DEVELOPMENT OF COST-EFFECTIVE AND COMPARABLE MONITORING COMPONENTS FOR PROTECTED AREA MANAGEMENT IN VIETNAM AND GERMANY – A CASE STUDY OF BACH MA NATIONAL PARK

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ABSTRACT

Despite of a network of more than 100.000 protected areas worldwide and numerous international commitments on nature conservation, the exploitative use of natural resources seems to be inexorable. Apart from an adequate funding as well as highly motivated and well-qualified staff, continuous monitoring of ongoing developments is indispensable for an effective protected areas management.

The present study is an integrative and interdisciplinary approach to create simple and cost-effective monitoring components for a sustainable protected area management. Thereby, the Bach Ma National Park (Vietnam) and the biosphere reserve Mittelelbe (Germany) were used as unequal investigation area. The remote sensing methods and the GIS component, including various landscape metrics, provides a great potential for various useful facts and statistics, related to the extent of former land cover change. The subsequent social research component was used to identify the reasons behind these changes and prospective improvements for effective protected area management. The weaknesses of the used quantitative and qualitative measurements were mitigated through the use of the triangulation process.

The study illustrates clearly the urbanization process within the surrounding landscape of the Bach Ma National Park as well as the adopted laws and policies by the Vietnamese government. Nevertheless, for the last twenty years, it has been showed the promising achievements and merits of the protected areas management and their illimitable efforts. It demonstrates as well that a comprehensive range of simple and cost-effective methods are sufficient for an adaptive monitoring to fulfill various data gathering and reporting requirements.

1. INTRODUCTION

The designation of protected areas has been a major activity of nature conservation strategies since decades. Nowadays, much more than 100.000 protected areas are established. However, certain restrictions, lack of funding or the existence of paper parks contradicts promising signs. Besides a constantly funding and qualified staff, suitable management plans including various arrangements are necessary for an effective protected area management. The Vietnamese government itself has been ratified several international treaties during the last decades (e.g. RAMSAR Convention in 1988, CITES in 1994 and the Convention on Biological Diversity (CBD) in 1994) (Rambaldi *et al.* 2001). This is strongly correlated with governmental directives and programs like the "National Five Million Hectare Reforestation Program (decision 661) or the "Strategy for a Protected Area System in Vietnam to 2010" (Bremer 2008).

These past developments causes to an increasing monitoring demand for protected areas. The reporting requirements make a draft on a large fraction of existing workload, which cannot be used for other activities. Hence, it is supporting the demand for rapid and

cost-effective monitoring approaches. However, the applied methods should be as simple as possible. This facilitates the implementation of current existing monitoring efforts and decreases the demand for establishing necessary capacities (Danielsen *et al.* 2000). Accordingly, the Vietnamese government starts the first national wide monitoring surveys in the early 1980s. Especially the Forestry Inventory and Planning Institute (FIPI) take the lead, based on Vietnam's strong dependency on forest. But despite a new program in 2006 including a list of 18 indicators, main monitoring aspects are not continuously measured due to distributed responsibilities and required international comparisons of indicators are still not feasible.

Moreover, the demand for comprehensive monitoring schemes becomes indispensable by various pilot studies, which have to be supervised and evaluated. For instance, the benefits sharing decree by decision 126 which allows local people to access to the core areas of certain protected areas for collecting and harvesting non-timber forest products and to provide alternative livelihood options. Another example is the Payment for Forest Ecosystem Services (PFES) project by decision no. 99.

2. INVESTIGATION AREAS

The presented approach was tested in two investigation areas with unequal monitoring demands and landscape components. The first case study is the Bach Ma National Park (Vietnam), which was established as protected area in 1991 and features nowadays a size of approximately 37.500 ha. The National Park is dominated by mountainous natural forest, but illegal logging and hunting activities has been main threats since several decades. Thereby, the establishment of alternative livelihood options and sustainable forest management strategies has been main challenges for the past years.

The current biosphere reserve Mittelelbe (Germany) is the consequence of several spatial adjustments during the past years and covers currently an area of about 125,510 ha. Forests are an important feature in this area as well. However, the river Elbe and anthropogenic influences are the most important topics for the management board. For the applied monitoring approach these huge differences are one of the major intricacies.

3. METHODS

This study uses an interdisciplinary approach, combining various methods from different scientific disciplines. The triangulation concept contains a quantitative part, where descriptive and as much as possible automatic remote sensing and GIS analysis (incl. landscape metrics) approaches are combined. That includes not only the automation of different procedures, but also the site-unspecific adaption of the workflow.

The other part of the triangulation concept is built by a qualitative research element. Indeed, this part is inductive and individual. Hence, this method is strongly site-specific and numerous information have to be collected from different sources.

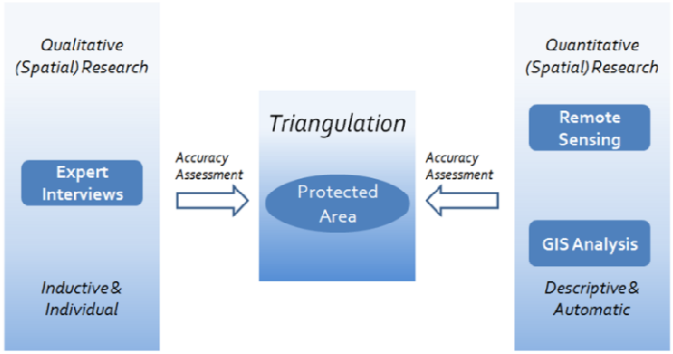

Figure 1. Triangulation concept.

Conceptually this part consists of several expert interviews with different stakeholders. Due to a strong bias to international experts and a large language barrier regarding to the local inhabitants, the methods were supplemented by a standardized questionnaire particularly created for the local residents in preselected communes.

The combination of both quantitative and qualitative measurements allows us to not only detect the extent and location of land cover changes during the past decades, but also to correlate these changes with the knowledge and experience of the involved stakeholders and accordingly with the reasons and policies behind the past and ongoing developments. As a result, management activities can be improved and decision-makers can be supported with invaluable information.

3.1. The remote sensing component

The first component consists of typical remote sensing applications and provides the database for subsequent GIS analyses. The analyses are based on Landsat TM / ETM^+ and RapidEye data, ranging from the year 1973 to the year 2010. At the beginning several pre-processing steps were performed. A master image was chosen, which exhibits a high radiometric quality and a central location within the time-series. For this master image, a dark object subtraction (DOS) was performed to remove atmospheric scattering and other sources of noise (Schroeder *et al.* 2006). Due to missing atmospheric data, a radiometric normalization technique was used for all other Landsat images. The applied multivariate alteration detection (MAD) was developed by Nielsen *et al.* (1998) and can be used for numerous other applications (e.g. mosaicking, land cover classifications) due to its reliable and robust results (Canty *et al.* 2004). Several cloudy areas were superseded by data of other images, where care has been taken to utilize images from the same phenology phase. The classification process was a progressive unsupervised ISODATA classification, where different hierarchical levels could be achieved. The first iteration processes produced eight different land cover classes, whereas the second iteration process produced fourteen different classes. The accuracy assessment is still pending, but an overall accuracy of about 80% was estimated. Particular small areas like wetlands or the mixture between urban and barren areas reduced the accuracy to some extent.

Table 1. Accomplished interviews.

Institution	Position
Environmental Protection Agencies (e.g. WWF, IUCN, FFI, ICRAF)	Project Manager; Programme / Project Coordinator; Representative; Country Director
Development Agencies (e.g. GIZ, SNV, KfW)	Project Manager
Staff of Protected Area (e.g. BMNP)	Director / Vice-Director; Forest Rangers
Educational Organizations (e.g. HUAF, VAST, HUS)	Ph-D Student; Professor
Governmental Institutions (e.g. MARD, FPD)	Deputy Head; Vice-Director; Chief of Department

3.2. The GIS component

The additional aim of the first phase was to establish an appropriate database for further utilization. Various GIS analyses could be possible, varying from simple comparisons to sophisticated neighborhood analyses. The core of the second monitoring components is compound by several landscape metrics. The computer-based theories behind these methods were developed and consistently enhanced by the US-American landscape ecology within the 1980s (Forman and Godron 1986; Turner 1989). Accordingly, with the Fragstats software various metrics were calculated and interpreted (given in figure 2 and 3). These figures show the perimeter / area ratio of the Bach Ma National Park and its surrounding. In this case, the greater the value of the patch, the smaller is the area of the patch in relation to the perimeter.

Patches with a high perimeter / area ratio possess curvilinear and complex boundaries. As a result, the core area of the patch decreases and edge species feature an advantage in comparison to interior species. Additionally, small patches with large perimeters foster the interaction between different habitats and land cover classes. Meyfroidt and Lambin (2008) demonstrated in a countrywide survey that for the last decades forest patches within the Annamite ecoregion have increased in size and possessing an improved connectivity, but at the same time forest patches increasing in complexity, resulting in an unchanged core area value. As described above, the first and the second monitoring component represent the descriptive and most technical part.

3.3. The social research component

Social research is the main element of the third monitoring component. This part is strongly site-specific and inductive, starting without any expectation or hypotheses. Particular focus has been put on expert interviews with the aid of a half-standardized questionnaire. Indeed, half-standardized questionnaires comprise specific questions and a certain direction, but offering enough tolerance for a fluent and natural conversation with a pleasant atmosphere. The first objective was to identify crucial stakeholders and important actors with regard to land cover change and nature conservation. Table 1 provides examples of accomplished interviews with involved institutions and several positions of the interviewees.

Due to the barrier of language and strong bias to international experts with partly absence of knowledge concerning the local and regional conditions, a standardized questionnaire for the local population was generated. The questionnaire for local inhabitants was prepared in close connection to the half-standardized questionnaire for the experts. Hence, results of particular question could be compared and used as evidence for strong correlations.

4. RESULTS

The analyses covering a period of nearly 40 years and a couple of changes for the Bach Ma National Park and the surrounding can be highlighted. Probably the most interesting development regarding the forest is a decreasing dense forest cover and at the same time an increasing sparse forest cover, which is related to the establishment of plantations (particular acacia) in recent years. Nevertheless, increasing urban settlements and rangeland areas could be detected as well. Major cities like Hue and Da Nang will play an increasingly important role even for rural areas like the Phu Loc province or Nam Dong province. This development is closely correlated with an improved infrastructure system, composed of airports, harbors and convenient road connections between the central cities.

Figure 2. Perimeter / area ratio 1989.

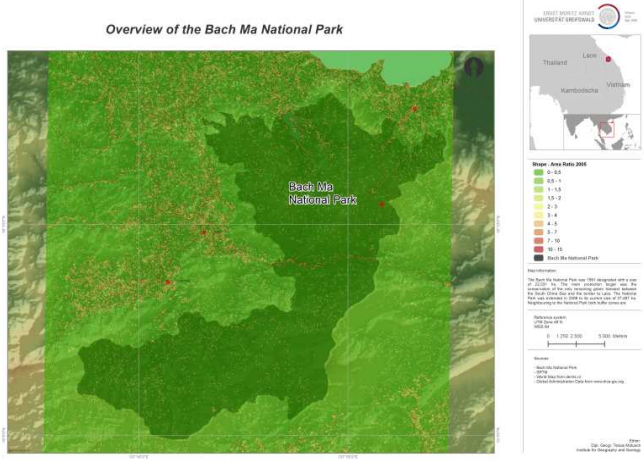

Figure 3. Perimeter / area ration 2005.

Another example regarding to the Bach Ma National Park is given by figure 2 and figure 3. The perimeter / area ratio indicates patches with complex boundaries and corresponding interactions with surrounding habitats. Comparison of figure 2 and 3 elucidate that within figure 2 the Bach Ma National Park possesses considerable more areas with a higher perimeter / area ratio. Hence, between 1989 and 2005 the areas could be increased and boundaries simplified. Considering that the National Park was designated in 1991, one can assume successful nature conservation and environmental protection efforts. The vicinity illustrates more regions with curvilinear boundaries than the National Park. With the aid of additional datasets (e.g. demographic data) it is given an indication to urbanization and intensification of farming activities with corresponding size reduction of habitats and fragmentation of the landscape structure.

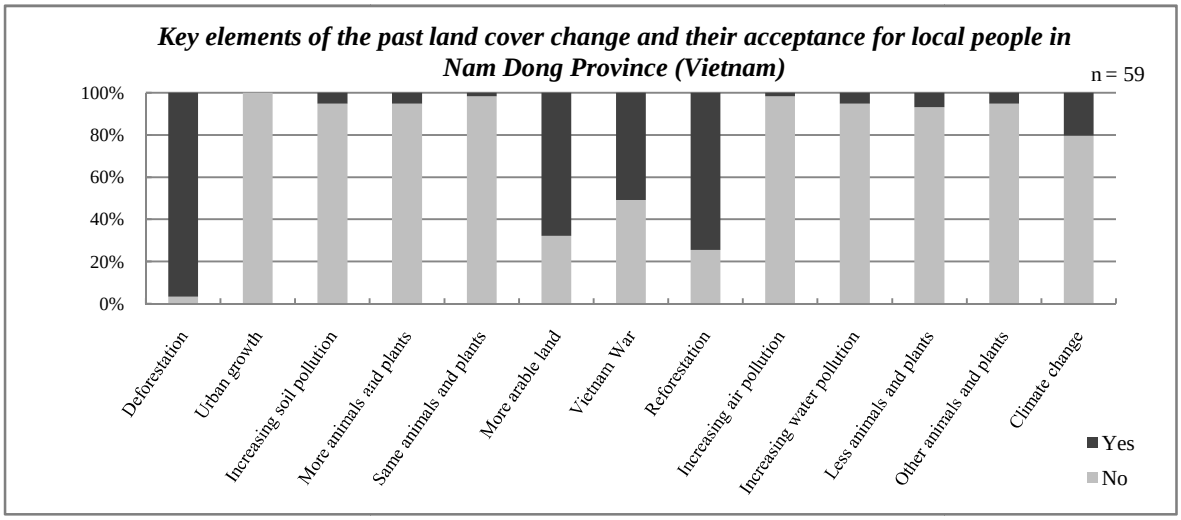

Figure 4. Perception regarding key elements of the past land cover change in Nam Dong province (Vietnam).

The results of the expert interviews were diverse as expected. However, in general they support the results of the first two components. The most important issue for the interviewed experts are local people living in the vicinity of the boundaries. Their daily encroachment within the National Park is often connected with illegal activities (e.g. harvesting trees and collecting non-timber products as well as hunting certain wild species) and is considered as major threat regarding the loss of biodiversity or reduction of rich forest. Both deforestation and reforestation are the most important key elements of the past land cover change for the local people (represented by figure 4). This reflects the high importance of the forest within

this province. Other important factor for the people is the increase of arable land for cultivating different types of crops. The Vietnam War is still associated with the land cover change, but surprisingly more for the younger generation.

5. DISCUSSION

This study demonstrates the high potential of interdisciplinary methods combining quantitative measurements like remote sensing or GIS with qualitative techniques like social research. An important step toward the future would be an improved spatial resolution of data. With new techniques like microwave and hyperspectral image processing forest monitoring could be achieved to new levels and helping on the ground rangers and protected areas to manage and protect the environment. Nevertheless, due to the importance of the local people and their behavior, these approaches should include biodiversity monitoring as well as social monitoring aspects.

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