THE IMPORTANCE OF SYSTEMS THINKING AND PRACTICE FOR CREATING BIOSPHERE RESERVES AS "LEARNING LABORATORIES FOR SUSTAINABLE DEVELOPMENT"

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ABSTRACT

UNESCO has recommended the launch of pilot projects to use biosphere reserves as learning laboratories or spaces to address the gap between biosphere reserve knowledge systems (scientific, experiential, and indigenous) and the imperative for wider sustainable development. In this regard, a pilot project in the Cat Ba Biosphere Reserve (CBBR) in northern Vietnam has been initiated. The project has three major aims that address:

- the needs of UNESCO/MAB and the Decade of Education for Sustainable Development (DESD) initiative by contributing to sustainable development knowledge and education globally;
- the environment (e.g. biodiversity), livelihood of people (e.g. poverty alleviation) and economic benefits (such as sharing in the revenue from a booming tourism industry); and
- the adoption of policies and processes by Government and management bodies to ensure that long term sustainable management will become institutionalised and ongoing.

This paper discusses the use of systems thinking concepts and tools in creating learning laboratories for sustainable development. The biosphere reserve and sustainable development literature as well as the learning laboratories for sustainable development concept will be briefly described. The importance of systems thinking methodology and applications to deal with ever-increasing complexities of sustainable development will be discussed. A Causal Loop Model of Cat Ba Biosphere Reserve integrating policy, social, environmental, and economic dimensions has been developed to identify key leverage points and where systemic interventions will be most effective (potential research projects). This model also serves as a platform for research collaboration through alliances and multi-disciplinary teams to address the various domains, leverage points, and interventions identified. The model and approach could serve as a pilot for other biosphere reserves in Vietnam and globally.

Keywords: systems thinking; causal loop modelling; leverage points; learning laboratories; sustainable development; Cat Ba Biosphere Reserve.

INTRODUCTION

Biosphere reserves (BRs) are sites recognised under UNESCO Man and Biosphere (MAB) program to demonstrate innovative state-of-the-art approaches to conservation and sustainable development. There are currently 531 biosphere reserves in 105 countries (UNESCO, 2008a). Through MAB and its BRs, UNESCO has advanced notions and concepts as early as the 1970s and 1980s that now find resonance with current thinking on integrated conservation and development models, conservation and sustainable use of biodiversity and the broader discussions and debates on sustainable development.

Sustainable development is now a globally endorsed principle whose nature and practice is multidimensional and complex; and each biosphere reserve could be a context-specific experiment in sustainable development at varying scales (Ishwaran et al., 2008). Biosphere reserves can be platforms for policies and practices that facilitate conservation and sustainable use of biodiversity, economic growth of local communities, and the emergence of knowledge-based management arrangements at local, provincial and national levels. In other words, biosphere reserves can serve as “learning laboratories for sustainable development”.

UNESCO has recommended the launch of pilot projects for biosphere reserves to address the gap between biosphere reserve knowledge systems and the imperative for wider sustainable development. In this regard, a pilot project in the Cat Ba Biosphere Reserve (CBBR) in northern Vietnam has been initiated. A description of the CBBR can be found in Brooks’ report (Brooks, 2006) and the background to the pilot project is described in a recent paper (Bosch, 2008). Cat Ba is currently experiencing strong growth in tourism (and revenue), while environmental degradation continues and high levels of poverty in several of the communes persist (Bosch et al., 2007a).

This paper describes the learning laboratories for sustainable development concept and demonstrates how this concept has been operationalised by using a systems thinking approach.

BIOSPHERE RESERVES AND SUSTAINABLE DEVELOPMENT

The Convention on Biological Diversity emphasises the conservation of biological diversity, the sustainable use of its components, and the equitable sharing of benefits (Bridgewater and Cresswell, 1996). Particularly since the Rio Earth Summit in 1992, there has been a great interest in approaches which marry conservation and sustainable development, and thus provide working models of how these aims can be mutually supported (IUCN, 1996).

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 (Ishwaran et al., 2008). Phillips (1996) states that there is a close complementarity between biosphere reserves and protected areas at both the policy and site levels. However, Bioret (2001, p.27) lists many distinguishing features between the two concepts. According to Bioret (2001), biosphere reserve management must take account of the multiple functions of conservation, sustainable development for local communities, and scientific research, education and training. It must also accommodate changes over time. As such, biosphere reserves tend to be more complex and dynamic than classic protected areas.

IUCN (1996) suggests that biosphere reserves, with their interrelated objectives of conservation, development and logistic support, offer a practical and creative approach to the imperative of linking conservation and sustainable development. In addition, the biosphere reserve calls for new forms of institutional co-operation and increased integration between levels of economic and political decision making (UNESCO, 2000). The concept builds on the idea that humans and nature are intrinsically linked and the only way to conserve and protect our remaining natural places is to work closely with the people living there.

There are examples where the establishment of a biosphere reserve has led to improving economic opportunities and providing concrete benefits for the local communities. This can be seen in the Tonle Sap Biosphere Reserve of Cambodia (Bonheur, 2001) and the Clayoquot Sound Biosphere Reserve in Canada (Birtch, 2001).

The biosphere reserve concept may provide opportunities to revive the local economy. Along with diversifying production, the image of the biosphere reserve offers possibilities for branding agricultural products. Furthermore, it offers opportunities for developing tourism as an alternative source of income (Birtch, 2001, West, 2001).

Stockholm University in Sweden is in the process of developing a major cooperative arrangement with UNESCO on ecosystem management for human wellbeing in dynamic landscapes, using biosphere reserves as pilot and demonstration sites for the next twelve years. Several countries, such as Mexico, Brazil, Australia, Germany, Italy and others are very actively working on these issues (UNESCO, 2008b).

THE LEARNING LABORATORIES FOR SUSTAINABLE DEVELOPMENT CONCEPT

The learning laboratory is defined as a process as well as a setting in which a group (i.e. a management team) can learn together. The purpose of the learning laboratory is to enable managers and other stakeholders to experiment and to anticipate the consequences of their actions, policies, and strategies (Maani and Cavana, 2007).

The biosphere reserve concept was originated almost four decades ago (UNESCO, 1971). However, only in the last three years has one important stream of thought emerged, that is the notion that biosphere reserves serve as international learning laboratories for sustainable development (Ishwaran et al., 2008).

In a recent paper, Ishwaran et al. (2008) argue that 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. They also believe that 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 (Ishwaran et al., 2008).

In a recent experiment[1], the participants found the learning laboratory an interesting and useful approach and tool for the promotion of conservation and sustainable use of biodiversity, ecology and socio-cultural development as well as for integration of scientific and other relevant knowledge for building context-specific conservation-development partnerships. Focusing on sustainable development learning at the land/seascape level also helps to resist the legacy that encourages viewing biosphere reserves as an international designation dedicated solely for the conservation of biodiversity (UNESCO, 2008b).

Given the complex, multi-dimensional and dynamic nature of biosphere reserves, we believe that a systems thinking approach is the most appropriate way to successfully operationalise the concept of using biosphere reserves as learning laboratories for sustainable development.

A SYSTEMS THINKING APPROACH

Systems thinking is a 'new way of thinking' to understand and manage the 'natural' and 'people' systems associated with complex problems in sustaining and enhancing the natural resources (Bosch et al., 2007a). Although the range of methods and methodologies are extensive, many of these new ways of thinking have emerged from or embrace the concepts inherent in systems thinking (Bosch et al., 2007b).

Maani and Cavana (2007) use the analogy of an iceberg to illustrate the four levels of thinking (Figure 1) as a framework for systemic interventions. While events represent only the tip of the iceberg yet most decisions and interventions take place at this level. This is because events are the most visible part of day to day reality which often require immediate attention and action. The next level of thinking is patterns where a larger set of events (or data points) are linked together to create a 'history'. The next level of thinking is systemic structures which reveal how such patterns relate to and affect one another. Thus, systemic structures unravel the intricate lace of relationships in complex systems. There is yet another, deeper level of thinking that hardly ever comes to the surface. This is the mental models of individuals and organisations that influence why things work the way they do. Mental models reflect the beliefs, values and assumptions that we

[1] Side-event on biosphere reserves as platforms for learning and innovation that was organized by UNESCO-MAB with the Vietnam MAB National Committee and the UNESCO National Commission of Vietnam during the 15th session of the Commission on Sustainable Development that took place in May 2007 in UN, New York.

personally hold, and they underlie our reasons for doing things the way we do (Maani and Cavana, 2007).

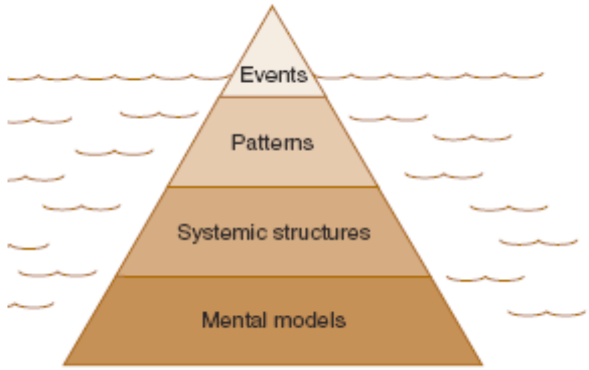

Figure 1: Four levels of thinking model

Source: Maani and Cavana (2007)

The tools of systems thinking focus on the four levels of thinking. They move the stakeholders and decision-makers from the event level to deeper levels of thinking and provide a systemic framework to deal with complex problems (Bosch et al., 2007a).

The application of systems thinking has grown extensively and encompassed work in many diverse fields such as health systems (Cavana et al., 1999), business (Sterman, 2000), ecological economic systems and policy (Rosser, 2001), commodity systems (Sawin et al., 2003), agricultural production systems (Wilson, 2004), natural resource management (Allison and Hobbs, 2006), environmental conflict management (Elias, 2008), education (Hung, 2008) and organisational learning and change management (Maani and Fan, 2008). Nevertheless, this is the first project using a systems thinking approach to apply in a biosphere reserve context. It would therefore have high potential to apply globally considering the comprehensive network of biosphere reserves. The following sections illustrate how systems thinking has been used in this research to address the learning laboratories for sustainable development in a biosphere reserve context.

Conceptual models of Cat Ba Biosphere Reserve

A two-day systems thinking workshop was conducted at the School of Natural and Rural Systems Management, The University of Queensland in March 2007[2]. The case of Cat Ba Biosphere Reserve (CBBR) in Vietnam was used as an example to demonstrate the application of systems thinking to multi-dimensional problems. A researcher[3] from the World Conservation Union (IUCN), who has had rich experience working in CBBR, was invited to serve as an informant providing context and issues related to CBBR. In

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[2] An introductory workshop for staff and post-grad students conducted by Professor Kambiz Maani

[3] Ashley Brooks whose PhD research evaluates the effectiveness of various NGO projects/programs in CBBR.

addition, some of the workshop participants (25 academic staff and postgraduate students) have also had prior experience in various projects in CBBR.

Figure 2 shows the initial causal loop diagram (CLD) (Maani and Cavana, 2007, p.18) which was developed at the workshop to describe the current situation in CBBR. A causal loop diagrams provide '… a framework for seeing interrelationships rather than things, for seeing patterns of change rather than static snapshots' (Senge, 1990, p.68).

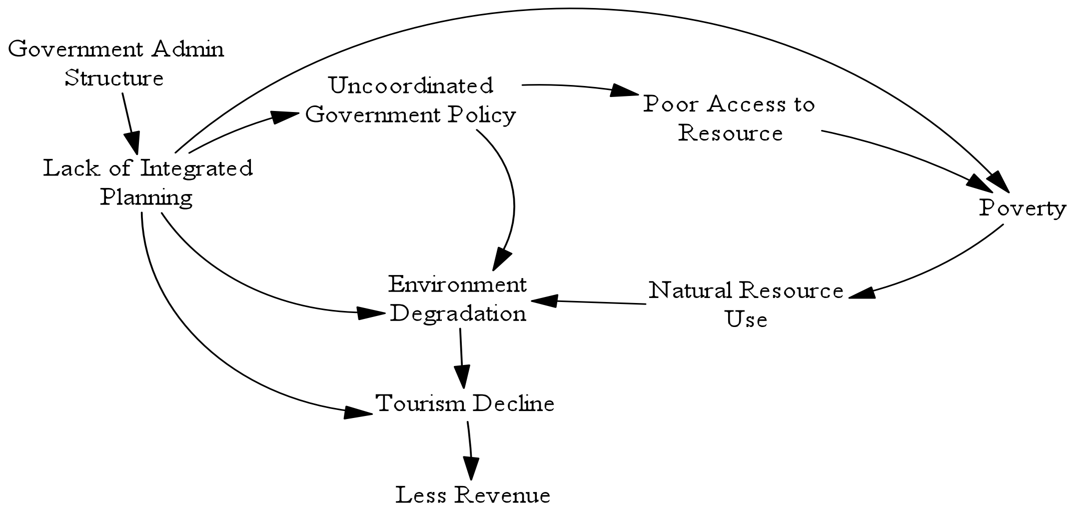

Figure 2: CLD for the Cat Ba Biosphere Reserve current situation

Source: Bosch, O., Maani, K. & Smith, C. (2007a)

The CLD in Figure 2 explains the sources of complexity that has given rise to Cat Ba's predicament. From the CLD it is apparent that the relationships between the key variables are far from simple or linear. An inspection of this CLD reveals that the current undesirable outcomes (poverty, environmental degradation and unsustainable tourism growth) can be traced back to the lack of integrated planning leading to fragmented government policies. An unintended consequence of this is that the international aid agencies operate in isolation, each trying to 'fix' a different problem separately (Bosch et al., 2007a).

Once a representative CLD is constructed, the appropriate intervention strategy can be devised to address the root causes and leverage points of complex problems. Leverage points are places within a complex systems where a small shift in one thing can produce big changes in everything (Meadows, 1999). In the case of Cat Ba, the leverage points lie in integrated planning and coordinated government policies. The effects of these strategies are shown in the following CLD (Figure 3). As can be seen, these strategies create two positive reinforcing 'loops' (shown by 'R'). These loops represent the reciprocal and beneficial effects of integrated planning and international co-operation (through aid agencies) and their chain effects on sustainability and livelihood of the communes (the link from tourism revenues to livelihood of the communes) (Bosch et al., 2007a).

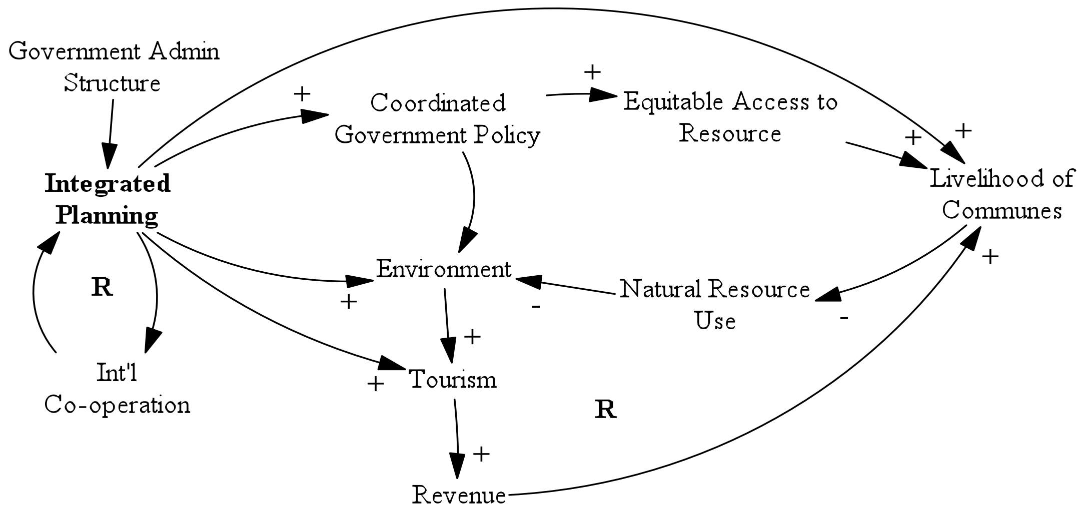

Figure 3: CLD for the sustainability model of Cat Ba Biosphere Reserve

Source: Bosch, O., Maani, K. & Smith, C. (2007a)

In summary, the causal diagramming process reveals the systemic structures underlying a complex system (i.e. the four levels thinking model described previously). It shows that the factors affecting a system are not isolated and independent but are dynamically linked and cause growth or decline in each other as well as in other key areas of the system. One of the strategic insights of the CLD process is that trying to improve the parts in isolation is counterproductive and can hurt the overall system and its performance (Bosch et al., 2007a).

The two CLD models shown above, however, have been developed primarily based on researchers' perspectives and understanding of the system in question. In order to validate the CLD models it is essential to involve relevant stakeholders in a confirmation process to help refine the model as well as to identify key leverage points and possible barriers to implementations. This process of 'group think' would also facilitate consensus building and alignment of thoughts and actions.

Adaptive management and learning laboratory workshop

Following the initial workshop, the Vietnam MAB National Committee and The University of Queensland conducted a joint workshop in Vietnam in October 2007[4] on adaptive management for using biosphere reserves as learning laboratories, using a systems thinking approach. Workshop participants (30 people) were from Vietnamese universities, the Vietnam Environment and Sustainable Development Institute (VESDI),

[4] Workshop facilitated by Professor Ockie Bosch

NGO staff working in Vietnam on development and conservation projects, and representatives from four biosphere reserves in Vietnam.

Workshop participants were introduced to the concept of adaptive management (a fairly new concept in Vietnam, especially for the representatives from biosphere reserves). In practice, the adaptive management approach has become a useful alternative to deal with complex systems and uncertainty. Adaptive management is often represented as a circle to emphasise the closing of the management cycle through evaluation and reassessment of the situation. This process is analogous to the PDCA (Plan-Do-Check-Act) cycle of continuous improvement in quality management. This process is an important transition from linear thinking in management and planning as the figure below explains (Bosch et al., 2003).

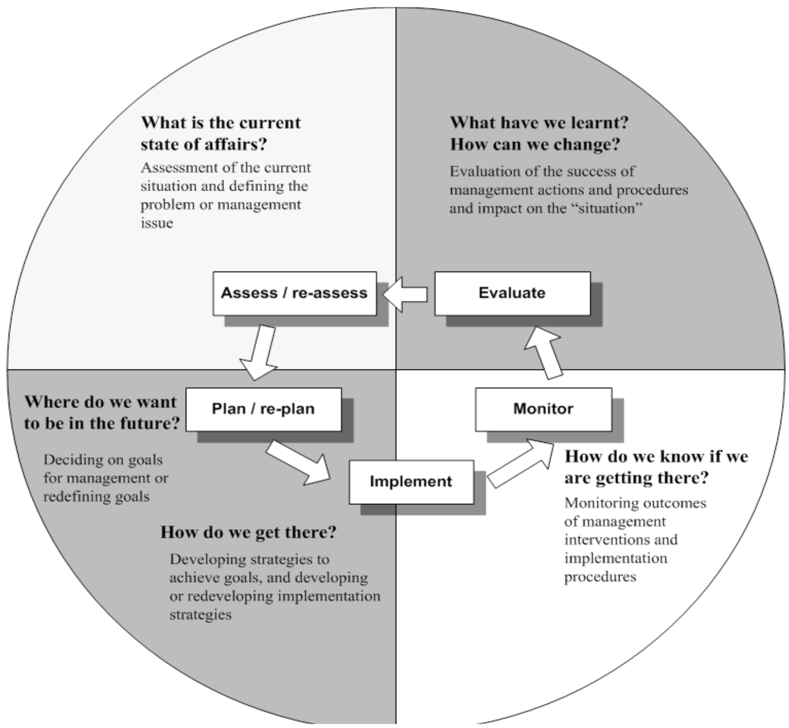

Figure 4: The main stages in an adaptive management framework

Source: Bosch et al. (2003)

Following this the learning laboratory concept was explained to the workshop participants. As defined previously, the learning laboratory is a process as well as a setting in which a group can learn together. It is an environment where policy makers, researchers and managers collaborate and learn together to understand and improve the problems of common interests (Maani and Cavana, 2007). The ultimate goal is to achieve sustainable outcomes (Figure 5).

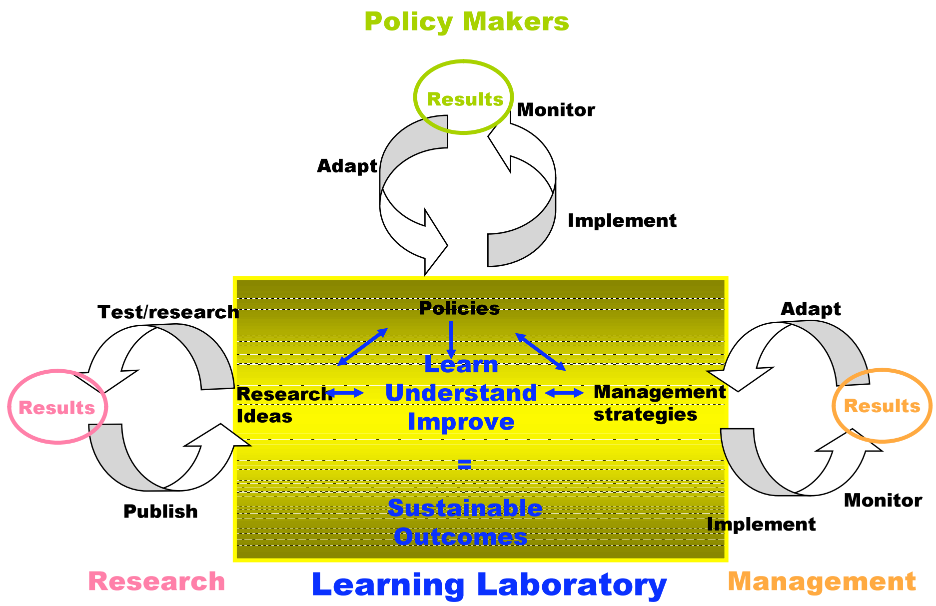

Figure 5: The formation of a learning laboratory

Source: (Bosch, 2007)

At the conclusion of the workshop, capacity building and institutional gap were identified by the participants (relevant stakeholders) as two key leverage points for the successful application of the learning laboratory for sustainable development in CBBR. Interestingly, this was in line with the findings of the first workshop where leverage points were identified by the researchers.

Based on the outcomes of these workshops, The University of Queensland applied for an Australian Leadership Award Fellowship (ALAF) grant for Vietnam. The 10 selected Fellows came from four levels of government (District, Provincial Departments, Provincial People's Committee, and National Government), representing relevant technical and administrative agencies of Cat Ba Biosphere Reserve. The ALAF program has been pivotal in bringing these agencies together in a single learning forum held in Queensland, Australia for two month, as well as a strong foundation for joint planning and policy development upon their return. The program has enhanced capacity amongst current and emerging leaders by developing skills and expertise in systems thinking and integrated planning and management of natural resources. A sequel paper will discuss interdisciplinary curriculum and lessons learnt from this program.

The systems model of Cat Ba Biosphere Reserve

In order to carry out a successful implementation of the learning laboratory for sustainable development it is essential to understand the dynamics of the CBBR system. Figure 6 shows these dynamics (the interrelationships and interconnectedness between the key components of a system) via a CLD and its sub-systems. This model has been informed by relevant literature and available documents as well as consulting with the ALAF Fellows during their visit in Queensland. Furthermore, the model (Figure 6) was refined and validated by relevant stakeholders in a series of workshops and in-depth interviews conducted in Cat Ba between December 2008 and January 2009.

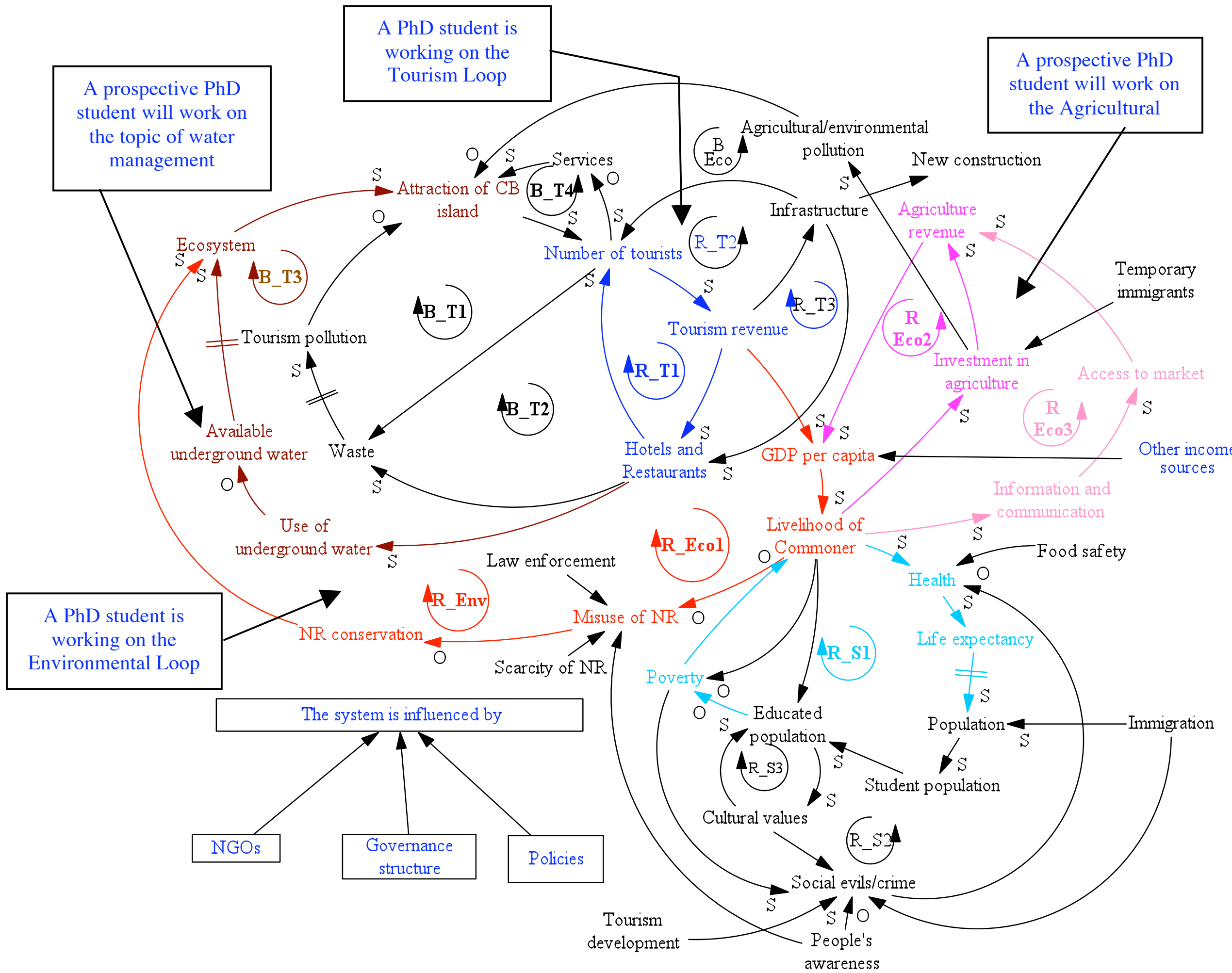

Figure 6: Current systems model of Cat Ba Biosphere Reserve

Causal loop diagram (CLD) modelling was used to develop the model where the model variables are causally linked. As shown, each pair of variables can move either in the same (s) or opposite (o) direction. If an increase (or decrease) in variable X at the tail of the arrow causes a corresponding increase (or decrease) in variable Y at the head of the arrow, then this is a change in the same direction (denoted by ‘s’ near the head of arrow). That is, the two variables move up and down together. On the other hand, if an increase (decrease) in one variable causes a decrease (increase) in the other variable, then this is a change in the opposite direction (denoted by ‘o’ on the head of the arrow). In other words, as one variable moves up, the other will move down and vice versa (Maani and Cavana, 2007).

The systems model of CBBR is analysed by identifying feedback loops formed in the model. Feedback loops can be reinforcing or balancing. The feedback loops identified in this model include ten reinforcing and five balancing ones. Reinforcing loops are positive feedback systems. They can represent growing or declining actions. Unlike reinforcing loops, balancing loops (negative feedback loops) seek stability or return to control (Maani and Cavana, 2007). The analysis of the feedback loops is discussed in the following paragraphs.

Tourism development loops (three reinforcing loops – R_T1, R_T2, and R_T3)
A possible starting point for the first loop in the system is the variable 'number of tourists'. The number of tourists to Cat Ba has increased significantly over the years. According to statistical figures from Cat Hai Tourism Information and Development Centre (Cat Ba island), there were over six hundred thousand overseas and domestic tourists came to visit Cat Ba in 2008; and the forecast number for 2015 will be one and a half million tourists.

When the number of tourists increases, the revenue from tourism will increase. An increase in tourism revenue will enable the tourism industry in Cat Ba to build more hotels and restaurants. More hotels provide more available accommodation options for tourists (especially in peak season), which will in turn increase the number of tourists to Cat Ba. Thus, 'Tourism development loop R_T1' is a reinforcing feedback loop. Similarly, the other two loops are also reinforcing loops representing growing actions (i.e. R_T2: 'number of tourists' – 'tourism revenue' – 'infrastructure' – 'number of tourists' and R_T3: 'number of tourists' – 'tourism revenue' – 'infrastructure' – 'hotels and restaurants' – 'number of tourists').

If these were the only loops operating in the system, it would achieve its objective. With the growing number of tourists more hotels and infrastructure need to be built to accommodate the increase. However, these are not the only loops operating in the system and it is essentially important to look at the other feedback loops to get a better understanding of the system.

Tourism development loops (four balancing loops – B_T1, B_T2, B_T3, and B_T4)
These balancing loops operating in the system explain some of the long-term effects of tourism development on the environment and on tourism development itself. When the number of tourists increases, there will be an increase in the amount of waste (e.g. litter and plastic bottles) discarded to the environment. An increase in the amount of waste, after several years (delay, denoted by □ in the model), will result in an increasing level of pollution. Pollution increases will reduce the attraction of Cat Ba island. This, consequently, will reduce the number of tourists to the Island. So the 'Tourism development loop B_T1' is a negative feedback (balancing) loop resulting in reduced number of tourists due to the increasing amount of waste and reducing attractiveness of Cat Ba.

The ‘Tourism development loop B_T2’ is quite similar to the previous loop (B_T1). An increase in the number of tourists will increase tourism revenue, which will in turn increase the number of hotels and restaurants in Cat Ba. This will result in an increasing amount of waste (currently in Cat Ba, most of the sewage from the island is flown directly into the sea without any treatment and solid waste is collected and either burnt or buried). When waste is higher, pollution increases, decreasing the attractiveness of Cat Ba island. This will eventually bring down the number of tourists to the Island.

The ‘Tourism development loop B_T3’ is another similar loop to the previous two (B_T1 and B_T2). Starting from an increase in the number of tourists to the increase in the number of hotels and restaurants in Cat Ba will speed up the use of underground water (Cat Ba currently relies entirely on underground water). This will reduce the availability of underground water, having negative effect on the Island’s ecosystem in the long-term. This will in turn reduce the attractiveness of Cat Ba and hence the decreasing number of tourists to the Island.

In addition, an increase in the number of tourists will reduce the quality of services in the tourism industry due to the limited carrying capacity. This will in turn reduce the attraction of the Island, turning the tourists away. ‘Tourism development loop B_T4’ is therefore another balancing loop.

The effect of these balancing loops is to reduce the attractiveness of Cat Ba due to an increase in the number of tourists to the Island. Thus, they all tend to reduce the number of tourists, thereby negating the effect of the previous reinforcing loops (R_T1, R_T2, and R_T3).

Environmental development loop (R_Env)

‘Livelihood of commoner’ (local people in Cat Ba island) is a possible starting variable for the analysis of this loop. Local people (especially those who are living inside and around Cat Ba National Park, the Core Zone of CBBR) are still very much dependent on the ‘misuse’ of natural resources (e.g., illegal hunting, burning forests to get natural honey, and chopping tree) as one main sources of their income. When the livelihood of local people increases (due to having income from other sources rather than from ‘misusing’ natural resources) they will possibly reduce their ‘misuse’ of natural resources. This will in turn reduce the number of deliberate fires (for natural honey collection) and the extent of deforestation, contributing to a better ecosystem and more attractiveness of Cat Ba. An increasing attractiveness of Cat Ba will result in more tourists coming to the Island, increasing tourism revenue. This will increase GDP per capita and the livelihood of local people on the Island.

The ‘Environmental development loop’ is thus a reinforcing loop. It shows the interrelationships between the livelihood of local people, the environment, and tourism development. It explains how an increase in one variable could lead to an increase (or decrease) in another variable and vice versa.

Economic development loops (three reinforcing loops – R_Eco1, R_Eco2, and R_Eco3)
These loops explain the interrelationships between key economic components (variables) of the system. The 'Economic development loop R_Eco1' is not new but a simplified version of the 'Environmental development loop'. It can be interpreted as an increase in tourism revenue (one main income source of local people) will increase GDP per capita, which in turn will increase the livelihood of local people. This will possibly reduce the 'misuse' of natural resources, increasing the attractiveness of Cat Ba and contributing to more tourism revenue. The 'R_Eco1' is a reinforcing loop and explains the growing effect of increasing tourism revenue.

Revenue from agriculture is another main source of income for local people in Cat Ba. When agriculture revenue increases, GDP per capita will increase, thereby increasing the livelihood of local people. An increase in income and livelihood will enable local people to invest more in agriculture, thus creating more revenue from agriculture. The 'Economic development loop R_Eco2' is again a reinforcing loop and it affects the system in a similar fashion to the 'R_Eco1' loop.

The 'Economic development loop R_Eco3' is similar to the 'Economic development loop R_Eco2'. The main difference is an emphasis on access to market, which is currently a big issue concerning local people (farmers) in Cat Ba. It is expected that an increase in income and livelihood of local people (as result from increasing agriculture revenue) will increase their information and communication capacities (i.e. enabling them to buy fixed phones, connect to the Internet, etc), contributing to better access to the market. This will increase agriculture revenue, forming another reinforcing loop (R_Eco3) in the system.

Economic development loop (balancing loop – B_Eco)
This loop describes the effect of agricultural development on tourism, and ultimately livelihood of commoner. The starting variable is 'investment in agriculture'. There has been an increase in investment in agriculture (with some bad practices for the environment, especially the operation of many floating farms around the Island which has caused a lot of pollution and environmental concerns). This will have a negative impact on the attraction of Cat Ba, reducing number of tourists and tourism revenue. Consequently, there will be lower GDP per capita which will reduce livelihood of commoner therefore decreasing investment in agriculture. Thus, 'B_Eco' is a balancing loop representing the counteracting effect of agricultural development on tourism and livelihood of people.

Social development loops (three reinforcing loops – R_S1, R_S2, and R_S3)
There are three main social development loops in the system, and they are all reinforcing loops showing the interrelationships between population, the educational system, the health system, and cultural values. 'Livelihood of commoner' is a possible starting variable of the 'Social development loop R_S1'. When livelihood of people increases, it will increase their health and life expectancy, contributing to an increase in the population in the long-term. This then will increase the number of student population. People with higher educational standards tend to have more chance finding good jobs and earning high income. This will therefore reduce poverty, and in turn increase livelihood of local people.

Similarly, 'health' is a good starting variable in the 'Social development loop R_S2'. Better health will have a chain effect as discussed in the previous paragraph leading to a reduction in poverty. This will reduce the incidence of social evils, contributing to better health. Likewise, 'educated population' and 'cultural values' interact with each other to create another reinforcing loop ('Social development loop R_S3) in the system.

Discussion

The systems model described above will be refined further with relevant stakeholders and will be validated by quantitative data. While no model represents a 'true' reflection of reality, a systems model can usefully describe important dynamics of complex system (Jørgensen and Bendoricchio, 2001). Nevertheless, the development of this current model, and subsequently an advanced systems model of CBBR, will serve several well-defined purposes.

There is an old Chinese saying that "a picture is worth a thousand words". The systems model represents a 'big picture' of CBBR system and will be a useful platform for learning, collaboration and decision making for relevant stakeholders including policy makers, managers, and local people. A key obstacle in the management of CBBR is that the decision makers lack a shared vision and hence lack of coordinated action. The CBBR Management Board has members from different technical departments each with different expertise but no decision-making right. Moreover, their suggestions to the decision makers are usually biased being favourable to their own departments. On the other hand, it is difficult for the decision makers to see the big picture. Therefore, it is essential to have an overall picture of the system to show the interconnectedness and roles of various departments and agencies.

The development of a systems model for CBBR will enable the identification of leverage points of the system which can be used for informing future research and international funding of projects and programs. Moreover, this research will draw lessons for sustainable development. The research has potential to create reinforcing cycles within the systems model that positively affect the identified leverage points. This could highlight where the priorities for local level planning (e.g. in agriculture, tourism, and conservation) should or should not be placed. The development of an advanced systems model of CBBR will also address the five-point agenda of the Action Plan for the World Network of Biosphere Reserves for the period 2008-2012 (UNESCO, 2008c).

Currently, there are two Vietnamese PhD students (studying at The University of Queensland) working on the tourism development and community-environmental development loops of the system. Two more Vietnamese PhD student are expected to join this team in late 2009 to commence their studies focusing on the agricultural development loop and water management issue of the CBBR system. These PhD studies will complement each other and contribute significantly to the comprehensiveness of the advanced systems model of CBBR.

Importantly, not only will this research have real applications to other biosphere reserves worldwide, it should contribute materially to poverty alleviation (Strategy for

Development and Poverty Alleviation, Vietnam 2003, and global priority) and environmental sustainability objectives (Millennium Development Goal 7).

CONCLUSION

This paper reports on an extensive multi-year research program at The University of Queensland. Using systems thinking and modelling as research paradigm and methodology will form the theoretical and practical foundation of the learning laboratory for sustainability. We agree with Ishwaran et al. (2008) that documenting and disseminating such case studies are an important part of the work to be undertaken as part of the learning laboratories focus.

In summary, a systems model has been developed to identify key dynamics and leverage points, potential research areas, and possible alliances as well as to create a collaborative platform for natural resource management and social, economic and environmental development in Cat Ba Biosphere Reserve. The systems model will be refined, validated and developed into an advanced systems model. The advanced model and systems thinking approach will be applied to other biosphere reserves in Vietnam and globally. A subsequent paper will detail the theory of the learning laboratory and will demonstrate its applications in practice.

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REFERENCES

Allison, H. E. & Hobbs, R. J. (2006). *Science and policy in natural resource management: Understanding system complexity*. Cambridge University Press, UK.

Bioret, F. (2001). Biosphere Reserve manager or coordinator? Conclusion from EuroMAB, *Parks*. 11 (1): 26-29.

Birtch, J. (2001). Clayoquot Sound, Canada - new economic opportunities for different social groups, *Parks*. 11 (1): 9.

Bonheur, N. (2001). Tonle Sap Biosphere Reserve, Cambodia: Management and zonation challenges, *Parks*. 11 (1): 3-8.

Bosch, O. (2007) Adaptive Management and Learning Laboratories (Presentation at the October 2007 workshop in Hanoi, Vietnam). The University of Queensland, Australia.

Bosch, O. (2008) Biosphere Reserves as Learning Laboratories for Sustainable Development with special reference to the involvement of The University of Queensland, Australia (unpublished paper). Brisbane, Australia.

Bosch, O., Maani, K. & Smith, C. (2007a). Systems thinking - Language of complexity for scientists and managers, *Improving the Triple Bottom Line Returns from Small-scale Forestry*, 18-21 June, 2007, Ormoc, the Philippines.

Bosch, O., Roos, H., Witt, B. & Smith, C. (2003). Guidelines for Adaptive Management - Outcomes of the OzAM 2003 Workshop, Brisbane, Australia.

Bosch, O. J. H., King, C. A., Herbohn, J. L., Russell, I. W. & Smith, C. S. (2007b). Getting the big picture in natural resource management - systems thinking as 'method' for scientists, policy makers and other stakeholders, *Systems Research and Behavioral Science*. 24 (2): 217-232.

Bridgewater, P. B. & Cresswell, I. D. (1996) The reality of the world network of biosphere reserves: Its relevance for the implementation of the conservation on biological diversity. IN IUCN (Ed.) *Biosphere reserves - myth or reality?: Proceedings of the Workshop on Biosphere Reserves World Conservation Congress*. Montreal, IUCN, Gland, Switzerland.

Brooks, A. (2006). Enhancing the effectiveness of projects on Cat Ba Island - an evaluation of ten years of international support, IUCN Vietnam Country Office, Hanoi, Vietnam.

Cavana, R. Y., Davies, P. K., Robson, R. M. & Wilson, K. J. (1999). Drivers of quality in health services: different worldviews of clinicians and policy managers revealed, *System Dynamics Review*. 15 (3): 331-340.

Elias, A. A. (2008). Towards a shared systems model of stakeholders in environmental conflict, *International Transactions in Operational Research*. 15 (2008): 239-253.

Hung, W. (2008). Enhancing systems-thinking skills with modelling, *British Journal of Educational Technology*. 39 (6): 1099-1120.

Ishwaran, N., Persic, A. & Tri, N. H. (2008). Concept and practice: the case of UNESCO biosphere reserves, *Int. J. Environment and Sustainable Development*. 7 (2): 118-131.

IUCN (1996). *Biosphere reserves - myth or reality?: Proceedings of the Workshop on Biosphere Reserves, World Conservation Congress, Montreal*. IUCN, Gland, Switzerland.

Jørgensen, S. E. & Bendoricchio, G. (2001). *Fundamentals of ecological modelling*. Elsevier, New York, USA.

Maani, K. E. & Cavana, R. Y. (2007). *Systems thinking, system dynamics: Managing change and complexity*. Prentice Hall, Auckland, NZ.

Maani, K. E. & Fan, A. (2008). Systems thinking and organisational learning - Resolving performance measure conflicts in a supply chain, *Proceedings of the International System Dynamic Society Conference*, Athens, Greek.

Meadows, D. (1999). *Leverage points: Place to intervene in a System*. The Sustainability Institute, Hartland, VT, USA.

Phillips, A. (1996) Biosphere Reserves and Protected Areas: What is the difference? IN IUCN (Ed.) *Biosphere reserves - myth or reality?: Proceedings of the Workshop on Biosphere Reserves World Conservation Congress*. Montreal, IUCN, Gland, Switzerland.

Rosser, J. B. (2001). Complex ecological-economic dynamics and environmental policy, *Ecological Economics*. 37 (April): 23-37.

Sawin, B., Hamilton, H. & Jones, A. (2003). *Commodity system challenges: Moving sustainability into the mainstream of natural resource economies*. Sustainability Institute, Hartland, USA.

Senge, P. M. (1990). *The fifth discipline: The art and practice of the learning organization*. Doubleday/Currency, New York, USA.

Sterman, J. D. (2000). *Business Dynamics: Systems Thinking and Modelling for a Complex World*. Irwin McGraw-Hill, Boston, USA.

UNESCO (1971). International co-ordinating council of the programme on Man and the Biosphere (MAB), First session, UNESCO-MAB report series No.1, Paris, France.

UNESCO (2000). *Solving the puzzle: The ecosystem approach and biosphere reserves.,* UNESCO, Paris.

UNESCO (2007). Meeting of the Bureau of the International Co-ordinating Council: Final report, UNESCO Headquarters, Paris.

UNESCO (2008a) Biosphere reserves: Reconciling the conservation of biodiversity with economic development. [Online access] 17th April: http://www.unesco.org/mab/BRs.shtml

UNESCO (2008b) How can biosphere reserves be used for learning, governance and adaptive management approaches for sustainable development of land/seascapes? *3rd World Congress of Biosphere Reserves*. 4-9 February 2008, Madrid, Spain.

UNESCO (2008c) Message by the Secretary of the MAB International Co-ordinating Council (ICC). *3rd World Congress of Biosphere Reserves*. 4-9 February 2008, Madrid, Spain.

West, G. (2001). Biosphere Reserves for developing quality economies: The Fitzgerald Biosphere Reserve, Australia, *Parks*. 11 (1): 10-15.

Wilson, J. (2004). *Changing agriculture: An introduction to Systems thinking*. Print on Demand Centre, University of Queensland Bookshop, QLD, Australia.