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Research article

Biosphere reserves: Attributes for success

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ABSTRACT

Biosphere reserves established under the UNESCO Man and the Biosphere Program aim to harmonise biodiversity conservation and sustainable development. Concerns over the extent to which the reserve network was living up to this ideal led to the development of a new strategy in 1995 (the Seville Strategy) to enhance the operation of the network of reserves. An evaluation of effectiveness of management of the biosphere reserve network was called for as part of this strategy. Expert opinion was assembled through a Delphi Process to identify successful and less successful reserves and investigate common factors influencing success or failure. Ninety biosphere reserves including sixty successful and thirty less successful reserves in 42 countries across all five Man and the Biosphere Program regions were identified. Most successful sites are the post-Seville generation while the majority of unsuccessful sites are pre-Seville that are managed as national parks and have not been amended to conform to the characteristics that are meant to define a biosphere reserve. Stakeholder participation and collaboration, governance, finance and resources, management, and awareness and communication are the most influential factors in the success or failure of the biosphere reserves. For success, the biosphere reserve concept needs to be clearly understood and applied through landscape zoning. Designated reserves then need a management system with inclusive good governance, strong participation and collaboration, adequate finance and human resource allocation and stable and responsible management and implementation. All rather obvious but it is difficult to achieve without commitment to the biosphere reserve concept by the governance authorities.

1. Introduction

Biosphere Reserves are a mechanism within the UNESCO Man and the Biosphere Program (MAB) that seek to promote an approach to land management that harmonises interactions between people and nature. It is distinct from a protected area model as it considers the entire range of landscapes bound within the geographic limits of the management area (Batisse, 1985; UNESCO, 1996; Bridgewater, 2002), although protected areas are commonly the core of any biosphere reserve (BR). The conceptual model behind the BR idea was first developed in the 1970s and is based on integrated management across a landscape through a new approach to zonation of core, buffer and transition zones in order to harmonise conservation and development (Ishwaran et al., 2008; Axelsson et al., 2011). However, the gap between theory and practice is still a significant challenge for BR management due to poor understanding of how a BR should work on the ground to achieve the goals of sustainability by harmonising interactions between people and the environment across the landscape (Matysek et al., 2006; UNESCO, 2010; Reed and Egunyu, 2013).

Discrepancies in understanding the concept of the BR model and its implementation in the early stages hampered their development at both national and international level because many BRs were purely designated or proclaimed within the areas of high value of biodiversity with the aim of facilitating research in protected areas (Brunckhost, 1997; Ishwaran et al., 2008; Price et al., 2010). As a consequence, the BR concept was re-articulated through the Seville Strategy formulated at the International Conference on BRs in Seville, Spain in 1995, to include sustainable development as a priority with local people involved in planning and management of the reserve. The Seville Strategy provided a legal statutory framework to ensure sites could fulfil the three BR functions: biodiversity conservation, development and logistic

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support (UNESCO, 1996).

Recent rapid growth in the extent and number of sites in the world biosphere network (WNBR) across biodiversity hotspot countries, particularly after adoption of the Seville Strategy in 1995, demonstrates promising progress in the recognition of the value of the biosphere program for providing achievable models for conservation and sustainable use of natural resources (Ishwaran et al., 2008; Brenner and Job, 2012; Coetzer et al., 2013). Since the first BRs were set up in 1976, the current WNBR has grown to include 651 sites in 120 countries with a total area of more than 600 million hectares (UNESCO, 2015). However, the BRs are still considered undervalued and underutilised, and their roles and functions not yet recognised and clearly understood by the public and governments (UNESCO, 2010). Within the current WNBR, the conventional approach of top-down biodiversity conservation involving multi-stakeholder arrangements and the aspiration for community-led management makes it more challenging to effectively manage BRs (Stoll-Kleemann and Welp, 2008; Schultz and Lundholm, 2010; Schultz et al., 2011).

Evaluation for individual reserves through a ten-yearly periodic review process was called for by the Man and Biosphere Program under the Seville Strategy. This Strategy document was incorporated under "*The Statutory Framework of the World Network of Biosphere Reserves*" and adopted by the General Assembly of UNESCO (UNESCO, 1996). The evaluation process aims to assess achievements of site management relating to the three core functions of BRs and explore learning opportunities at both national and international scales (Price et al., 2010; Coetzer et al., 2013). These assessments are used to show the appropriateness of the particular BR approach to achieve both conservation and sustainable development (Price, 2002; Reed and Massie, 2013). However, periodic reports mainly focus on the article 4 of the Strategy relating to BR selection criteria. As a result, the evaluation reports focus on assessment of zonation schemes while disregarding other aspects such as management practices and governance (Reed and Egunyu, 2013). The ten-year interval between reviews also hinders the process of active learning, adjusting and adapting management action (Price et al., 2010; Reed and Egunyu, 2013).

Using a Delphi process to elicit expert opinions, this paper identifies internationally recognised examples of successful and less successful BR implementation and key factors influencing success or failure of the BR model. The common factors defining the BR success or failure as well as their relationship to the frameworks and principles of the Seville Strategy are discussed and recommendations are made about attributes that are likely to be transferable across countries and governance systems.

2. Material and methods

The views of people with particular expertise in BRs were gathered using a Delphi Process. The Delphi process, named after the ancient Greek oracle at Delphi, was developed in 1960s by the RAND Corporation (Dalkey and Helmer, 1963). Using two or more rounds of consultation, the Delphi process allows for eliciting, refining and drawing-out the considered views of experts who are knowledgeable about the topic area (Gupta and Clarke, 1996; Okoli and Pawlowski, 2004).

Two rounds of a Delphi process were undertaken to identify successful and less successful BRs and identify factors impacting on success or failure. A list of 55 potential experts including scientists and managers was prepared for this process. From this group, 25 potential panellists from the scientific community were selected based on their work, experience and publications relating to BRs. Thirty senior managers who are now working at the UNESCO-MAB headquarters and the national MAB committees representing all five MAB regions (AfricaMAB, IberoMAB, EuroMAB, AsiaMAB and ArabMAB) were also approached to join the expert panel.

Structured questions were sent to experts in round one asking them to: nominate five successful BRs and five less successful BRs in the global network; provide personal opinions or statements for up to five factors influencing the success and failure of each nominated site; and general statements about the contributing and hindering factors affecting the WNBR.

Information from respondents was synthesised to develop a list of nominated successful and less successful BRs. The attributes identified as contributing to the success or failure were grouped into 11 main factors. These were then returned to all people in the contacted list of both responders and non-responders in the first round. In this second and final round, the panellists gave their rating for the 11 the factors based on 5 levels: critical, very important, important, somewhat important and not important. Responders also were asked to add and rate any missing factors that they think are important to success or failure of BR management.

Feedback from the second round was synthesised as a rating on a scale from critical (5 for success factors/-5 for failure) to not important (1/-1). SPSS 20 then was used to calculate mean score of the influencing factors, develop the ranking list and identify the significant relationships among influencing factors using Spearman correlation.

3. Results

Twenty out of fifty-five (36%) contacted experts and managers participated in the first round questions. Thirteen respondents were scientists and 7 managers from the national MAB committees or BRs in both developed and developing countries. The response rate of the panellists in the second round was 27 out of 55 people (49%). This represented sixteen panel respondents in the first round and nine new participants (people who did not respond in the first round) who provided their rating and assessment in this round.

3.1. Nomination results

3.1.1. Successful and unsuccessful biosphere reserves

A total of 90 BRs belonging to 42 countries representing all five regions of the WNBR were nominated. Forty-seven nominated BRs belong to the post-Seville generation, set up from 1996 to the present and forty-three pre-Seville sites, which were established from 1976 to 1995. Approximately two thirds of the successful sites belong to post-Seville while two thirds of less successful BRs belong to pre-Seville generation. Four BRs (Rhon, Tonle Sap, Riverland and Fitzgerald) received both successful and less successful nominations.

Sixty BRs were nominated as successful examples in 28 countries representing all five regions of WNBR (Supplementary Online Material, Table 1). Thirty-seven BRs belong to the post-Seville generation and 23 sites belong to pre-Seville generation. The top 5 countries having the highest number of nominated successful BRs were Canada and Germany (8), Vietnam (5), Mexico, Spain and South Africa (4).

Thirty sites (10 post-Seville and 20 pre-Seville BRs) in 20 countries were nominated as less successful examples (Supplementary Online Material, Table 2). Australia (7) and Germany (4) are the countries having the largest number of less successful BRs. Interestingly, Rhon BR which was nominated in the set of most successful examples in the WNBR received one nomination as a less successful site due to a lack of staff.

Twelve nominated sites that belong to 10 countries of five regions within the WNBR were identified as the most common successful examples. Of these, five BRs received three or more

nominations as successful sites and six reserves received two nominations (Table 1).

Although the post-Seville generation had the highest proportion (59%) in the list of the successful sites, a significant percentage (41%) of successful sites belonged to the pre-Seville generation. Having a compliant designation of three zones under the landscape approach, either in the original pre Seville designation (Rhon, Spreewald and Dana) or transformed effectively through zonation extension after the review as recommended by the Seville Strategy (North Devon and Camargue region), supports the implementation of the BR concept:

> *"[North Devon] the first UK BR to revise its design from a 1970s structure to one that fully met Seville Strategy"* (Respondent 5, hereafter R5).

Such zone designation then allows for a strong partnership with a wider stakeholder and land user group who participate in the new opportunities for development and this collaboration contributes to BR concept delivery. This development opportunity promotes a sustainable financial base for the BR and results in local and regional input to sustainable resource management and also encourages adaptive learning, for example:

> "[North Devon] *Considerable experimentation in buffer and transition zones – in fields linked to sustainable energy, agriculture and forestry*" (R5).

Or

> "[Rhon] *Effectively linking the BR -brand to local produce-socio-economic successes, contributing to 'economic revival' of the region*" (R7).

Successful application of the biosphere concept model in Rhon BR is given below:

Rhon– example of a biosphere reserve identified as successful through the Delphi Process

Rhon is a transboundary BR that crosses three federal states of Bavaria, Hesse and Thuringia in Germany. Covering a total area of 185,276 ha and characterised as a rural man-made landscape, Rhon is home for about 162,000 people who live in small villages and towns with small-scale farming. Long history of land use created a rich cultural landscape and habitat for great number of endangered and rare wildlife species. However, land abandonment as a result of agricultural decline since the 1980s has posed a threat to the integrity of the regional landscape and its biodiversity which particularly depends on extensive grassland management.

Designation

Designated in 1991, but this pre-Seville reserve had from the beginning a compliant landscape designation of core, buffer and transition zone which provides for fulfilment all three functions of a BR.

Participation

Strong stakeholder engagement supported formulation of good participatory governance in Rhon. Although every state has its own administrative agency, a legal binding requirement for cross-border responsibility and cooperation beyond administrative boundary was formulated in 2002 and this facilitated setting up a Regional Working Group (ARGE Rhon) to coordinate biosphere activities with support from an Advisory Board which consists of 12 representatives of district administrators, local stakeholders, NGOs, and scientists.

Delivery

The management framework for Rhon was developed with strong local and regional integration based on the combination of top-down and bottom-up participation and consultation process. This framework integrated different interests of conservation, agriculture, forestry, economy, research and environmental education. Especially, strong government and stakeholders' commitment ensures the long-term finances and resources for BR implementation.

Conservation and sustainable development activities are undertaken based on the principle 'Conservation by utilisation' and this encourages preserving and using indigenous domestic livestock (lamb, beef, and brown trout) and plants (apple) under strong partnership between local producers and enterprises. Rhon is also a successful example of value adding for local products and services through marketing using the biosphere brand at the regional level. Research and monitoring is regularly conducted in the reserve. Half of the German studies on BRs are carried out in Rhon and these support for preparing BR periodical reports that serve for adaptive learning and enhancing nature conservation and sustainable development. The environmental education and campaigns are conducted regularly with diverse activities, events and exhibitions and these promote biosphere brand and create a regional identity for the reserve (Pokorny, 2006; Kasperczyk et al., 2009).

Six commonly nominated less successful BRs were spread across five countries (Australia, Chile, Kenya, the US and Thailand). Except for Mount Kenya National Park, all other reserves in the less successful category had conducted and provided the periodic reviews to UNESCO MAB but there was no follow up action relating to zonation requirement to meet the Seville criteria. Ranong, a post-Seville site, was nominated as unsuccessful due to lack of a clear zoning scheme and weak implementation as a result of top down management approach:

> "*The designation [of the Ranong] appeared to be driven by a desire for international status, rather than to further the BR concept*" (R17).

With three nominations, Wilson's Promontory was the most nominated less successful site:

Wilson's Promontory -a biosphere reserve identified as less successful in implementing the biosphere reserve model

Wilson's Promontory BR is situated along the coast of the Bass Strait at the southern most point in southeast mainland Australia. Covering 49,000 ha of terrestrial and marine area, the reserve consists of eleven main habitats and provides living place for 296 animal species and over 740 native vascular plant species. Wilson's Promontory National Park is a well-known location valued for its biodiversity, wilderness and as a prime tourism destination (Parks Victoria, 2006).

Designation

Wilson's Promontory was recognised as a BR in 1982. However, lack of rigorous application of the BR concept in the early stage, resulted in this pre-Seville site only covering the National Park with its high conservation and research value (Brunckhost, 1997; Matysek et al., 2006).

Participation

Lack of landscape zonation meant the reserve only undertook conservation, just one of three biosphere functions. The reserve only has a core zone of land owned by Government and managed by its conservation agency. This leads to a negative perception by local communities about the ownership and caring responsibility for the reserve (Brunckhost, 1997). There is no organisational structure for the reserve operation linked to its status as a BR.

Delivery

The National Park Management Plan (Parks Victoria, 2006) while mentioning that it is a Biosphere Reserve, gives no indication how it might function as a Biosphere Reserve. Lack of engagement by government and stakeholders has led to limited funding and resources for biosphere operation (Matysek et al., 2006). While there was Seville Strategy compliance Periodical Review in 2002, there was no follow-up action to add buffer and transition zones. There have been no further ten-year periodical reviews.

3.1.2. Promoting and hindering factors to biosphere reserve success or failure

The Delphi panellist responses were reviewed grouped into eleven common factors (Table 2). The relative importance of these factors was then calculated and ranked from the highest (1) to the lowest (11).

Of the 170 general statements on key features of the WNBR, 96 detailed aspects supporting the concept and 84 detailed impeding aspects. All these statements were grouped into 11 main factors (Table 2).

Based on the ratings of the promoting and hindering factors, three main functional groups were identified: (a) BR designation, (b) participation and (c) delivery (Fig. 1). Biosphere designation includes factors relating to landscape zonation, monitoring and evaluation, regional integration, learning orientation and system thinking, and research linkage. Participation includes governance, stakeholder participation and collaboration, and awareness and communication. Biosphere delivery relates to management and implementation, finance and resources and economic development.

3.1.2.1. Participation. Participation was regarded as the most important function influencing the success or failure of the WNBR. In this functional group, good governance, strong stakeholder participation and collaboration, and good awareness and communication were the most significant attributes and their lack hindered BR success. Biosphere governance was the most important aspect followed by stakeholder participation and collaboration, and good understanding of the BR concept:

> *"While the BRs that are struggling would argue that they are lacking in funds, I would suggest that they are lacking in vision and good governance. With the vision and structure in place, then there are ways of leveraging to enhance resource allocation* (R1).

The role of stakeholder participation in biosphere planning and delivery was mentioned as:

> *" The BR model requires designation across a human landscape, requires a landscape scale approach to conservation, rather than*

Table 1
Successful and unsuccessful biosphere reserves with multiple nominations.

No	Name of BR	MAB Region	Seville Generation	No of nominations	Periodic review	Zoning action in response to ICC-MAB review[b]
Successful Biosphere Reserves						
1	Rhon	Euro	Pre	8	2004; 2014	No recommendation
2	North Devon	Euro	Pre	4	1999; 2009[a]	Zone extension in 2002
3	Camargue region	Euro	Pre	2	2000; 2006	Zone extension in 2006
4	Spreewald	Euro	Pre	2	2003; 2013	No recommendation
5	Dana	Arab	Pre	2	2014	No recommendation
6	Noosa	Asia	Post	3		
7	Jeju	Asia	Post	3	2013	No recommendation
8	Sierra Gorda	Ibero	Post	3	2013	No recommendation
9	Schaalsee	Euro	Post	2	2012	No recommendation
10	Aya	Asia	Post	2		
11	K2C	Afri	Post	2	2013	No recommendation
12	Entlebuch	Euro	Post	2	2012	No recommendation
Less Successful Biosphere Reserves						
1	Wilson's Promontory	Asia	Pre	3	2003	Recommended but no zoning action
2	Kosciuszko	Asia	Pre	2	2003	Recommended but no zoning action
3	Torres del Paine NP	Ibero	Pre	2	1999	Recommended but no zoning action
4	Mount Kenya NP	Afica	Pre	2	No periodic review	
5	Golden Gate	Euro	Pre	2	2014	Recommended but no zone action
6	Ranong	Asia	Post	2	2011; 2014	Recommended but no action to clearly designate zones

[a] North Devon did not have separate MAB periodic review report as it was reviewed under the UK Reserve System.
[b] All Successful Biosphere Reserves now have Seville Strategy compliant zonation, and Less Successful BRs do not have.

Table 2
Major factors influencing biosphere reserve management.

	Factors	Description
1	Participation and collaboration	Participation, engagement, collaboration of local community, public, private stakeholders, NGOs
2	Governance	Leadership, coordinating agency, building partnerships, government and stakeholder commitment, support and on-going support.
3	Awareness and communication	Understanding BR concept and MAB program, liaison, communication program, stakeholders have a sense of BR ownership.
4	Landscape and zonation	Application of landscape and zonation to fulfil all 3 desired functions across different land uses.
5	Regional integration	Link to regional development, socio-economic program and other management systems in the region.
6	Learning orientation and system thinking	Use of BR as living laboratory, experiment application, adaptive management, learning by doing
7	Finance and resources	State funding availability, support projects and human resources (number, quality, education, professional experienced staff)
8	Economic development	Economic development, livelihood and production, tourism development, branding and marketing activities
9	Management and implementation	Management plans and vision, ground activity implementation, law enforcement
10	Monitoring and evaluation	M and E frequency, measurement of tangible indicators
11	Research linkage	Partnership with research institutes, universities in research

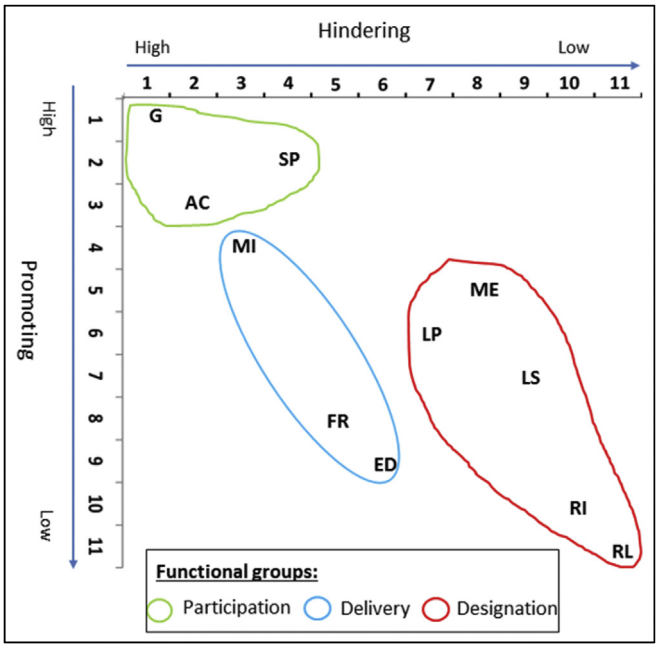

Fig. 1. Factors influencing overall management of the World Network of Biosphere Reserves grouped into 3 functional groups based on ranking of their importance for promoting or hindering the success of biosphere reserve management. (G: Governance; SP: Participation and collaboration; AC: Awareness and communication; MI: Management and implementation; FR: Finance and resources; ED: Economic development; ME: Monitoring and evaluation; LP: Landscape and zonation; LS: Learning orientation and system thinking; RI: Regional integration; RL: Research linkage).

focus only on conservation 'islands', and thus requires commitment and participation from different sectors of the community" (R3).

Respondents highlighted that good awareness and communication about the biosphere approach leads to willingness to support the biosphere program and to implementation of designation compliant activity. In practice, however, misunderstanding of the BR concept has not only resulted in establishment of non-compliant pre-Seville sites but also misuse of the buffer zone and associated transition zone:

"*In many cases, the BR title was added on top of a protected area title with little understanding of the difference*" (R19).

"A lot of misinformation and misuse of the purposes of the buffer and transition zones by different types of NGOs. Extreme conservation of NGOs have used these outside zones to restrict natural resource use" (R5).

3.1.2.2. Delivery. Biosphere concept delivery was the second important group of factors with management and implementation regarded as the most important contributing factors within this group. For successful delivery of the BR concept and objectives, a strategic plan developed with stakeholder participation and consultation process is needed:

"*Engaging different sectors in a process of strategic planning to achieve consensus on goals of BR is critical. The resultant plan that everybody can retain some ownership of could include detailed objectives for conservation (species, actions, funding etc.), boundaries, zones, responsibilities, timeframes, as well as communication procedures and contacts, and possibly some kind of conflict resolution process*" (R3).

3.1.2.3. Designation. Biosphere designation was the least important functional group. Monitoring and evaluation was an important factor in promoting success, but was not considered a significant contributing factor to BR failure.

" *Lack of monitoring means that managers and other stakeholders are not very well aware of whether or not the BR is achieving its aims*" (R13).

In discussing specific sites nominated by respondents as illustrating relative success or failure, 268 statements characterised successful BRs and 141 statements related to failure were grouped into the 11 key factors. Stakeholder participation and collaboration, governance and management remained the most important roles for BR failure and success in general (Fig. 2). Awareness and communication was necessary but not sufficient to achieve success.

Landscape zonation was not the most important factor contributing to success but lack of zonation was considered as a major contributor to failure, especially in developed countries (e.g., the US and Australia) where the most pre-Seville sites are entirely national parks or protected areas (Fig. 2a). In developing countries, economic development became an important factor contributing to biosphere success or failure (Fig. 2b). Lack of finance and human resource was considered the important contributor to biosphere failure in both developed and developing countries.

Similarly, the grouping process also was applied to the commonly nominated sites (12 successful and 6 unsuccessful BRs) from 108 promoting statements and 53 hindering statements given

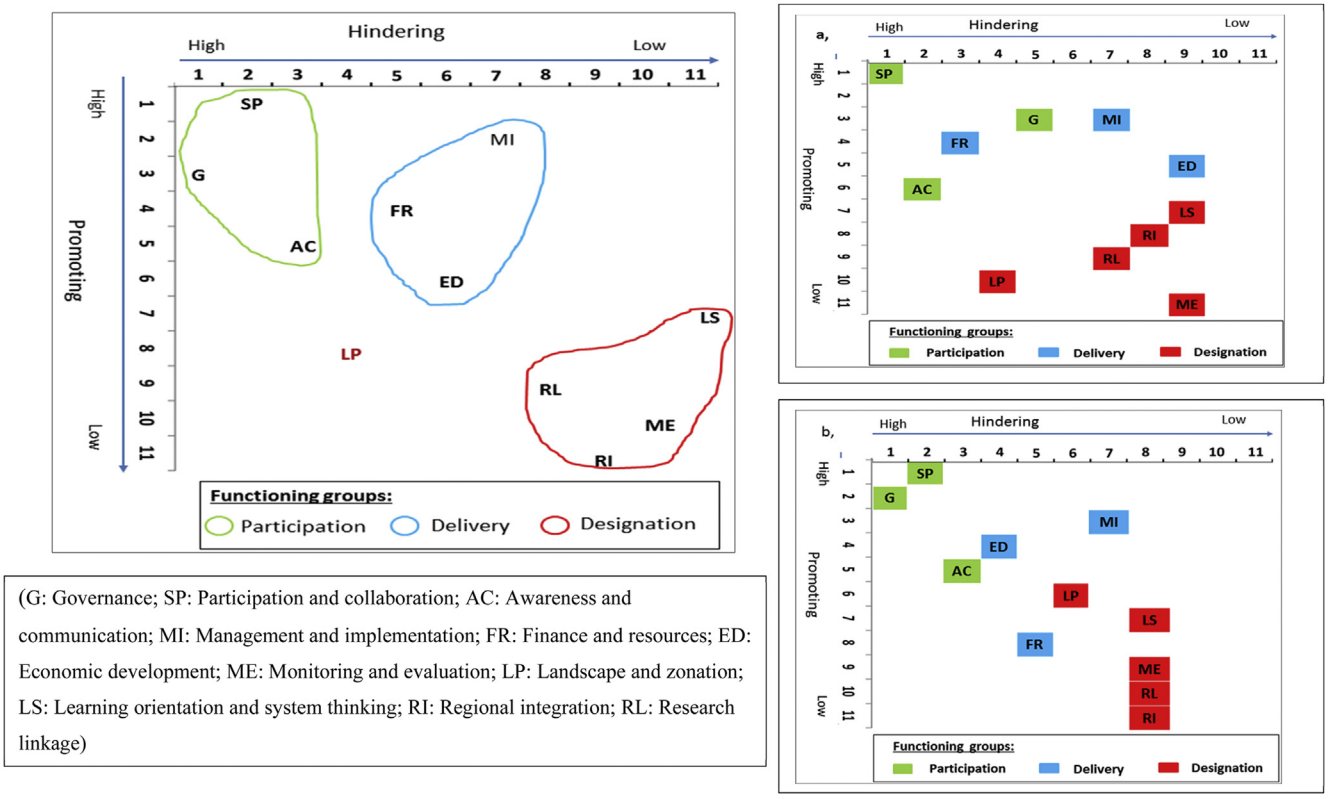

Fig. 2. Factors promoting or hindering successful management of all the biosphere reserves nominated in the Delphi process grouped into 3 functional groups based on ranking of their importance for promoting or hindering the success of biosphere reserve management. Landscape and zonation is an outlier. In Fig. 2a & b these factors are disaggregated into developed countries (a) and developing countries (b).

by the panellists. Fig. 3 shows that most factors remained in their three functional groups as identified across the whole WNBR, except for landscape and zonation which was an outlier, separate from all other groups.

While landscape zonation became the major hindrance in the commonly less successful reserves, it was considered the least important factor in the successful sites. This is because all successful sites have established 3 clear zones as required to meet the Seville criteria. In contrast, less successful BRs are pre-Seville sites which are managed as national parks with its associated protected area approach.

> "*Because they are not managed as BRs at all but instead as traditional nature reserves, with all the management effort aimed at the core zone and the buffer zone never developed as a context. Many of the older BRs fall into this group*" (R13).

Having secure finance, and sufficient, qualified staff with appropriate educational background is considered important for BR success. Hence, BR financial sustainability from state funding and projects is important:

> "*Community members are often encouraged to see strong government commitment (funds, projects, etc.) but seeing projects and funding from other sources can be just as important*" (R3).

Respondents highlighted the economic development needs, particularly in developing countries. Ecotourism, green energy, branding and product certification and alternative income activities are expected to be included in BR management, but this appears a significant limitation in practice:

> "*There are few attempts to develop activities related to biosphere – such as ecotourism or the labelling and selling of products from the reserve, so that residents or local people experience increased restrictions and costs without seeing any benefits*" (R13).

3.2. Rating the importance of the promoting or hindering factors to biosphere reserve management

In addition to the importance ratings for the 11 factors in the Delphi round 2, panellists also provided 64 additional comments (41 promoting attributes and 23 hindrances) which they considered important but were missing from the key attribute lists. All these attributes were placed within the existing list of factors for inclusion in the analysis.

Table 3 shows that there was a fairly even balance between the factors being rated as promoting and hindering. Stakeholder participation and collaboration, governance, finance and resources, and management were critical for BR management. Landscape and zonation, awareness and communication, economic development, regional integration, monitoring and evaluation, and system thinking were scored as very important for the success or led to failure of the BRs.

Spearman Correlation shows a significant relationship between finance and resources and governance, economic development, and implementation. Awareness and communication had a strong correlation with learning orientation and system thinking, and regional integration. Significantly, research linkage scored as the least important among 11 factors but it had a strong correlation with other factors such as landscape and zonation, regional integration, economic development, and learning orientation and system thinking (Supplementary Online Material, Table 3). There are

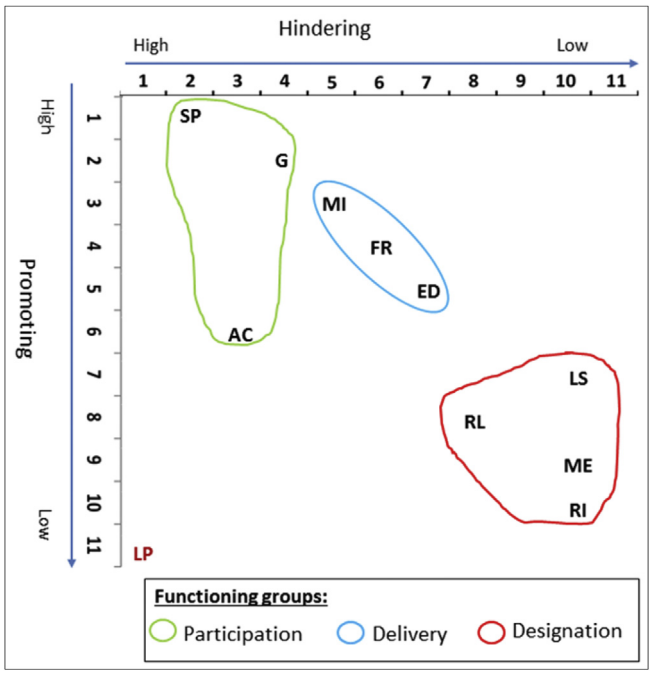

Fig. 3. Factors promoting or hindering successful management of the most commonly nominated (>2 nominations) biosphere reserves in the Delphi process grouped into 3 functional groups based on ranking of their importance for promoting or hindering the success of biosphere reserve management. Landscape zonation is again an outlier, its lack very important (rank 1) for hindering BR management but of least importance in promoting successful BR management. (G: Governance; SP: Participation and collaboration; AC: Awareness and communication; MI: Management and implementation; FR: Finance and resources; ED: Economic development; ME: Monitoring and evaluation; LP: Landscape and zonation; LS: Learning orientation and system thinking; RI: Regional integration; RL: Research linkage).

Table 3
Mean score and rankings of the factors influencing biosphere reserve success and failure.

Factors	Mean score and ranking	
	Promoting	Hindering
Participation and collaboration	4.53 (1)	−4.21 (1)
Governance	4.37 (2)	−4.21 (1)
Finance and resources	4.27 (3)	−4.18 (3)
Management and implementation	4.26 (4)	−4.12 (4)
Landscape and zonation	3.74 (5)	−3.62 (6)
Awareness and communication	3.66 (6)	−3.60 (7)
Economic development	3.46 (7)	−3.73 (5)
Regional integration	3.42 (8)	−3.46 (8)
Monitoring and evaluation	3.30 (9)	−3.18 (9)
Learning orientation and system thinking	3.03 (10)	−3.14 (10)
Research linkage	2.89 (11)	−2.85 (11)

(Critical: 5/-5; very important: 4/-4; important: 3/-3; somewhat important: 2/-2; not important: 1/-1). Ranking order in the bracket.

large benefits from having partnerships with research institutes and universities because:

> *"Having partnerships with research institutions can bring other kinds of connections and support including broader training opportunities for young people, more fruitful exchanges in curriculum, volunteer activities by students, financial support, etc."* (R1).

4. Discussion

Most of the successful BRs were established post-Seville while the pre-Seville sites were more commonly identified as less successful. We identified eleven key factors and assigned them into 3 main functional groups of biosphere designation, participation and delivery. Among these factors, awareness and communication, and landscape planning are preconditions but beyond that stakeholder participation and collaboration, governance, finance and resources, management including sustainable development are sufficient conditions for BR success. Monitoring and evaluation appears to be a less important factor influencing the BR success but it is an important component for adaptive learning and management within the WNBR.

4.1. Biosphere designation

Implementing a landscape zonation approach distinguishes the BR model from other protected area approaches. A true BR is only recognised when it has a strictly protected area for conservation while also acknowledging the need to support sustainable development in the neighbouring zones and providing for the basic needs of local communities through a strong connection with the buffer zone and transition zone (Batisse, 1990). Rhon and North Devon illustrate how old, pre-Seville reserves can be made compliant with zonation requirements. Pre-Seville sites that just cover a core zone can be made to conform to Seville criteria by adding additional zones through boundary expansion. The zonal approach can promote stakeholder participation and collaboration through a common vision harmonising conservation, sustainable development (through product branding, marketing, regional linking), adaptive learning, education and research, across the landscape. We also found that establishment of a management system for participation (stakeholder participation, governance structure) and delivery (e.g., finance, human resources, and management strategy plan) is more important to success than stakeholder understanding of the BR concept.

4.2. Participation

Participation increases social acceptance and support that results in improved BR management (Stoll-Kleemann and Welp, 2008; Stoll-Kleemann et al., 2010; Albert et al., 2012). The landscape approach to zone designation is inclusive, fulfilling all three biosphere functions (conservation, development and logistic support), but needs participation and cooperation from public, private stakeholders and communities. When BR management is based on land management (UNESCO, 1996), it pays particular attention to the transition zone where it includes different land users and jurisdictions. In practice the landscape approach only achieves the designed outcomes as the result of participation and negotiation between stakeholders and institutions (Bouamrane, 2007). Participation from scientists through research partnership also contributes to BR success because they provide new information and evidence for planning, decision-making and policy development (Sabatier and Jenkins-Smith, 1993).

Stakeholder participation and collaboration is critical for good governance either in formal or informal structures. This ensures provision of a central coordinating service which facilitates dialogue, participation and cooperation in BR planning and management. However, setting up informal governance by local communities or non-government organisations could be weakened in their operation because they lack authority (Brunckhost, 2001). Thus, government commitment, involvement and understanding of the role of local participation is crucial for biosphere success.

Our study reveals that good awareness and communication is necessary for biosphere success because it makes the BR concept a reality to the community and enables implementation. The failure

of a great number pre-Seville sites resulted because the BR nomination was only an exercise in rebranding existing national parks (Brunckhost, 1997; Ishwaran, 2012). Additionally, low public attention and support due to this limited communication has resulted in the MAB program being less popular than other programs such as National Park and World Heritage (UNESCO, 2010). In Australia, BRs were even perceived as a funding competitor to other government funded conservation programs resulting in less successful implementation of the Australian biosphere program (Matysek et al., 2006). Use of social media (Facebook, Twitter, LinkedIn, YouTube) supports the disseminating and marketing of the biosphere brand (Coetzer et al., 2013). The recent BR Smart Initiative (biospheresmart.org) provides a platform for networking and information sharing across the WNBR.

4.3. Delivery

Rapid expansion of the global network shows a theoretical potential of the model for conservation and sustainable development internationally (Ishwaran et al., 2008). However, network expansion does not necessarily mean improved management effectiveness. Schliep and Stoll-Kleemann (2010) found that some countries did not actively contribute to BR management but only use the biosphere badge for fundraising based on existing protected areas.

Sustainable development that provides economic benefit to the local people is the best way to gain their acceptance and participation in BR management (Stoll-Kleemann, 2005; Schultz et al., 2011). Unlike the conventional conservation practices that focus mainly on conservation (Brandon and Well, 1992; Brown, 2002), the BR model encourages use of the BR brand for sustainable economic development while taking into account the needs for environmental protection. Promotion of certified clean agriculture products (e.g., milk) and regional market linkage in the Rhon BR (Knickel, 2001), or alternative incomes from farming activity in dry land of Dana BR (Adeel and Safiel, 2008) are successful examples of integrated conservation and sustainable development at the regional level.

Our results show that sustainable finance and resources is a major factor leading to successful implementation and their lack leads to BR failure. Price (1996) and Coetzer et al. (2013) found that resource limitations are significant hindrances for implementing innovative, collaborative studies and knowledge transfer in developing countries. In developed countries like Australia funding shortage was also the major hindrance to biosphere awareness and implementation (Matysek et al., 2006). As well, lack of finance was a significant hurdle inhibiting completion of periodic reviews which in turn discouraged non-compliant designated sites from making changes to conform to the BR concept (Price et al., 2010).

5. Conclusions

The BR within the UNESCO Man and the Biosphere program provides an enabling mechanism to reconcile biodiversity conservation and development, which cannot be effectively solved under the conventional protected area schemes. The Seville Strategy in 1995 has made a significant impact on the way BRs are designed and managed and there are many efforts to bring the concept into practice, but the management effectiveness of the WNBR is still under evolution. BRs are considered to be a novel approach to conservation and sustainable development that human-beings are attempting to achieve (Batisse, 1997; Ishwaran et al., 2008; Ishwaran, 2012).

The aim of this paper was to identify successful and unsuccessful BRs and factors involved through capturing Delphi expert opinions. BR management is influenced by factors relating to designation, participation and delivery. First, BRs need to have proper zonal designations that allow for landscape planning, and regional integration. Then, the designated sites must obtain strong stakeholder participation and an inclusive governance structure for planning and management. Finally, biosphere finance and resource allocation are critical for implementing successful conservation and sustainable development. Last but not least, monitoring and evaluation is necessary for the key processes of adaptive learning and management improvement. However, fully implementing the periodic review recommendations, which may include an “Exit Strategy” for closure of non-performing BRs over time, may be a useful solution for improving overall effectiveness of the evaluation process and quality of the WNBR (ICCMAB, 2014).

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Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.jenvman.2016.11.069.

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