Concept and practice: the case of UNESCO biosphere reserves

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Abstract: Sustainable development is a globally endorsed principle whose practice is multidimensional and complex. The biosphere reserve as a concept and a tool of UNESCO has an origin in the protected areas domain but has now evolved into an international designation that allows context-specific conservation and development relationships to be developed in land and seascapes where more than 80% of the designated area lies outside of legally protected core zones. As such, each biosphere reserve could be a context-specific experiment in sustainable development at varying scales. The origin and evolution of the concept and practice of biosphere reserves have lessons to offer for future efforts to track changes in the principle and practices of sustainable development. The emphasis, over the next 5–10 years on biosphere reserves as learning laboratories for sustainable development provides interesting opportunities to track such changes in site-specific application of the principle and practices of sustainable development.

Keywords: sustainable development; biosphere reserves; UNESCO MAB; learning; science and policy relations.

Reference to this paper should be made as follows: Ishwaran, N., Persic, A. and Tri, N.H. (XXXX) 'Concept and practice: the case of UNESCO biosphere reserves', *Int. J. Environment and Sustainable Development*, Vol. X, No. Y, pp.XXX–XXX.

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1 Introduction

About 20 years after making its mark as the concept that significantly raised global awareness of inter-generational equity and responsibility (WCED, 1987), sustainable development has become a near-universal anchor for all international dialogue and discussion on environment and development issues. The notion of sustainable development had been used before Gro Harlem Brundtland raised it as the rallying call for international cooperation in 1987. In 1984 the Action Plan for Biosphere Reserves observed that:

> "Biosphere reserves, by definition and intent have economic and social benefits for local people, but also have value in demonstrating sustainable development tied to conservation in the wider biogeographical region" (UNESCO, 1984).

UNESCO's Man and the Biosphere (MAB) Programme was launched in 1971 and it was from this framework that the biosphere reserve concept originated. In this paper we trace the evolution of the concept and its practice over a period of almost 35 years – from its formulation by an international expert panel (UNESCO, 1973) to the present day – when an agenda for the next 5–10 years is being elaborated for discussion and adoption at the Third International Congress on Biosphere Reserves to be held in February 2008 in Madrid, Spain. One important stream of thought that has emerged in the last three years and which is expected to mature by the conclusion of the Madrid Congress is the notion that biosphere reserves serve as international learning laboratories for sustainable development. The elegance of the biosphere reserve concept lies in its simplicity; yet the practice of converting the concept's implications into reality at international, national and local scales raises a number of challenges. A similar relationship exists between the simplicity of the principle of sustainable development and the multidimensional complexity of its practice. This paper's attempt to analyse the links between the concept and practice of the biosphere reserve could perhaps provide insights into ways and means of studying the relationships between the principles and practices of sustainable development during the UN Decade (2005–2014) of Education for Sustainable Development (UNESCO, 2005).

2 Biosphere reserve: the origin and the evolution of the concept

The biosphere reserve concept originated as a tool for international cooperation, addressing issues and problems at the interface between nature conservation, interdisciplinary research and monitoring and educational prerogatives in the ecological and environmental sciences. The concept's expansion into the development dimension

became a noticeable trend in the 1980s, a trend that was noted at the First International Congress on Biosphere Reserves in Minsk, Belarus in 1983, and which matured at the Second International Congress on Biosphere Reserves in Seville, Spain in 1995. Post-Seville practices in the implementation of the concept reveal a number of notable divergences compared to the period prior to 1995.

Presently, a biosphere reserve is an international designation granted by UNESCO's MAB Programme. Hence, inevitably the origin and the evolution of the concept has enjoyed an interactive relationship between MAB's interdisciplinary research, training and educational agenda and the nature conservation and related socio-economic development interests of the global environmental and conservation communities.

In 1971, the former Director General of UNESCO, Mr. Rene Maheu, informed the First International Coordinating Council (ICC) of the MAB Programme that the General Conference, that is, the governing body of UNESCO, had conferred to MAB the following focus:

> "…on the general study of the structure and functioning of the biosphere and its ecological regions, on the systematic observation of the changes brought about by man in the biosphere and its resources, on the study of the overall effects of these changes upon the human species itself and on the education and information to be provided on these subjects" (UNESCO, 1971).

The human impacts on a range of ecosystems and the ecological perspectives of a number of major development schemes constituted the mix of the fourteen MAB projects launched in the early 1970s (Table 1).

Table 1 Projects adopted by the ICC of the MAB Programme in 1971

1. Ecological effects of increasing human activities on tropical and subtropical forest ecosystems.
2. Ecological effects of different land uses and management practices on temperate and Mediterranean forest landscapes.
3. Impact of human activities and land use practices on grazing lands, savannah and grassland (from temperate to arid areas).
4. Impact of human activities on the dynamics of arid and semi-arid ecosystems, with particular attention to the effects of irrigation.
5. Ecological effects of human activities on the value and resources of lakes, marshes, rivers, deltas, estuaries and coastal zones.
6. Impact of human activities on mountain and tundra ecosystems.
7. Ecology and rational use of island ecosystems.
8. Conservation of natural areas and of the genetic materials they contain.
9. Ecological assessment of pest management and fertiliser use on terrestrial and aquatic ecosystems.
10. Effects on man and his environment of major engineering works.
11. Ecological aspects of urban systems with particular emphasis on energy utilisation.
12. Interactions between environmental transformations and the adaptive, demographic and generic structure of human populations.
13. Perception of environmental quality.

In 1974, ICC added a 14th Project on environmental pollution and its effects on biosphere.

The biosphere reserve concept originated as the principal tool for implementing project number: 8, namely the *conservation of natural areas and the genetic materials they contain*. The expert panel that met to discuss the scope and content of activities for MAB project number 8 suggested that the project "provide the focus for action on conservation problems within the MAB Programme". The panel wished for the conservation of examples of all the world's biomes to be provided for through the creation and promotion of a 'worldwide network of representative significant ecosystems, or biosphere reserves'. The panel's report made many other suggestions and observations in line with the conservation thrust which the expert panel wished to place on the biosphere reserve project. Conservation measures for wild species were to be based on survey, inventory and management; the research and education function received clear emphasis and there was a call to increase public awareness and support for conservation activities (UNESCO, 1973).

At the first meeting of the ICC, delegates identified Parts A and B of Project No. 8. Part A was concerned with the establishment of a coordinated network of protected areas and Part B addressed the problem of animal, plant and microorganism conservation (UNESCO, 1971). However, the expert panel recommended a limitation of the possible range of activities of Part B in the further development of Project 8:

> "For the conservation of genetic diversity, two categories of organisms (…) are excluded from consideration: domesticated plants and animals, (…) and micro-organisms of direct application to science, technology, agriculture or medicine, since they are contained in many general or specialized culture collections which are expertly maintained, generally accessible, and catalogued on a world-wide scale" (UNESCO, 1973).

In 1974, a task force on the criteria and guidelines for the choice and establishment of biosphere reserves (UNESCO, 1974) reiterated the wish of the expert panel (UNESCO, 1973) and the ICC (UNESCO, 1971) to view the principle objectives of biosphere reserves as: conservation, ecological and environmental sciences research and education and training. However, the task force discussions reflected a continued ambivalence towards human-impacted areas, somewhat comparable to the expert panel's decision to exclude the genetics of domestic plants, animals and microorganisms from the considerations of Project 8. The task force called for the establishment of several categories of biosphere reserves – natural areas which could be 'representative' or 'unique' and human-impacted areas. It noted that within 'reserved' areas different levels of human modification may exist.

> "The concept of a protected core and a peripheral buffer zone or zones, available for a variety of purposes, will be fundamental to most biosphere reserves" (UNESCO, 1974).

The Action Plan for Biosphere Reserves (UNESCO, 1984), the primary outcome of the First International Biosphere Reserve Congress, underlined the vision of biosphere reserves as "protected areas of representative terrestrial and coastal environments which have been internationally recognized for their value in conservation and in providing the scientific knowledge, skill and human values to support sustainable development". The Plan also acknowledged that the buffer zone of a biosphere reserve may include a larger undelineated area where cooperative efforts to ensure that its uses are managed in a manner that is compatible with the conservation and research functions of the biosphere reserve are emphasised. During the elaboration of the draft plan, the cooperation function of biosphere reserves attracted considerable attention:

> "Through these co-operative efforts, an area around the biosphere reserve can eventually be developed which represents a zone of influence in which co-operative activities and harmonious land uses can be implemented. The spatial dimensions of this area expand as more participants co-operate in building the biosphere reserve. Developing the network of co-operation for carrying out the mission of biosphere reserve is an open-ended process" (UNESCO, 1984).

Interpreting the Action Plan for the benefit of UNESCO Member States and other stakeholders directly concerned with matching local and national realities to the global conceptual imagination led to the generation of many valuable insights during the 1980s. Batisse (1986) claimed that biosphere reserves served three roles: a conservation role; a logistic role that encompassed the international network for research and monitoring, which had been a salient feature of biosphere reserves from the earliest days and a development role, which was an attempt to associate environment with development. In fact the larger undelineated area of the buffer zone or the zone of influence of the Action Plan was referred to as a 'transition' area by Batisse (1986) – it covered such functions of biosphere reserves as experimental research, traditional use and rehabilitation.

By the end of the Second International Biosphere Reserve Congress in 1995, some of these emerging trends, with regard to the framework of the concept, had become better defined. The Seville Strategy (UNESCO, 1995) defined biosphere reserves as "areas of terrestrial and coastal/marine ecosystems or a combination thereof, which are internationally recognized within the framework of UNESCO's Programme on Man and the Biosphere". The explicit definition of biosphere reserves as protected areas found in the Action Plan (UNESCO, 1984) had given way to a vision that is closer to the earlier expert panel view (UNESCO, 1973) that biosphere reserves constitute a 'world-wide network of representative significant ecosystems'.

The Seville Strategy saw each biosphere reserve serve three complementary functions:

> "a conservation function, to preserve genetic resources, species, ecosystem and landscapes; a development function, to foster sustainable economic and human development, and a logistic support function, to support demonstration projects, environmental education and training and research and monitoring related to local, national and global issues of conservation and sustainable development" (UNESCO, 1995).

With regard to zoning, each biosphere reserve was expected to contain one or more core areas, a clearly identified buffer zone and an adaptable transition area. The Statutory Framework of the World Network of Biosphere Reserves that accompanied the Seville Strategy (UNESCO, 1995) encouraged the creation of regional and thematic networks and established procedures for a periodic review of each biosphere reserve to be submitted every ten years. Referring to the periodic review, Article 9 of the Statutory Framework in paragraph 6 set outs conditions whereby a biosphere reserve may cease to belong to the World Network while paragraph 8 outlines the procedure that a state opting to remove a biosphere reserve under its jurisdiction from the network could follow.

3 Biosphere reserve: practice and *in situ* realities

Practice refers to the entire range of actions and activities that facilitate the expression and implementation of the biosphere reserve concept at international, national and local

levels. The functions and organisational affiliations of the authors of this paper allow them to comment more on the effectiveness of practice at the international and national level than at the local level. It is the authors' expectation that the next 5–10 years of experimentation with biosphere reserves as learning laboratories for sustainable development will generate a significant pool of data, information and knowledge about local level practices that give context-specific expression to the global concept of the biosphere reserve.

Three generations of biosphere reserves can be recognised from the 507 biosphere reserves situated in 102 countries that currently make up the World Network (see www.unesco.org/mab/ for the full list of biosphere reserves). For the purposes of this article the first generation of sites are those from 1976, the year of the first designations to the publication of the Action Plan in 1984. The second generation marks those designations from 1985 to the adoption of the Seville Strategy and the Statutory Framework for the World Network in 1995. The third generation includes those sites recognised since 1996 to the present day.

The data in Table 2 can be interpreted in a variety of ways. However, the post-Seville period (third generation) marks the first time that the total number of biosphere reserves in Africa, Arab States, Latin America and the Caribbean and Asia and the Pacific together exceeded the number in Europe and North America; during the first and second generation, Europe and North America, that is, Western, Eastern and Central Europe, USA and Canada, comprised more than 50% of the total number of sites in the World Network.

It is possible that the 1970s vision of biosphere reserves as sites for conservation and interdisciplinary research appealed more to the industrialised world than the developing economies of those times.

For example, 26 of the 47 biosphere reserves in USA were registered in the World Network in 1976. Those 26 sites included many research areas such as the H.J. Andrews (Oregon) and Hubbard Brooks (New Hampshire) Experimental Forests and the Beaver Creek (Arizona) experimental watershed. Many others, for example, Big Bend, Glacier, Rocky Mountains and Yellowstone, also part of the 26 US biosphere reserves included in the World Network in 1976, were national parks or similar protected areas. However, interestingly USA is one of the few countries that have yet to propose a biosphere reserve in accordance with the Seville Strategy and the Statutory Framework in the post-1995 period.

Table 2 Number of three generations of UNESCO biosphere reserves by the five principal UNESCO regions

Region	*1st generation*		*2nd generation*		*3rd generation*	
	N° sites	*%*	*N° sites*	*%*	*N° sites*	*%*
Africa	27	11.44	3	3.57	17	9.09
Arab region	20	8.47	3	3.57	10	5.35
Asia and Pacific	33	13.98	10	11.90	40	21.39
Europe and North America	128	54.24	46	54.76	75	40.11
Latin America and the Caribbean	28	11.86	22	26.19	44	23.53
Total	236	47%	84	17%	187	36%

The post-Seville period marked the time when biosphere reserves were not considered merely as protected areas and additional zones, but seen as ecosystems and landscapes where sustainable development, characterised by a context-specific relationship between biodiversity conservation and socio-economic growth, came to be viewed as the essence of the governance and management of the designated area. The realisation of this vision, particularly at the local level, continues to be challenged by complexities in zonation and land tenure, inadequate science, research, education and monitoring and inappropriate governance and coordination mechanisms for moderating stakeholder interests throughout the biosphere reserve. Yet an essential link between conservation and development promoted by the post-Seville vision as the hallmark of the biosphere reserve appeals to many policy and decision-makers. This vision seems to have also been more attractive to countries in many parts of the developing world, particularly since 1992, as the ecosystem approach to management of biodiversity and biological resources received endorsement from the Conference of Parties of the Convention on Biological Diversity.

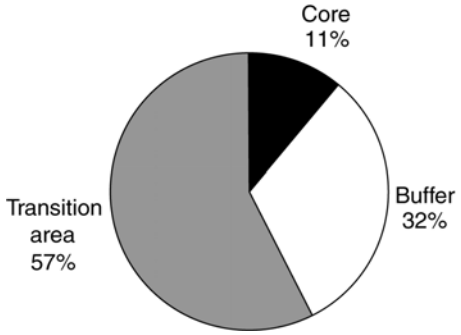
Early signs of the post-Seville vision were visible in the Action Plan of 1984. Nevertheless the second generation was a period of transition in biosphere reserve designations and the fact that the number of designated biosphere reserves in the World Network during the second generation was much lower than the first and third generations (84 compared to 236 for the first generation and 187 for the third generation), respectively, supports the view of the period between 1984 and 1995 being one of considerable reflection and refinement of the concept and its practice.

Similar trends in practice that parallel the evolution of the concept described above could also be detected in the zonation of the biosphere reserves (Table 3). More than 40% of first generation of sites did not describe the zonation of the nominated area. However, by the third generation of post-Seville sites, 98% of the designated sites had described all three zones in the nominations submitted by the states and included in the World Network. Among the third generation post-Seville sites, about 11% of the total area constitutes the legally protected core zone; 32% of the total area comprises the buffer zone and 57% make up the transition zone (Figure 1). In most countries, with the exception of some such as Mexico in the Latin America and the Caribbean region, buffer zones are not legal but notional; all transition zones demarcated in biosphere reserves are notional and have, by design, fuzzy boundaries in conformity with the open-ended nature of the process of stakeholder cooperation deemed to be an essential feature of biosphere reserves (UNESCO, 1984).

Table 3 The different zones of biosphere reserves nominated by UNESCO member States and included in the World Network for first, second and third generation of sites

	1st generation	*2nd generation*	*3rd generation*
No zonation	106 sites 44.92%	13 sites 15.48%	2 sites 1.07%
Core only	32 sites 13.56%	1 site 1.19%	1 sites 0.53%
2 zones	42 sites 17.80%	15 sites 17.86%	0
3 zones	56 sites 23.73%	55 sites 65.48%	184 sites 98.40%

Figure 1 Percentage of areas in core, buffer and transition zones among the 187 third generation (post-Seville) biosphere reserves



Today post-Seville biosphere reserves are the only international designations covering all major ecosystem types, including urban ecosystems, where more than 80% of the total area designated lies outside of legally protected cores. There is perhaps no better set of internationally networked areas where conservation and sustainable use of biodiversity and its relationships to broader regional sustainable development perspectives could be studied and tested and the gained experience and knowledge shared amongst all nations of the world.

Improvements in the descriptions of the core, buffer and transition zones during post-Seville times were significantly facilitated by an International Advisory Committee on Biosphere Reserves established in 1992 by the Director General of UNESCO, Mr. Frederico Mayor. A Scientific Advisory Panel for Biosphere Reserves had been set up as early as 1985 soon after the publication of the Action Plan (UNESCO, 1984). As noted by Batisse (1986) the establishment of such an Advisory committee should perhaps have been done earlier. Nevertheless, its establishment, particularly noted during post-Seville nominations to the World Network, brought greater conformity between the conceptual vision and the national submissions on biosphere reserves.

Yet another feature of the post-Seville period is the introduction of the periodic review of biosphere reserves every ten years. At the time of writing, nearly 50–60% of the first and second generation sites have been reviewed at least once and review of some post-Seville sites have begun. An exemplary outcome of the periodic review process was seen in the UK. As noted at the 17th session of the MAB ICC in March 2002:

> "The observer for the United Kingdom informed the Council that, after a study covering all the biosphere reserves in her country, the decision had been taken to withdraw from the Network the following four biosphere reserves: St. Kilda, Claish Moss, Isle of Rhum and Caerlavaerock. That decision had been conveyed to the Secretariat. She added that the other biosphere reserves would be completely reorganized to meet the criteria. The Council took note of the decision and congratulated the United Kingdom on the positive results of its periodic review" (UNESCO, 2002).

For example, the UK Government followed up on its commitment to modify the boundaries of the Braunton Burrows Biosphere Reserve, which is now considered, both within and outside the UK, as a good working model of a biosphere reserve.

Despite these successes in the UK and elsewhere, a large number of sites from the first and second generation are not fully compatible with the Seville vision. Even in those sites where the periodic review had identified steps to lessen the disparities, the

implementation of those steps has not always been possible due to a range of constraints. It is at this level of matching scientific and technical analysis of the periodic review and implementing the recommendations of the review for the whole biosphere reserve that practice lags significantly behind thinking and conceptualisation. An example illustrating the constraints and opportunities inherent in the follow up of the recommendations of the periodic review process can be seen in the case of the Amboseli Biosphere Reserve in Kenya.

The current Amboseli National Park, a 390 km^2 area is all that remains of a 27,000 km^2 Southern Game Reserve of Kenya established as early as in 1906. The biosphere reserve designation in 1991 was based on a proposal that covered nearly 5500 km^2 including the buffer and transition zones with 390 km^2 of national park as its core. The periodic review process led to wise recommendations for the management of the overall biosphere reserve, for example, the review recognised that the future of the wetlands within the core, that is the national park, and the tourism industry which depends on it, is strongly influenced by hydro-ecological linkages between the Amboseli and the Mt. Kilimanjaro National Park of Tanzania located across the international boundary that separates the two countries. The glaciers on the summit of Mt. Kilimanjaro, which due to global warming are melting, are likely to impact on the hydrology and ecosystem characteristics of the entire Amboseli-Kilimanjaro complex in unforeseen ways (Croze et al., 2006). Understanding those impacts and forming the cooperation needed among the various stakeholders in this semi-arid region so that ecosystem services, wildlife and the livelihoods of communities can all benefit at the same time is the governance challenge for the management authorities of the Amboseli Biosphere Reserve. It is unlikely that this challenge can be met by the park management alone. Discussion amongst the stakeholders who have an interest in the Amboseli Biosphere Reserve should be coordinated and must be the responsibility of one or more of the authorities with the necessary mandate to convene all stakeholders, including those from Tanzania, and who share concerns for the future of the Biosphere Reserve. The governance and management challenge of Amboseli as with many other biosphere reserves demands a combination of political, scientific and administrative skills that are difficult to obtain. Constraints are encountered that actually prevent the much-desired cooperation among stakeholders in the buffer and transition zones from taking place even in biosphere reserves where elaborately documented plans and strategies for doing so are within easy reach of planners and policy-makers. The challenge of the biosphere reserve is to identify the appropriate authorities that can influence governance and management regimes not only in the legally protected core but in the entire core, buffer and transition zones that define the biosphere reserve.

This is a particularly critical challenge in post-Seville sites where more than 80% of the designated area is not under any protected areas legislation. The protected area manager has no jurisdiction beyond the core, in buffer and transition zones. The identification of an authority or authorities with the mandate and resources to coordinate stakeholder interests throughout the entire biosphere reserve will be the key to innovation and success in the next phase of the interlinked evolution of the concept and its practice.

4 Biosphere reserves: learning laboratories for sustainable development

Four years after the publication of *Our Common Future* in 1987 (WCED, 1987), Redclift (1991) observed that:

> "sustainable development is usually discussed without reference to epistemological issues (i.e. those concerned with ways of acquiring knowledge and their integration into conceptual systems)."

Although discussions on epistemology could lead us into an intellectual territory which is clearly beyond the scope of this paper, it is perhaps reasonable to assume that ways of 'acquiring knowledge and their integration into conceptual systems' that Redclift refers to, constitute an essential part of the learning process.

Learning requires that statements we derive from principles and concepts are regularly tested against real-life situations, which such statements claim to describe. Furthermore, universally applicable principles such as sustainable development and concepts like biosphere reserves engage us to derive specific and limited claims that can be tested in given political, cultural, ecological and socio-economic contexts. Adaptive management based on the environment-development or conservation-development relationship assumes an inherent learning process that, at any particular moment, enables decision making to be based on the best combinations of data, information, experience, knowledge and judgement.

The notion of learning laboratories for sustainable development emphasises the importance for the geographical, administrative and legal space designated as a biosphere reserve to be considered as a context-specific locality for testing the match between policy prescriptions and practices that drive biodiversity trends and socio-economic change. The mismatch between policy and practice may be attributable to information, data or knowledge gaps. But more often, it is due to the absence or lack of human or institutional resources that is a precondition for optimising the use of available knowledge to influence policy and politics so as to generate simultaneous benefits for people, biodiversity, ecology and economies of biosphere land- and seascapes.

The Vietnam National Committee of the MAB Programme has developed a vision to articulate and convey the meaning of the notion of biosphere reserves as learning laboratories for sustainable development around a few essential features that anchor the idea:

1 The space under consideration must encompass the whole biosphere reserve, that is, the core, buffer and transition areas.

2 Conservation and development must be seen as interdependent and applicable to the functioning of all three zones; it is not desirable to think of conservation, even with regard to the biodiversity in the core zone, as being free of any relationship to social and economic development in the broader biosphere landscape; similarly development in buffer and transition zone must clearly be related to environmental improvements, including sustainable use and conservation of biodiversity.

3 Clean energy and zero-emission of greenhouse gases that are becoming part of the ecological economics of a warming world introduce new dimensions into sustainable development practices. As one of the fastest growing economies in Asia, Vietnam intends to target buffer and transition areas of biosphere reserves

as priority locations for experimenting with such new development pathways. Recently, one of Vietnam's environmentally-friendly projects that uses bio-degradable rubbish and manures to produce biogas has received the 2006 Global Energy Award in Brussels, Belgium. This award is considered one of the most prestigious environmental honours in the world. Vietnam MAB National Committee wishes to use such experiences in gradually rendering buffer and transition zones of biosphere reserves as places for demonstrating clean development pathways.

4 Education, research and long-term monitoring continue to occupy the important role they have always enjoyed throughout the origin and evolution of the concept and practice of biosphere reserves; together they constitute the link that promotes an iterative and learning interaction between policy and practice. In the case of Cat Ba Archipelago Biosphere Reserve, Hai Phong City, Vietnam, the local Government/People Committee is the coordinator with the authority to approve, defer or reject sustainable development projects and initiatives in and around the biosphere reserve and as foreseen under the Provincial Agenda 21 of Vietnam, which emphasises the need to mastering the balance between conservation and socio-economic development at the Provincial level. Hence the Cat Ba biosphere reserve serves as laboratory to experiment with the conservation-development relationship that the authorities wish to apply throughout the Hai Phong Province. Cat Ba biosphere reserve is also a pilot whose experiences will be adapted for applying to other biosphere reserves in the country.

In order to effectively test the model of biosphere reserves as learning laboratories, the MAB National Committee of Vietnam is turning to the Chair and the Vice-Chair of the People's Committees of the Provinces where its biosphere reserves are located. The Vietnam MAB National Committee feels that effective coordination of all biosphere reserves functions in all three zones is only feasible through the active involvement of governance, management and administrative professionals in charge of the overall province where the biosphere reserve is located.

Throughout the world there are many biosphere reserves with an interesting mix of biodiversity conservation, socio-economic development and education, training, research and environmental monitoring activities. What is often difficult to come by are examples or cases where different stakeholders come together to combine their knowledge and experience to stabilise and/or improve an existing conservation-development relationship.

Each one of the biosphere reserves in the World Network must have many examples where the necessary relationship between conservation, socio-economic well-being and research and monitoring is clearly demonstrated. Searching, collecting, documenting and disseminating such case studies should be an important part of the work to be undertaken as part of the learning laboratories focus. Hypotheses about the integrated relationship between certain practices could be assumed but data to verify, refute or modify that relationship may or may not be available. In the Sinharaja Biosphere Reserve in Sri Lanka several welfare activities, for example, the creation of a mobile eye-clinic and the free distribution of glasses, were implemented as part of rural renewal projects in the buffer zone (Ishwaran, 1994). The humane nature of these welfare activities make them worthy of support irrespective of the place or time of their implementation. But their prioritisation in the buffer zone of a biosphere reserve was questioned by those evaluating the implementation of the management plan for the reserve because it lacked

any statements concerning expected outcomes and their impacts on conservation and the sustainable use of biodiversity. These welfare projects may have been designed and implemented as a step to build confidence between the rural population and biosphere reserve management and hence facilitate future design and implementation of integrated conservation and development projects that have a direct benefit for conservation and the sustainable use of biodiversity. If that is the case, then in the absence of an accompanying effort to gather relevant data that can test if the changes in the villagers' perception of the management are heading in the desired direction one can neither confirm nor refute the assumption on which rural renewal projects in the buffer zone were designed and implemented. It would also be difficult to use these activities as a justification for implementing future projects that integrate conservation and development more directly.

The ability of knowledge to serve as an improvement of conservation and development relationships is the fundamental rationale for the biosphere reserve. While examples from biosphere reserves must be searched, documented and shared those from places that may not enjoy biosphere reserve status nationally or internationally may also be worthy of incorporation into any library of the laboratory, particularly if the case study clearly illustrates issues and problems and their resolution through cooperation amongst stakeholders that is key to biosphere reserve governance and management. The case of Pitchavaram mangroves in the Tamil Nadu State of India (Selvam and Ravichandran, 1996), is a good case in point. Over a long period of time, government authorities held the view that tree felling and grazing carried out by local people was causing the degradation of the Pitchavaram Mangrove forest. The area of the forest shrank from 700 ha to 140 ha between 1897 and 1993. Research carried out by the M.S. Swaminathan Foundation located in Madras, India, discovered that local people knew that degradation was most severe in the core zone which was not accessible to cattle and suffered minimum human interference. More detailed studies revealed that mangrove degradation was attributable to stagnating tidal waters in certain areas due to topographic features of the forest-floor. This finding led to a better understanding of the causes of ecosystem degradation that had earlier fueled the mistrust between the local community and government officials and led to collaboration between the government, local people and the foundation in restoring degraded mangroves.

Reviewing historical perspectives on forest policy changes in Asia, Edmunds and Wollenberg (2001) stress that:

> "[T]he only reasonable approach to policy making has been and is increasingly to accept the uncertainty and complexity and put into place mechanisms for monitoring, analyzing and adapting policies in a timely and efficient manner."

Edmunds and Wollenberg categorise this as the 'learning approach'. It is our firm belief that the next phase of the evolution of the biosphere reserve concept and practice must emphasise such a learning approach. Due to the dynamic nature of this approach, knowledge generated from relevant scientific research and monitoring and on-ground experience has an important role to play in informing management actions and policy decisions in response to uncertainty and continuous change. It is necessary to caution against the belief that each biosphere reserve will illustrate one 'master' case study demonstrating clear integration amongst all its roles and functions. A prudent way forward would be to encourage use of research, data gathering and monitoring of change so that it becomes a routine practice for testing the validity of assumptions made with regard to the relationships between conservation and the sustainable use of biodiversity

as well as the socio-economic development of communities and people at the local, regional and national levels.

What is envisaged are biosphere laboratories full of on-going experimentation used by national authorities and international policy constituencies – such as the Convention on Biological Diversity, the United Nations Framework Convention on Climate Change, the UN Convention to Combat Desertification, the Commission on Sustainable Development and others – to generate insights and hopefully occasional successes for integrating specific conservation and development agendas. Demonstrating the role that learning and knowledge accumulation plays in integration could perhaps be the best contribution of MAB and its biosphere reserves to sustainable development practices over the next 5–10 years.

5 Conclusion

The constancy of the MAB identity and the biosphere reserve designation over the last three-to-four decades conceal the depth and range of changes that the concept and the practice of biosphere reserves have undergone. Recognition of such changes in the context of the current mood of reform within the UN in general, and UNESCO in particular, will help better appreciate the value of biosphere reserves in terms of international collaboration for sustainable development. The future of biosphere reserves has arrived at a point where combining knowledge generated from scientific research and practice-based learning from context-specific policy experiments in individual biosphere reserves may take precedence over further adjustments of the concept to develop new universal or 'one-size-fits-all' models of integrated conservation and development. Learning, together with accumulation and transfer of knowledge in a range of natural and social science disciplines to all relevant stakeholders, including managers, decision-makers and the local community, will be key to the future of biosphere reserves as learning laboratories for sustainable development. The fact that such learning will be based on experimentation in areas where 80% of the designated territory is outside legally protected zones makes the process even more challenging and interesting and such learning laboratories could be tools for preferred use by UN and other multi- or bi-lateral systems of international cooperation during the UN Decade of Education for Sustainable Development (2005–2014) and beyond.

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