificial wetlands created in the core of the BR (Ma *et al.*, 2009).

With dual conservation and development priorities, the challenge is for BR authorities to identify change trajectories and react appropriately, pre-empting unfavourable transformation before it results in irreversible environmental degradation. The reality of effectively aligning conservation and development is likely to be a dynamic balancing act between conservation *versus* development objectives over time. Sensible choices need to consider the (changing) socio-ecological context of the landscape, and involve repeated reassessment of potential impacts of development projects, i.e. a pragmatic and adaptive management approach that

responds to defined thresholds of acceptable/unfavourable land-cover transformation. Remotely sensed data will be a useful tool in this regard (see Section VI.2).

(2) Consequences for economic circumstances and the Biosphere Reserve 'brand'

Where the development activities planned for a BR detract from the notion of a pristine environment, i.e. a common expectation of a 'National Park' or 'Nature Reserve', the consequences for tourist visitation may be severe, especially when these activities impact the formally protected areas inside the BR. BR authorities may need to adopt precautionary measures to ensure that economic development projects do not diminish the conservation values (tourism, biodiversity protection) of existing protected areas, particularly when the BR label as an attractor for tourism is frequently overshadowed by the protection status of the protected areas within the BR.

For example, in the Lake Torne BR in Sweden, before it was withdrawn from the WNBR in 2010 (Table 1), tourists were unaware of the BR, and were attracted to the region by the presence of Abisko National Park (Reinius & Fredman, 2007). In Slovakia, Hungary and the Czech Republic, the BR label is largely ignored by tourists, and even by local conservation authorities, compared with other conservation designations in the area (Nolte, 2004). In Australia, excluding the recent additions to the national BR network, BRs have been traditionally perceived (by tourists, as well as by federal decision-makers) to be areas that do not uphold environmental protection due to their emphasis on development. They have been seen as competing with existing national conservation programmes [e.g. National Heritage Trust 'Care' Program (1997–2008, now: 'Caring for our Country')], thought to be an unnecessary addition to existing conservation policies, and challenged for limited funding allocated for National Parks (see Matysek, Stratford & Kriwoken, 2006, for specific details).

However, this is not the case for all BRs, and in the Entlebuch BR, Switzerland, for example, the reverse is true. Broad-based image campaigns have raised awareness for the BR and its 'back-to-nature' style tourism. Targeted tourism marketing concentrated on the subregion has also been utilised extensively. Entlebuch BR is well accepted as the paradigm of Swiss regional parks, with the Swiss media frequently (almost daily) reporting on the BR and its various economic activities, specifically the high-quality food products bearing the Entlebuch identifier, and the BR's 'Gastropartner' concept (UNESCO Biosphere Entlebuch, 2007; see Table 3).

Similarly, in the Bañados del Este BR, Uruguay, an eco-labelling initiative identifies certain products produced in-line with the BR's sustainable approach to resource-use, and the direct involvement of local residents in product development and marketing. Besides the promotion of locally sourced products, the label, '*productos Banados del Este*', also highlights the territory as unique in the region, i.e. a 'Biosphere Reserve' (Bouamrane, 2007). In the Grosses Walsertal Biosphere Park, Austria, BR branding links local agricultural products to the Biosphere Park (e.g. timber, agricultural brands: 'Walserstolz', 'Bergtee', 'die kostliche Kiste') with the local hospitality industry awarded the label '*Partner Company of the Biosphere Reserve*'. Although the direct tourist value from this branding remained insufficient, it elicited a strong positive response from the partners involved; effectively enhancing co-operation between local businesses across the BR (Lange, 2011). As such, it is incorrect to restrict the opportunities in BR branding to only marketing specifically for increasing tourist awareness. Rather, BR-linked product (and service) labelling may have an important role to play in creating and strengthening the regional identity of local communities located within BRs (see Lange, 2011).

Thus better marketing of the BR label may adjust people's perception of the designation. The BR designation is a relatively new label compared to those of 'National Park' and the other well-known protected areas within the BR region. There will be a lag period before BRs have the same effect on tourist visitation as these other, better known conservation areas (Reinius & Fredman, 2007). Such marketing initiatives need not be expensive; with social media, i.e. *Facebook*, *Twitter*, *LinkedIn*, *YouTube*, BR authorities can easily reach, and popularise their reserves with international audiences. The viral nature of the online community will ensure self-propagation of the BR campaign. The newly launched *BiosphereSmart* website initiative may be instrumental in this regard (http://biospheresmart.org/). The interactive portal is a global observatory created to share experiences and best practices among BRs. It is based on the idea of maximising (new) information technologies to strengthen partnerships across the WNBR, as well as empowering communities by providing access to information and enhanced decision-making capacity, i.e. with citizens acting as beneficiaries *and* actors in this BR information-sharing arena.

Clever use of the MAB mandate in these campaigns, i.e. social justice ideals, development initiatives that preserve ecological and cultural integrity, aggressively linked to contemporary issues in the traditional media, may target the social conscience of potential visitors, i.e. concepts of environmental responsibility. This should generate discourse amongst like-minded internet users, and mainstream the BR concept more rapidly.

VI. BIOSPHERE RESERVES AND PRACTICAL IMPLEMENTATION: THE CASE OF THE KRUGER TO CANYONS BIOSPHERE RESERVE (K2C), SOUTH AFRICA

Given the potential benefits of the BR concept for developing countries outlined in previous sections, generating broader public support and goodwill towards this 'new' conservation approach may need to become a priority. The history of conservation decisions has been fraught with ethical injustices (reviewed in West *et al.*, 2006; Redford & Fearn, 2007), with many of these historical actions still having negative effects

today, e.g. protected area establishment tied to longer term poverty, cultural changes and subsistence losses (Rangarajan & Shahabuddin, 2006; West *et al.*, 2006). BRs need to ensure that they do not follow the same trends—given that displacement from the core zones or limitations on access rights may accompany designation.

In the South African conservation context, there is a long history of discriminatory displacement and eviction associated with protected area establishment, which has given rise, in some cases, to enduring attitudes of resentment. In fact, the Kruger National Park (KNP), South Africa's flagship protected area for biodiversity conservation, when it was first established was seen 'as a means of providing more effective control over neighbouring Africans, as well as those who remained in the park' (Carruthers, 1995, p. 65). The establishment of the park prioritised white South African interests over those of other races, with the description 'National' and 'Kruger' equivalent with 'white' culture and heritage at this time (Carruthers, 1995).

Thus, for a large portion of the South African population, protected areas, KNP in particular, are seen as symbols of 'apartheid repression' rather than viewed with national pride. There have even been calls for KNP's de-proclamation, stating that its 20 000 km^2 of untransformed African savanna would be better utilised as agricultural land for the impoverished communities who live immediately outside its boundaries (Carruthers, 1995).

However, recent systematic biodiversity assessments have also flagged these areas immediately west of KNP as requiring urgent additional conservation in response to land-use pressures (e.g. Driver *et al.*, 2005; Ferrar & Lotter, 2007). Given the historical inequalities in the subregion, and current socio-economic circumstances, the further exclusion of local communities to enhance levels of biodiversity protection will be met with strong opposition. Thus, for the South African situation, the BR model may be especially appropriate.

The Kruger to Canyons Biosphere Reserve (K2C, http://www.kruger2canyons.org) of South Africa includes the iconic KNP, and the aforementioned impoverished communities located adjacent to it. The apartheid era displacements have had long-term repercussions for the social fabric of this sub-region, and the BR designation here has been applied with the hope of redressing the inequalities in socio-economic circumstances across the landscape. Should this model be effective in this regard, it would have broader relevance for other parts of South Africa, or other countries where similar circumstances prevail, e.g. China (e.g. Yuan *et al.*, 2008), India etc., where large portions of the population still rely on direct harvesting for daily livelihood demands, and/or live in close proximity to sensitive conservation areas. This section details the difficulties of establishing a BR in an already well-established cultural landscape, and suggests a management strategy for the future that will better align the BR model with the situational context of the South African political, social, economic and conservation environment.

(1) Background to the subregion

K2C is located in the north-eastern part of South Africa (Fig. 5A, B) and is one of the largest BRs in the world, at approximately 2.6 million ha in extent. Established in 2001, K2C includes a diverse array of economic and conservation land-use types, and has a resident human population of >1.5 million people, most of whom reside in the transition zone in rural communities.

Conservation accounts for more than half of the available land area in the BR, while in the unprotected remainder, economically important (nationally and regionally) commercial agriculture, mining (e.g. Palabora mine, the largest open cast copper mine in southern Africa) and forestry sectors persist. The settlement areas continue to expand. In places population densities in these settlements exceed 300 people/km^2 (Pollard, Shackleton & Carruthers, 2003), despite the semi-arid environment.

The expansive rural settlement areas in K2C are well-established artefacts of the former apartheid era. The forced relocations of black South Africans to the rural 'homelands' of Lebowa, Gazankulu and KaNgwane (encompassed in the present-day Bushbuckridge and Maruleng administerial districts in K2C; Fig. 5A), and the associated separate development policy of the apartheid regime have had long-term repercussions for the socio-economic circumstances of the communities here.

High population densities, entrenched poverty, and poor economic opportunities have ensured a well-established relationship with the natural resource-base in communal rangeland areas associated with each village to support household livelihoods (Shackleton & Shackleton, 2004; Twine, 2005). Rangeland usage includes traditional agriculture, grazing of domestic stock, fuel- and construction-wood harvesting, and the collection of food items, thatching grass and medicinal plants.

While non-destructive use of the environment should not compromise the ecological integrity of the BR in general, the recent influx of foreign refugees into the region (Polzer, 2007), and the weakening control of the traditional authorities over resource management (Twine, 2005), may compromise the sustainability of this resource extraction long term. Already, recent studies indicate that current levels of timber resource extraction in the BR are unsustainable (Fisher *et al.*, 2012; Matsika, Erasmus & Twine, 2013; Wessels *et al.*, 2013).

(2) The designation of K2C and the situational context

For K2C's resident population, the listing of the site with MAB provides access to previously unavailable economic and livelihood opportunities in the future (see Table 3 for specific examples of projects that have been piloted or are planned for K2C). In terms of future developments proposals, K2C management authorities have established a zone-specific, conceptual framework that guides further development initiatives (http://www.kruger2canyons.org/index.html). These appear to be sufficiently broad to be incorporated into

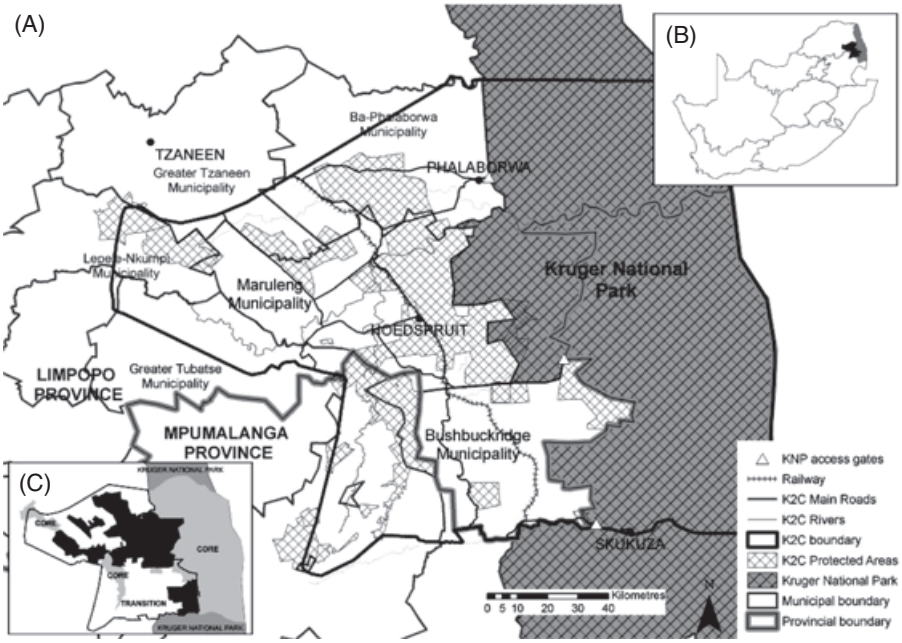

Fig. 5. (A) Regional location of the Kruger to Canyons Biosphere Reserve (K2C), including protected areas, municipal districts, main roads and rivers. (B) Map of South Africa showing provincial boundaries. (C) Spatial arrangement of core, buffer and transition zones in K2C.

national policy around land-use planning. Their practical alignment, however, is likely to be more challenging.

The zonation of this BR is neither the stylised concentric rings of model BRs, nor is it the spatial arrangement of core: buffer: transition zone envisioned by the BR concept (Fig. 5C). In K2C, with reference to KNP and the south-eastern portion of the BR in particular, densely populated settlement areas lie immediately adjacent to the National Park, with negligible buffering between the two land-use types.

Admittedly, settlements were established prior to the listing of K2C, which limits the delineation of the subsequent zonation. Yet, this negligible spatial buffering (note: not 'buffer zone' as in the formal BR zonation), between the National Park, and a growing settlement expanse (with an associated increase in unregulated resource extraction), may eventually compromise the conservation values of KNP, and other protected areas in the BR.

In K2C, between 1993 and 2006, settlement areas increased by 39%, with expansion tracking transport routes (Coetzer *et al.*, 2010). Given the relationship between the local communities and their communal rangeland areas, as settlements enlarged, the footprint of resource extraction increased, with consequences for the extent of intact habitat nearby. Furthermore, the land-cover change occurring in the transition zone appeared to have impacts that extended beyond this zone, encroaching into the protected areas in the buffer zone of central K2C (K.L. Coetzer, E.T.F. Witkowski, B.F.N. Erasmus & B. Reyers, in preparation).

This scenario is not restricted to K2C, and in other developing countries, land-use change in the transition zone has also threatened the longevity of conservation initiatives in the core zone (e.g. Ma *et al.*, 2009). Where solutions were offered in order to address the resultant environmental degradation that occurred as a result of the development process, as in the case of Yancheng BR, they focused on specifically redefining the nature, extent and location of all three zones, given that significant changes had occurred in the transition zone since the BR's first listing (Ma *et al.*, 2009). K2C may find value in considering a similar revisionary approach.

While K2C may have produced guidelines for future land-use in the BR, the available land area for development and expansion is a severe limiting factor, not only for the local settlement communities but also the other land-use stakeholders of the subregion. Limitations on 'free space', together with an impoverished and growing population and their more intensive usage of the local environment, will undermine any theoretical zonation and restrictions on 'use' in the BR. For the expanding settlement communities, the immediate fulfillment of daily living demands may take precedence over any longer-term benefits from the planned development initiatives, with consequences for the land-cover of the BR. This raises questions around the validity of the BR designation, as it has been currently been applied, for K2C's already well-established land-use matrix, particularly around issues of sustainability.

However, the land-cover change presented here has occurred regardless of the subregion's listing as a 'BR', rather than as a result, i.e. due to BR-linked sustainable development objectives fuelling land-use change—given that the site was only established in 2001. K2C has also made noteworthy advancements around stakeholder alignment

for resilient socio-economic development (Coetzee & Biggs, 2012). This was an extensive consultation process that set the baseline for a sustainable mixed(land)-use landscape mosaic in the future, and K2C been formally recognized by UNESCO in this regard.

However, it may still be useful to re-evaluate the appropriateness of K2C's zonation in the future, with the BR management exploiting adaptive management techniques which respond to changes in land-use in the BR over time. As such, historical, and future, land-cover change trends will be instrumental in this decision-making process, and should be a priority for this, and other BRs. The feasibility of such an approach for K2C and other developing countries is uncertain, given the limitations on financial and human capital (as opposed to natural capital; Brunckhorst, 2001), but the rewards are likely to be large. A dynamic management strategy may ensure the longevity of the BR into the future, which is likely to have important consequences for the subregion as a whole.

VII. BIOSPHERE RESERVES AS LEARNING SITES FOR INTERDISCIPLINARY RESEARCH

BRs are an ambitious designation when compared to traditional protected areas, and are essentially, when applied effectively, broader socio-ecological systems: cultural landscapes (*sensu* Farina, 2000) that require both social and ecological management strategies aligned for biodiversity protection and environmental sustainability. However, the implicit socio-ecological designation of the BR model raises the additional challenge of practically aligning these two 'cultures of conservation' (Rangarajan & Shahabuddin, 2006). In this regard, biologists/ecologists and social scientists are typically found on separate ends of the same (conservation) continuum, and will focus on different components of the bigger (BR) picture, i.e. people and nature. Research and management priorities of each will be disparate; disconnected by disciplinary preferences (Rangarajan & Shahabuddin, 2006).

Interdisciplinary research has received considerable interest in the conservation literature over time, but even recent publications emphasise the need to integrate the sciences more effectively (e.g. Balmford & Cowling, 2006; Meinke *et al.*, 2006; Margles *et al.*, 2010; Driscoll *et al.*, 2012). While conservationists certainly recognise the importance of an inclusionary approach that incorporates the social dimensions of conservation problems, the perception is that the gap between biological and social/economic/political sciences remains considerable, even with increasing awareness by both 'sides' (Fox *et al.*, 2006). There are few instances where practitioners and researchers have successfully integrated disciplinary approaches (with the possible exception of the field of ecological economics), due to lack of communication between parties (Fox *et al.*, 2006; Margles *et al.*, 2010). It is this gap that undermines effective biodiversity protection as, in general, contemporary conservation has become 'not about biology, but rather people and the choices they make' (Balmford & Cowling, 2006, p. 692); a complex problem that is also affected by development pressures and the prevailing political climate.

Advocates for mainstreaming interdisciplinary approaches more urgently stress the need for more structured opportunities for interdisciplinary collaboration, opportunities that allow collaboration from the project start-up, rather than at the end, i.e. as an ethical after-thought for better marketing with the public and political decision-makers (Fox *et al.*, 2006). MAB's BR model may be the ideal arena in which to do this.

When the BR concept was initiated, it was intended as a pioneer of intergovernmental interdisciplinary research and collaboration (Ishwaran, 2012), and while there may be a delay in the effective realisation of this role at the level of individual BRs, the theoretical framework already exists, i.e. in the form of today's WNBR and associated thematic activities. Herein, the Madrid Action Plan (UNESCO, 2008) specifically recognises the potential for the WNBR to function as 'learning sites for sustainable development'; emphasising BR's role in promoting the exchange of ideas and experiences from relevant site-based research across the global network (UNESCO, 2008). UNESCO's GLOCHAMORE project ('Global Change in Mountain Regions'; see Björnsen Gurung, 2006), and subsequent project, GLOCHAMOST ('Global and Climate Change in Mountain Sites'), are excellent examples of global collaboration and interdisciplinary research that has been undertaken within existing BRs (www.unesco.org). Since GLOCHAMORE was first initiated in 2003, more than 300 scientists from a wide range of scientific disciplines and some 25 BRs participated in the research, which focused on global change in mountain ecosystems and its socio-economic impacts on the livelihoods of mountain people (Lange, 2011; Schaaf, 2011).

The BR conceptual framework is well-established, and the underlying criteria of the concept already compel a relationship between social and environmental aspects in the conservation landscape. Where BR successes have been limited (see Sections IV and V), experience has shown that it is typically a failure on behalf of BR authorities properly to consider different stakeholders in decision-making and project design. Thus, explicitly incorporating a systematic, interdisciplinary approach from the initial stages of BR nomination, as well as more structured practical implementation guidelines, will serve both goals: ensuring the success of individual BR sites long term, and fulfilling the broader research need.

Thus all working BRs have the potential to deliver a solution to the disciplinary divide at the scale of individual sites: an adaptive management approach to develop 'prototype' programs for interdisciplinary (and ultimately, transdisciplinary) research and implementation (see Kleiman *et al.*, 2000 for details of a 'prototype program'; Biggs & Rogers, 2003 for an effective adaptive management approach specifically for conservation and resource management).

These prototype programs and their design principles, where successful, could be expanded for use within other BRs.

Such a structured program approach would address the concerns that the research completed in individual BRs is not being effectively up-scaled for international benefit; that individual BRs are not developing scientific approaches appropriate for other sites, and that the co-ordination of 'learning' is as yet unrealised (see Ishwaran, 2012, for details), regardless that the Madrid Action Plan (2008–2013) has set specific targets for collaborative, site-based, policy-relevant research and 'experience sharing' by 2013. Systematic interdisciplinary research programmes should also increase buy-in for the BR model in general, particularly at the level of acquiring donor funding. This could be crucial to the success for developing country BRs, lacking the financial and human capital for management but with abundant natural capital for conservation.

BRs are conservation designations that foster sustainability through their implementation, and given that they contain formal protected areas at their core, they are not immune to the challenges of environment-development reconciliations (Reed & Egunyu, 2013). However, while BRs are clearly aligned with the general ideals of 'sustainable development', it may be that the BR use of the term 'development' as a core objective of the concept (see Section II), may be intentionally or unintentionally overemphasizing the economic dimension of sustainable development, to the detriment of the social and environmental dimensions. Sustainable development is not merely economic development, but is anchored on the nexus of economic, environmental and social pillars of change. Thus the traditional expectation of 'development' as a specific function of a BR may also be deflecting from the designation's current role as 'learning sites' under the Madrid Action Plan (UNESCO, 2008) or 'learning laboratories' (Ishwaran *et al.*, 2008; Nguyen, Bosch & Maani, 2009). Contemporary BRs are to serve as learning sites for sustainable development: developing models and demonstrating approaches for global, national and local site-based sustainability.

The difference between the two expectations may be subtle (i.e. sustainable development as a core objective *versus* 'learning sites' for sustainable development), but in the contemporary context, the emphasis is on BRs to advance research and learning around sustainable development. They are to facilitate sustainability on the ground, not only in specific sites but also for up-scaling and international application elsewhere. This perception of 'learning sites' encourages experimentation and implies the opportunity for critical reflection on success and failure, an evaluation necessary for effective adaptive management (Schultz & Lundholm, 2010; Reed & Egunyu, 2013). Few existing BRs have the structures in place to fulfil their 'learning site' potential (see Schultz & Lundholm, 2010, for details). However, provided that research results are well documented and communicated, progress will be made towards this eventual goal, e.g. disseminated and shared *via* the *BiosphereSmart* website. The periodic review process may be an existing structure that may also be instrumental in this regard, presenting research results or project outcomes for the benefit of other sites (see Reed & Egunyu, 2013).

Holling (2001) indicates that the term 'sustainable development' is an amalgamation of the meanings implied in 'sustainability' and 'development'; that it is a logical partnership, with the goal of fostering adaptive capacity and creating opportunities for social, ecological and economic understanding. It has however, up until now, been somewhat slow to deliver on its 'promise' internationally. The notion of effective sustainable development goes beyond only what can be typically achieved through isolated integrated conservation-development projects or other conservation-development relations coupled with specific protected areas. Thus, a learning approach that is a global and interdisciplinary collaboration, undertaken across a range of socio-ecological or established natural experiments (in the form of the WNBR) may be the priority, not only for conservation, but for our understanding of complex adaptive systems in general.

VIII. CONCLUSIONS

(1) The backlog of first-generation Biosphere Reserves that do not meet the new requirements of the designation post-Seville remains large; regardless that the number of new sites listed each year continues to increase rapidly. This raises questions whether the current quality control mechanism enshrined in the Statutory Framework is working. It suggests the need for a more rigorous approach in applying, and reviewing conformity to the Biosphere Reserve model.

(2) Biosphere Reserves incorporate conservation areas recognised under other formal conservation designations. However, overlapping designation does not always ensure cumulative protection effort. Where sensitive environments exist, the 'development' and 'resource-use' requirements of the Biosphere Reserve model may not favour these existing conservation areas, and will require continuous re-evaluation.

(3) The Biosphere Reserve concept has been especially well received by developing countries, with the notion of dual conservation and sustainable development objectives attractive for encouraging socio-economic development in conservation landscapes. However, the literature has shown that similar approaches have not been especially effective in previous conservation efforts, i.e. ICDPs, with few compelling examples of success. Yet the literature also stresses the need for more human-centred conservation approaches, and the Biosphere Reserve model, when implemented effectively, is especially valuable in this regard. Already there are successful conservation-development projects existing in a number of listed sites.

(4) A more comparative integration of the 'lessons learnt' from existing Biosphere Reserves may improve implementation success of the model. This review has provided a number of case studies emphasizing ecological

and economic cautions in applying the designation. While a 'one size fits all' approach to implementation is unrealistic, a documented adaptive learning approach considering the successes and challenges of other reserves will be beneficial to both newly listed sites and other, older sites struggling with compliance to the Statutory Framework criteria.

(5) There are a number of excellent opportunities present in Biosphere Reserves, not only for ecosystem conservation and global-change scenarios given their typically larger sizes, but also for structured interdisciplinary research. This literature continues to emphasise the need for better integration amongst the disciplines, with few examples of this occurring successfully. The implicit 'social' and 'ecological' nature of working Biosphere Reserves suggests the potential, if harnessed appropriately, to function as 'prototype programs' for interdisciplinary collaboration. The global partnership, the GLOCHAMORE project has already been successful in this regard.

(6) It may be that continuing to emphasise 'development' as a core function of Biosphere Reserves is deflecting from the importance of the new roles of Biosphere Reserves under the Madrid Action Plan, i.e. as 'learning sites' for sustainable development. While the two objectives are clearly closely aligned, in the contemporary expectation the emphasis is on research and continuous action learning for sustainable development. Sustainable development has been slow in its global delivery. Re-assessing (*i*) the nature of research undertaken in Biosphere Reserves (e.g. as interdisciplinary from the project design phase), and (*ii*) utilizing the WNBR more effectively as established natural experiments for sustainability (as prescribed in the Madrid Action Plan), may be the way to improve the success of sustainable development initiatives worldwide.

(7) Biosphere Reserves are not intended to replace existing conservation designations/actions, but rather to enhance them: to improve the relationship between the environment, society and economic development in the landscapes in which they have been housed. This review has illustrated the potential of the Biosphere Reserve approach. This review has also indicated a number of challenges in applying the Biosphere Reserve concept internationally, with implementation lagging in many examples. However, with the more rigorous approach to evaluating sites since 2011/2012 (see Section III.3), it is likely that those Biosphere Reserves that do not function as the concept intends, i.e. a 'Biosphere Reserve' in label alone rather than in practice, will be withdrawn from the WNBRs in the near future, improving the successes of MAB globally.

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