Research Article

A framework for assessing conservation and development in a Congo Basin Forest Landscape

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Abstract
An integrated framework for assessing conservation and development changes at the scale of a large forest landscape in the Congo Basin is described. The framework allows stakeholders to assess progress in achieving the often conflicting objectives of alleviating poverty and conserving global environmental values. The study shows that there was little change in either livelihood or conservation indicators over the period 2006 to 2008, and that the activities of conservation organizations had only modest impacts on either. The global economic down-turn in 2008 had immediate negative consequences for both local livelihoods and for biodiversity as people lost their employment in the cash economy and reverted to illegal harvesting of forest products. Weakness of institutions, and corruption were the major obstacles to achieving either conservation or development objectives. External economic changes had more impact on this forest landscape than either the negative or positive interventions of local actors.

Key words: Congo Basin, landscape assessment, biodiversity conservation, poverty alleviation, forest governance, conservation and development trade-offs.

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Introduction

The Congo Basin contains the second largest area of rainforest in the world after the Amazon. The forests are of global significance for their mediating effects on climate change and their biodiversity. They also provide essential flows of benefits to local people, many of whom live in extreme poverty. These benefits include employment in forest harvesting, provision of foods from wild animals and plants, medicinal plants, wood energy, drinking water, and materials for housing and artisanal activities. Conservation organizations have argued that conservation of the global environmental values of the forests is also good for alleviating the poverty of local people. They have further argued that by working at a landscape scale they can provide a package of interventions that will optimize both conservation and development outcomes [1]. This study sought to test this assumption in one of the Congo Basin's iconic landscapes – the Tri-National de la Sangha (TNS).

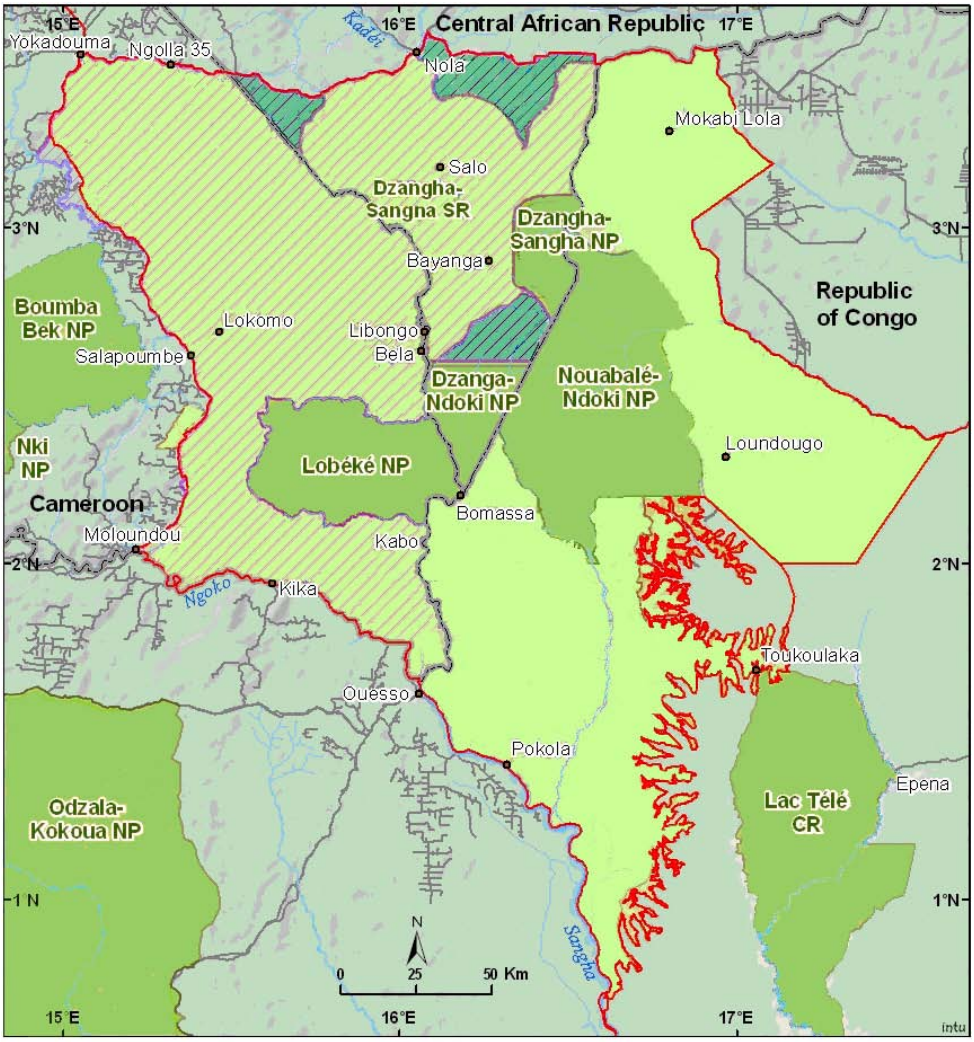
The Sangha tri-national landscape is an area of 43,936 sq km of humid tropical forest that lies astride the frontiers of Cameroon, the Central African Republic (CAR), and Republic of Congo (Fig. 1). The area is exceedingly rich in biodiversity and includes three national parks (Lobéké in Cameroon, Dzanga-Ndoki in CAR, and Nouabale-Ndoki in Congo), which together cover a total of 7889 sq km, Forest concessions, community hunting zones, commercial hunting concessions, mineral concessions, and agro-forestry zones make up the rest of the landscape.

The Sangha tri-national landscape is one of the priority landscapes being supported by international donors under the Congo Basin Forest Partnership (CBFP). This partnership between the governments of the countries of the region and their major donors was announced at the Johannesburg Earth Summit in 2002. It heralded a major international effort to reconcile conservation and development at the landscape scale in 13 landscapes located in 6 countries in the Congo Basin [1].

The TNS is of critical importance for African dense forest biodiversity. The area contains significant populations of forest elephants (*Loxodonta africana cyclotis*) and gorilla (*Gorilla gorilla gorilla*). A total of 16 species of primates, 14 species of ungulates, 14 species of carnivores and 105 species of other terrestrial mammals are known from the area [2, 3]. The TNS is important for the conservation of the endangered bongo antelope *(Tragelaphus euryceros);,* it is also home to 316 species of butterflies, and 379 species of birds, including one endemic, the forest red-throat (*Stiphrornis sanghensis*), and one endangered species of nightjar (*Caprimulgus binotatus*). There is a high diversity of reptiles, amphibians, invertebrates, and fish [3]. The national governments, commercial logging companies, World Wide Fund for Nature (WWF), Wildlife Conservation Society (WCS), International Union for Conservation of Nature (IUCN), and a German development assistance agency (GTZ) all support conservation and development programs. All these programs state that they are pursuing a "landscape approach," and that they are giving equal attention to global environmental values and local livelihoods [1].

The landscape has a total population of 191,000 people, about 90% of whom are Bantu and the remainder from Baka, Ba'Aka, and other pygmy ethnic groups [3]. Local Bantu groups and the pygmies have traditionally lived from hunting, gathering, fishing, and simple agriculture. Some Bantu immigrants from other parts of the three countries arrived after 1960 (Cameroon), 1970 (Congo), and 1972 (CAR), attracted by employment in industrial logging. Logging is now the main economic activity in the region and provides employment and revenues to local businesses and governments. However, a large proportion of the populations still depend on subsistence agriculture and hunting and gathering, and many of these people live in extreme poverty. The term "landscape approach" [4] is applied in this area and elsewhere in the Congo Basin to describe approaches to natural resource management that operate at the scale of large, diverse mosaics of land cover types. However, the reality on the ground is that these areas come under the jurisdiction of a diversity of sectoral agencies, and there is no effective integrating framework to foster agreement on how the different

parts of the mosaic fit together. "Landscapes" inevitably encompass a diversity of interest groups and are influenced by multiple drivers of change. There can never be a single "best" outcome for a landscape, and interventions at this scale are always a process of constant negotiation and adaptation [4]. International conservation and development agencies employ the term "landscape" to describe the latest generation of attempts to integrate conservation and development but are ambivalent about exactly what is meant by the term. There is no consistent methodology or approach to landscape scale interventions, and there is little rigorous thinking behind the use of the term.



Sangha Tri-National Landscape

Logging Concession
Hunting Concession
Hunting & Logging Concession
National Parks
Boundary of Sangha Tri-National landscape
Country boundary

Fig. 1. Map showing the location, boundaries and land-cover categories of the Sangha Tri-National Landscape (adapted from Congo Basin Forest Partnership website, 2009)

The Sangha landscape is thus similar to many landscapes where organizations such as WWF, IUCN, and development agencies like the World Bank and the Global Environment Facility seek to reconcile conservation and development benefits at a landscape scale [4]. These landscape-scale initiatives have rarely been subject to rigorous assessment of their performance in delivering either conservation or livelihood benefits [5]. A key challenge has been to measure and monitor the outcomes of these initiatives in ways that make the balance between conservation and development explicit. Conventional methods of assessing and monitoring projects or programs focus on process and outputs and rarely address ultimate outcomes or the trade-offs that are inevitable in a landscape approach. We argue that effective management of large landscapes such as those of the Congo Basin must be based on models that make the trade-offs between conservation and development explicit and measure the overall performance of the landscape in providing these often conflicting streams of benefits. The need for trade-offs to be more explicitly addressed and an assessment of the difficulties of doing this is argued by McShane et al. [6]. It has also been argued that biodiversity provides few instrumental values for poor people [7], and that the unwillingness of conservation organizations to recognize the extent of trade-offs is a major weakness of many field conservation programs [4, 5, 6, 7].This study sought to provide a framework around which the diverse stakeholders could come together to identify indicators of progress in achieving both conservation and development goals. The aim was to investigate the relationship between the global public goods values of the forests and the livelihoods of local people [6, 7]. We sought to test the hypothesis that local and global benefit flows could be optimized at the landscape scale [4]. We worked with a multi-stakeholder group to develop a framework that would allow the local stakeholders themselves to determine which conservation and development changes would be desirable and then to track progress in moving toward those outcomes. Our work responds to the challenge implicit in many integrated conservation and development projects: that they lack any assessment methodology that helps determine where the balance between conservation and development should lie [5, 6].

Our study built on ongoing work of aid agencies and international conservation organizations. These organizations support forest protection, the adoption of better logging practices and certification in production forests, management of both forests and wildlife by local communities, and a range of other small-scale interventions to improve local livelihoods. We were able to draw upon a considerable database of information built up by these organizations on wildlife numbers, extent and condition of forests, progress in achieving certification, and progress in the development of community management. Background information on the TNS and on the activities of the conservation organizations working there is provided on the website of the Congo Basin Forest Partnership (CBFP) [1], and an excellent account of the values and challenges of the TNS is provided in the bi-annual State of the Congo Basin Forests [3] published by the CBFP.

Methods

In 2003 we convened a meeting of the major conservation and development organizations working in the TNS together with representatives of local NGOs and government to debate a shared vision of how the landscape might evolve in the future, what these changes would mean for the population and for the biodiversity of the area, and how the activities of the different actors might combine to yield more desirable outcomes. Many of the organizations present at this meeting had their own ways of measuring their impact, but it was agreed that it would be desirable if all could agree on a shared approach to measuring change in the landscape. We adopted the principle that the people of the landscape should play a central role in assessments of progress. At the time we expected it to be relatively simple to agree upon a set of indicators of this progress and to facilitate an annual assessment of the indicators using participatory methods. The reality turned out to be far more complex than we had anticipated. The diversity of interest groups, the sheer scale of the landscape, and the difficulties of collecting data on some important attributes of the landscape greatly exceeded

our initial assumptions. We agreed early on to base our assessment on a broad range of landscape attributes that covered human livelihood and environmental issues. The group met annually, but it was not until 2006 that we finally established a common monitoring program in the three national sectors. We adopted the capital assets framework as the basis of our approach [9-12].

Indicators based upon the capital assets framework have been widely used by development practitioners to capture the diversity of livelihood values within geographically defined areas [9-12]. They have used these indicators as a basis for a dialogue among stakeholders on desirable future scenarios that would provide balance among divergent interests. We have drawn upon this work and applied it at the level of the TNS landscape [13, 14]. We sought to use capital assets to provide a single framework for integrating social, economic, and ecological assessments [12, 13]. The capital assets framework identifies five core asset categories: physical, financial, social, natural, and human capital [10, 12]. To meet the needs of the situation in the Sangha landscape we adapted it. We chose to distinguish local from global environmental values as the rare species that were the concern of the international conservation groups were not of instrumental value to local people [7]. The people were more concerned about features of the environment that provided immediate benefits such as water, soils, and non-timber products. We chose not to consider financial capital, as local people have little possibility to accumulate financial capital and any attempt to measure it would have been excessively intrusive. Some authors use material objects – such as tin roofs or mechanical cassava mills – as surrogates for financial capital, but we preferred to include these under the category of physical capital.

The capital assets framework provides a means of classifying the attributes of the landscape that support human livelihoods. Human capital describes the skills, knowledge, and good health that together enable people to pursue different livelihood strategies and achieve their livelihood objectives. Social capital describes the social networks and organizations that enable people to cooperate and to provide checks and balances in resource use. These include informal and formal networks, governmental and non-governmental organizations, customs, laws, and institutions. Local natural capital is used for the natural resource stocks from which benefits flow to local people or that provide services – these include the quality of land, water, forests, air, and some components of biodiversity that have immediate local use. Global natural capital is used for environmental features whose value accrues to the global community or to distant stakeholders; it covers rare and endangered species and forest extent and condition, which have value for climate regulation, notably through maintaining carbon stocks. Physical or built capital consists of the basic infrastructure and capacity to transform products and add value within the landscape. In the Sangha landscape this included affordable transport, secure shelter and buildings, crop processing equipment, adequate water supplies and sanitation, clean and affordable energy, access to employment, and value added from factories and plantations [8, 12-15].

In each geographical sector of the Sangha landscape the same participatory techniques were used to build shared understandings of the landscape system, help participants think at a landscape scale, and break down communication barriers between participants. These participatory exercises were conducted separately in each of the three national sectors as part of the ongoing work of WWF, IUCN, and WCS. But key actors from the three countries were brought together each year to compare and debate the findings. In initiating the work in each sector we used a number of standard participatory techniques including historical trends analysis, visualization exercises, and simple simulation modeling [14, 16, 17]. We drew upon all these techniques to explore scenarios for the future of the landscape. Representatives of the conservation organizations, local NGOs, local government, and a small sample of community leaders were then asked to write on cards their suggestions for priority criteria against which future landscape performance might be measured. These criteria were subsequently classified by arranging the cards on a corkboard under the five capital assets. The methods used are described in more detail in Sayer et al. [14].

This process generated valuable discussions about desirable and undesirable landscape scenarios and was especially valuable in casting the net wide in generating a "long-list" of potential criteria for assessing overall landscape performance. In each national sector the discussion was enriched by a series of participatory focus group meetings with representatives of Baka and Ba'Aka pygmy groups, local Bantu people and Bantu immigrants, and staff members of international conservation organizations and of commercial logging companies. Opportunities were provided for men and women to express their views independently. It is important to emphasize that it was not logistically possible to involve all interest groups in the annual meetings, but we did attempt to secure the participation of representative samples of the local populations. Although we invested heavily in seeking inputs from the widest possible range of local people, we were obliged to rely heavily for data and opinions on staff of the external conservation and development groups who were working on a daily basis throughout the landscape. All these organizations have staff specialists dealing with local peoples' issues who have their own networks of contacts and informants. Much of our quantitative data came from the internal reports and databases of WWF and WCS. Both organizations held large databases on the biophysical and social attributes of the landscape. The information was all brought together, reviewed, adjusted, and compared during the annual meetings held at the local facilities of the international conservation organizations in Bayanga (CAR), Mambélé (Cameroon), and Bomassa and Kabo in Congo. The consensus list of 31 criteria for which indicators were developed is presented in Appendix 1.

To establish a quantitative ranking for each of these criteria a scoring system was developed with local stakeholders. Against each criterion a set of indicators was defined, with each given a score out of 5 – the Likert scale – which went from a value of 1 as least desirable through increasing levels of "performance" to 5 as the most desirable [14,17]. The criteria for scoring are indicated in Appendix 1 and the source of information for assessing each criterion is given in a footnote to that table. Several authors have used such a scoring approach for assessment of landscape performance [8, 9, 17, 18]. As far as possible we used scores that were based upon surveys to provide a rigorous quantitative baseline that could be independently measured. However several of the indicators represent the consensus of opinions from a facilitated focus group. Some of the scores thus suffer from the weakness that they cannot be easily replicated. They do not provide absolute values for landscape attributes, and they simply reflect the combined opinion of a subset of concerned stakeholders.

Results

The scores for all the indicators for the three national sectors of the TNS and for the entire landscape are summarized in Appendix 2. The main value of the indicator scores will be their use in annual discussions among stakeholders about progress made and adaptations needed in conservation and development interventions. The data can be graphically presented and aggregated in a number of ways. We initially relied heavily on presenting the aggregated scores as radar diagrams (Fig. 2). Radar diagrams have been widely used [9, 14, 18] to represent changes in conditions without necessarily implying judgment on whether these changes are good or bad. The reality is that for different stakeholders different changes in capital assets will be desirable. The radar diagrams provide a visual image around which to conduct a debate on changes. However, they proved difficult to understand for local stakeholders, and we gradually reduced our use of this method.

Simple bar charts showing annual trends in individual indicators are much simpler to use, and we have adopted this as our main way of presenting data. As an example, bar charts showing changes in the Cameroon sector for the period 2006 -2009 are given in Appendices 3A and 3B.

Human capital scored highest in Congo, somewhat lower in Cameroon, and lowest in CAR. The high score in Congo results from the major investments in health care and education made by the forestry company, *Congolaise Industrielle des Bois* (CIB). In CAR there has been no commercial forestry for

several years and very little investment in health and education. The human capital score for Cameroon improved over the first three years, mainly as a result of the posting of more qualified teachers to primary schools, but in 2009 there was significant abandonment of posts as the financial downturn made life in remote areas more difficult. Human capital varies according to remoteness of settlements –and is clearly fundamental in enabling effective use to be made of the other types of capital assets.

Social capital scores were better in Cameroon than in the other countries. The difference is due to a higher level of associative activity, notably community-based natural resource management (CBNRM) in Cameroon. For instance, five local hunting management committees (COVAREFs, or *Comité de Valorisation des Resources Fauniques)* are operating in the Cameroon sector. The revenues and royalties from wildlife hunting are managed by these local organizations and invested in social infrastructure.

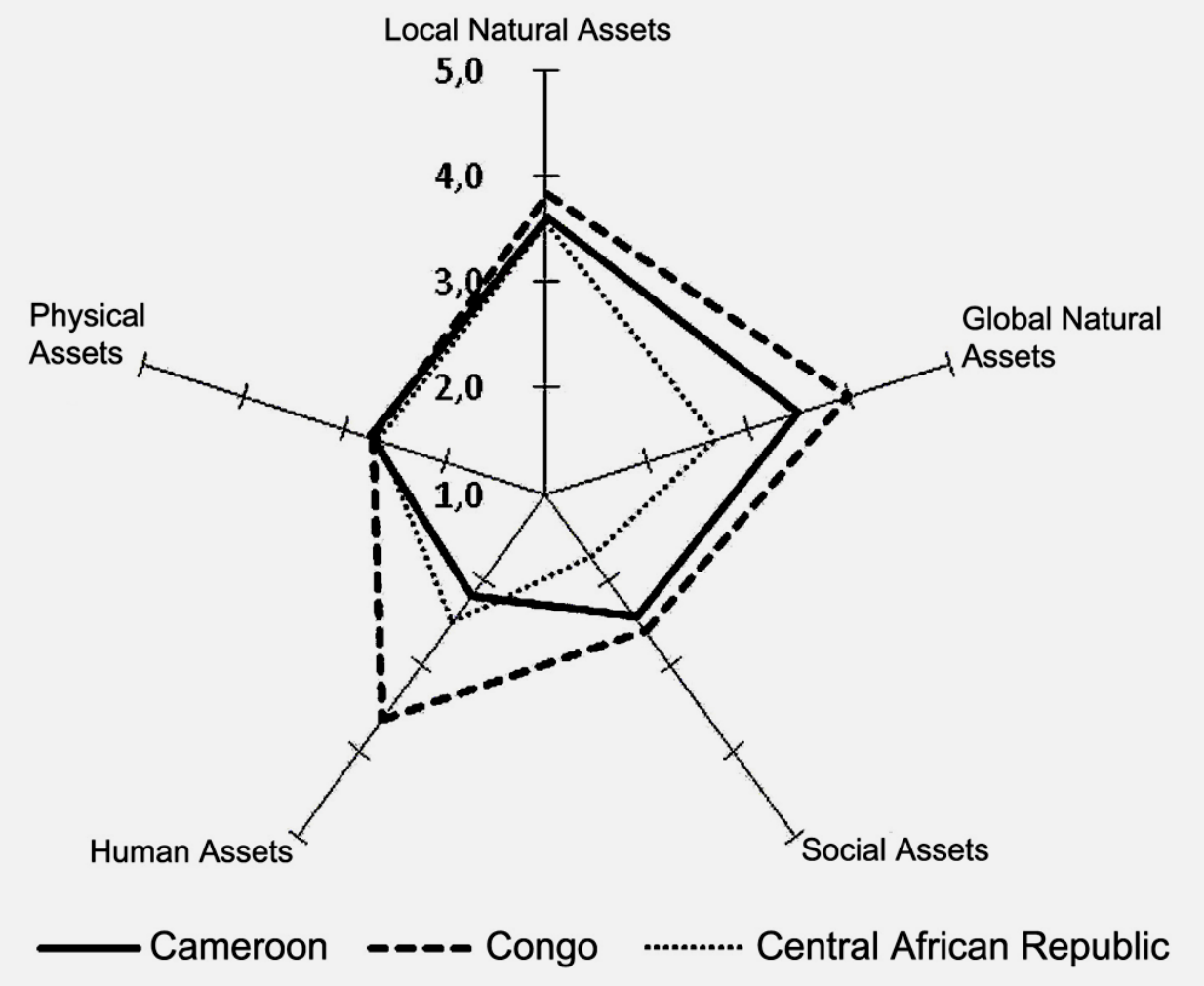


Fig. 2. Capital asset scores in the three national sectors of the Tri-National Landscape in 2009.

The indicators of social capital show that weak governance is perceived as a major problem in all three countries. Under present arrangements for industrial forest management, local people receive few benefits. Corruption is widespread in public agencies and in the commercial sector in all three countries. For instance, logging taxes intended to be reinvested in local social programs are often misappropriated by local and national elites. The rules and procedures for management of forests and wildlife are not respected because of the weakness of technical agencies. Some social groups, particularly pygmies and women, are excluded from the benefits. Social capital was perceived to be improving slightly in all countries during the first three years but then declining as a response to the global economic downturn in 2009. Physical capital scored better in Congo and CAR than in Cameroon. These countries have better water sources and access roads provided by logging companies and tourism infrastructure supported by international conservation organizations and aid agencies. CAR receives more than 1,000 tourists a year at a lodge that provides opportunities for observation of forest wildlife, especially gorillas and elephants. Congo has similar facilities but with a much lower capacity and with more difficult access. Few tourists visit the Sangha area in Cameroon as facilities and opportunities to observe wildlife are very limited. The wood-processing industry offers about 2,000 jobs in Congo and 100-400 in Cameroon. In CAR forestry operations are closed, and there is at present no employment. Infrastructure influences the sustainability of livelihoods as poor infrastructure precludes access to education and health services and to income-generating opportunities. Populations without good physical capital spend long periods in non-productive activities, such as the collection of water, which require labor that could be used for more productive purposes. Physical capital has increased marginally throughout the period, but in 2009 the global financial crisis led to a reduction in logging activity and hence of industrial employment and to a neglect of investments in water supplies and roads. Prices of basic products increased markedly in 2009 in all three countries.

Global natural capital scored best in Congo, slightly lower in Cameroon, and lowest in CAR. This difference between the countries is explained by a higher population density of elephants and great apes in Congo and Cameroon than in CAR. A decline in global natural capital in Cameroon was a result of a marked increase in organized elephant poaching in 2009.

According to the biannual State of the Congo Basin Forests [3], 96.9% of the entire TNS landscape was still forested in 2005 [3]. The data in appendices 1 and 2 show that deforestation rates are less than 1% per annum except in Congo where deforestation slightly exceeded 1% in 2006 and in Central African Republic in 2009. The condition of other biodiversity elements is the same in all countries with annual surveys conducted by WWF and WCS showing slightly higher densities of large mammals (e.g. gorillas, elephants) inside protected areas than outside. These survey results are summarized in chapter 19 of the biannual State of the Congo Basin Forests [3].

Local natural capital received the same scores in Cameroon and CAR and a slightly higher score in Congo. Non-timber forest products are freely available in Cameroon while scarcer in CAR. Wildlife resources used by local people are at the same level in all countries. The certification of logging is still at an early stage in Cameroon and CAR, but the very large CIB concession in Congo is certified by the Forest Stewardship Council and has strong measures in place to prevent over-exploitation of non-timber products and small game. Pollution with waste liquids is minor and localized in Cameroon and Congo, while in CAR it is still absent. Water course deterioration is a factor in CAR as a result of diamond mining and invasion of exotic plants like water hyacinth (*Eichornia crassipes)* [19]. Local natural capital declined in all three countries in 2009 as a result of the global financial downturn and layoffs of employees from logging companies. These people have resorted to poaching and collecting non-timber products to survive.

In Cameroon both livelihood and environmental indicators increased in the first three years of the study. However, in 2009 there was a decline in all categories of capital assets, a decline associated with the financial crisis and weakening governance.

In the CAR sector, landscape change was mainly a result of improved accessibility to the region. At the end of 2006, GTZ improved the road linking Bayanga to Nola. In addition the European Union rehabilitated the road network in other parts of the landscape. Improvement of road infrastructure has a major impact on livelihoods. The change in the social capital is due to improved involvement of the indigenous Ba'Aka in natural resource management. Ba'Aka traditional communities are now involved in planning the future of the Dzanga Sangha protected area. Overall declines in all categories of assets occurred in 2009 as a result of national-level instability and the global economic downturn.

In Congo the economic crisis had an even more pronounced impact since the local economy is totally dependent on the single very large forestry company CIB, which reduced its output by 50% in 2009. The 2,000 people employed by the company were given reduced working hours and lower pay. Revenues to local government and small local enterprises all declined, and investments by the company in health and education were reduced. Unemployed and under-employed people resorted to unsustainable hunting and gathering activities to augment their incomes.

Discussion

This study was a first attempt to assess the performance of an entire landscape in providing conservation and development benefit flows in the Congo Basin. Elsewhere in the region, donors and NGOs apply monitoring and evaluation to the individual cells in the landscape mosaic, and they focus on the delivery of planned project outputs such as persons trained, meetings convened, poachers apprehended, etc. Such information on components of the landscape does not help in understanding the overall performance of the landscape in meeting diverse human needs. Our study added to understanding of the dynamics of the larger landscape and thus suggested ways to improve overall landscape management.

Our indicators measured landscape performance and did not explain the causes of landscape change. However, in the debates among the stakeholders who conducted the annual assessments the causes of changes were frequent subjects of discussion. It was clear that the activities of conservation organizations did little to improve local livelihoods, and by restricting access to forest resources they may even have had a negative impact on local people. The main determinant of progress in almost all the livelihood indicators was access to employment in logging and timber processing. Thus the temporary closure of logging operations in the CAR sector led immediately to declines in livelihood indicators.

The impact of the global economic downturn reinforced recognition of the value of managed forests in providing local employment and tax revenues for reinvestment in local social infrastructure. The indicators also showed that changes external to the landscape, such as the opening up of new roads to distant markets and reduced economic activity resulting from the global recession, had more significant impacts on both conservation and development than did local project interventions.

Our results were particularly useful in enabling us to demonstrate the impacts of the global economic downturn in 2008-2009 on the landscape. Some forestry companies in Cameroon closed, and most in both Cameroon and Congo reduced their output. Employees were laid off or put on short time, and all had their spending power reduced. Local shopkeepers and artisans lost customers and all indicators related to economic activity declined. However, people did not immediately leave the area, and many resorted to illegal exploitation of forest wildlife and other products. The economic downturn therefore had a negative impact on both conservation and development.

The main value of our approach was to promote a meaningful and structured dialogue among different stakeholders around a set of measurable parameters. Local peoples' perspectives were presented by leaders of local associations and NGOs. The indicator set provided a conceptual

framework for a shared understanding among stakeholders of major changes in the landscape and their causes. This understanding allowed for the adaptation of management interventions to improve the landscape. For instance, our study encouraged the conservation organizations to shift the emphasis of their work towards sustainable forest management and away from simple anti-poaching.

The overall conclusion that emerged from the study was that the conservation activities of the projects of international organizations yielded few benefits for local people [16]. Sustainable forest management created jobs and local income and also maintained populations of the globally valuable wildlife species but tended to be associated with government corruption. The optimal "landscape" would contain larger areas of managed forests with good governance as a matrix within which smaller protected areas could preserve more specific conservation values. This conclusion is strongly supported for the Congo Basin as a whole in papers by Billand and Nasi and Nasi [20, 21]. The greatest improvements to local livelihoods in our study area came from employment in forest companies and in the improvements to infrastructure that the companies brought about. But these improvements also tend to encourage non-sustainable resource exploitation, so once again such infrastructure improvements must be linked to better governance and effective application of regulations.

The approach has helped local people and outside advisers to better share their understanding of problems and issues and to work toward more closely aligned goals for the landscape. It has also stimulated dialogue about tradeoffs and reduced the divergence in views of what types of outcomes are desired. The overall conclusion is that conservation alone will not deliver the livelihood benefits that are often claimed by conservation organizations [15], but increased levels of timber exploitation also fail to deliver these benefits unless governance is improved. One conclusion of the study has been to show the importance of strengthening institutions at all levels from the village to the national capitals [22].

Our results proved useful in communicating the problems of the landscape to outside decision makers. Our work was presented to a meeting of parliamentarians in the Cameroon capital Yaoundé and this led to parliamentary support for governance reforms. A presentation to aid donors led to a shift in emphasis from pure conservation to sustainable forest management. A presentation to activist NGOs, who normally oppose any logging as a matter of principle, may have led them to recognize the value of sustainable logging and helped them to see that logged forests, under the right conditions, make valuable contributions to providing multiple benefits. The study revealed the low rate of success of small local sustainable development interventions, but donors persist in funding these, apparently for ideological reasons. The main value of these small project activities lies in improving relations and understanding between local people and outside conservation groups. The study revealed the damage to local interests from corruption, and this led the Cameroon government to replace the more corrupt officials and to place one provincial governor in prison.

Our study also made us realize that attempting to intervene at these large spatial scales in ways that somehow respond to the needs and wishes of such a broad range of stakeholders is highly problematic. We were forced to the conclusion that the level of ambition of these large complex programs greatly exceeded the capacity of the external organizations to bring about change. The term landscape as it is now being used is ambiguous and represents an ideology of being "all things to all people." It is not backed up by rigorous concepts or methodologies.

Fig. 3. The rich biodiversity of the Sangha Tri National Landscape co-exists with some of the world's poorest people. Engaging these people in discussions about the future of the landscape is fundamental to achieving outcomes that balance local human needs with global conservation objectives. Photos ©Intu Boedhihartono

Implications for conservation

The approach outlined in this paper can assist conservation agencies to learn where the appropriate balance between conservation and development lies and help them to measure their progress in achieving this at a landscape scale. The framework contributes to social learning and can help stakeholders to develop greater understanding of landscape system dynamics and the linkages between livelihoods and conservation. The TNS has wildlife of global significance in an area where extreme poverty persists. The poverty of the populations must be alleviated whilst maintaining the biodiversity values. The stark reality of these trade-offs is illustrated in Fig. 3.

Our approach suffers from several shortcomings. Some of the individual indicator scores are the product of a consensus among a sample of stakeholders. This serves the purpose of promoting discussion and yields a shared understanding and vision of landscape values. However, it is difficult to replicate the measurement of these indicators or to attach confidence limits to them. To do this it would be necessary to base the measures on a survey of a sample of stakeholders. We now intend to do this for some of the more critical indicators. A second problem is that change is slow and the costs of sampling are high. Many of the indicators are derived from routine surveys conducted by conservation organizations. These include wildlife surveys, and in Cameroon comprehensive household livelihood surveys conducted by WWF. Limited resources have been available to complement this data with independent surveys. At present our resources allow us to conduct surveys and convene a stakeholder meeting only once a year. This means that it will be several more years before trends can be established with any degree of statistical confidence.

A monitoring system such as the one we have attempted becomes valuable only if maintained for several years. The time and resources to conduct the surveys and to maintain the annual meetings are considerable. For such monitoring to be sustainable it needs to be minimalist. We were struck by the level of detail required by aid donors for their own monitoring but at the same time by their unwillingness to provide the resources to collect data rigorously and maintain the effort over long periods. With hindsight we might have worked with even fewer indicators and been more selective in focusing on those that were easy to measure and provided the most information. The desire for simplicity was, however, countered by the participatory nature of the exercise and the desire of those who participated to ensure that their own special concerns were reflected in the indicators. Indicators of bushmeat and non-timber forest product availability are clearly weak scientifically but were considered of high importance by local communities. Corruption was of such overriding importance that even a rather subjective measure of its prevalence was felt to be necessary.

The use of the Likert scale to simplify the data set and enable the presentation of radar diagrams brings in additional layers of subjectivity and does not add greatly to the value of the results. We would recommend that future studies deal with the actual values measured for all variables and focus more on analyzing trends in their individual performances and less on attempts to aggregate them. The use of the capital assets framework was found to be useful as it forced all stakeholders to give attention to the broad range of goods and services provided by the landscape.

Overall, the monitoring program has generated a great deal of interest and has helped to bring together a group of scientists and practitioners around a more closely shared agenda for the landscape. This group now meets annually to review the indicators and discuss their implications. This informal Sangha Group now includes about 25 people who are influential in the organizations operating in the area. It provides for an annual stock-taking and a forum to debate landscape change and to identify possible adaptation of programs. The existence of this group and the relative coherence of its vision for the landscape represent perhaps the single most valuable impact of the monitoring program.

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Appendix 1. Description of the Indicators against which the capital asset criteria were scored for the Sangha Tri-National Landscape

	Score				
Local Natural Asset	**5**	**4**	**3**	**2**	**1**
Availability of Non-Timber Forest Products [1]	Totally available (very low price ; collection point very close to the village)	Good availability (low price ; collection point close to the village)	Available (average price ; collection point a bit distant from the village)	Limited (relatively high price ; collection point quite distant from the village)	Very limited (very high price; collection point very distant from the village)
Availability of bushmeat [1]	Very abundant (very low price ; collection point very close to the village)	Available (low price; collection point close to the village)	Available (average price; collection point a bit distant from the village)	Limited (relatively high price; collection point quite distant from the village)	Very scare (very high price; collection point very distant from the village)
Progress in certification [2]	More than 70% forest concessions certified	50-70% of forest concessions certified	First forest concessions certified	Initiation of process	Zero progress
Water pollution by liquid waste [2]	Zero	Minor localized pollution	Moderate levels of pollution	Pollution generalized	Major pollution problem
Siltation of water courses [2]	No problems	Big rivers with minor sand banks	Sand banks localized in river courses	Sandbanks in secondary rivers	River widely silted

	Score				
Global Natural asset	**5**	**4**	**3**	**2**	**1**
Rate of deforestation [2]	Zero	0% - 1%	1%- 2%	2% +	High deforestation
Populations of elephants [2]	More than 5000 elephants	4000-5000 elephants	3000-4000 elephants	2000-3000 elephants	Less than 2000 elephants
Populations of Gorilla [2]	More than 4000 gorillas	3000-4000 gorillas	2000-3000 gorillas	1000-2000 gorillas	Less than 1000 gorillas
Populations of Bongo [2]	More than 1 sign of Bongo in linear km	0.8-1 sign of Bongo in linear km	0.6-0.8 sign of Bongo in linear km	0.4-0.6 sign of Bongo in linear km	Less than 0.4 sign of Bongo in linear km

	Score				
Physical Asset	**5**	**4**	**3**	**2**	**1**
Number of cassava mills [2]	90- 100% of villages have 1 machine for 500 people	75-90% of villages have 1 machine for 500 people	50-75% of villages have 1 machine for 500 people	10-50% of villages have 1 machine for 500 people	less than 10% of villages have 1 machine for 500 people
Quality of housing [2]	75-100% have zinc roof	50-75% have zinc roof	35-50% have zinc roof	10-35% have zinc roof	less than 10% have zinc roof
Number of water sources [2]	80-100% of village have 1 well or pump for 1000 people	50-80% of village have 1 well or pump for 1000 people	25-50% of villages have 1 well or pump for 1000 people	10-25% of villages have 1 well or pump for 1000 people	less than 10% of villages have 1 well or pump for 1000 people
Journey time to the capital by road [3]	Less than 18 hours	18-24 hours	24-30 hours	30-36 hours	more than 36 hours
Number of tourist visits [2]	More than 1000 tourists per year	501-1000 tourists per year	300-500 tourists per year	50-299 tourists per year	Less than 50 tourists per year
Number of sport hunting permits [2]	More than 100 permits per year	60-100 permits per year	40-60 permits per year	20-40 permits per year	Less than 20 permits per year
Employment of local people in wood processing industries [3]	More than 1000 jobs	700-1000 jobs	400-700 jobs	100-400 jobs	Less than 100 jobs
Price of 3 staple foods [3]	Low decreasing	Decreasing	Stable	increasing	High increasing

	Score				
Social asset	**5**	**4**	**3**	**2**	**1**
Functioning of local NRM organization [2]	Operational and active in the field	Functioning with limited actions in the field	Established but non-functional	First steps taken for creation of NRM	No organization
Extent of Community-based Natural Resources Management initiatives [2]	Co-management operational in at least 3 villages	Co-management operational in 2 villages	Co-management operational in 1 village	Initiation of process	Zero progress
Effectiveness of state institutions[3]	Major support of the administration for law enforcement	Adequate support from the administration for law enforcement	Little support from the administration for law enforcement	Minimal support from the administration for law enforcement	Law enforcement totally lacking
Traditional governance (conflict resolution, participation in community affairs) [3]	More than 90% of litigations are solved by the traditional chiefs	70-90% of litigations are solved by the traditional chiefs	50-70% of litigations are solved by the traditional chiefs	20-50% of litigations are solved by the traditional chiefs	Less than 20% of litigations are solved by the traditional chiefs
Perception of corruption in public and private sectors [3]	Corruption Inexistent	Some isolated cases	Common	Generalized	Very serious
Level of activity of local NGOs [3]	90-100% of the households are members of an association	70-90% of the households are members of an association	50-70% of the households are members of an association	20-50% of the households are members of an association	Less than 20% of the households are members of an association
Involvement of indigenous people (Ba'aka, Baka) in Community-based Natural Resources Management initiatives [3]	More than 3 CBNRM initiatives	2 initiatives	1 initiative	Initiation of process	Inexistent
Participation of Baka in decision-making [3]	Effective participation in more than 90% of local policy making	Participation in 70-90% of local policy making	Participation in 50-70% of local policy making	Participation in 20-50% of local policy making	Participation in less than 20% of local policy making
Local reinvestment of forestry taxes in social infrastructure [3]	90-100% of forestry taxes are invested in local social infrastructure	70-90% of forestry taxes are invested in local social infrastructure	50-70% of forestry taxes are invested in local social infrastructure	20-50% of forestry taxes are invested in local social infrastructure	Less than 20% of forestry taxes are invested in local social infrastructure
	Score				
Human Asset	**5**	**4**	**3**	**2**	**1**
Access to health care [3]	More than 1 doctor for 2500 inhabitants	Less than 1 doctor for 2500 inhabitants	Less than 1 doctor for 4500 inhabitants	Less than 1 doctor for 5500 inhabitants	Less than 1 doctor for 7500 inhabitants
Quality of education [3]	Less than 50 pupils for each qualified teacher	50-80 pupils for each qualified teacher	80-90 pupils for each qualified teacher	90-100 pupils for each qualified teacher	More than 100 pupils for each qualified teacher
Number of people with technical and professional employment [3]	More than 80% of technical jobs in forestry industries held by locals	60-80%	40-60%	less than 40%	Zero technical jobs in forestry industries held by locals
Adoption by youth of rites, ceremonies and traditions [3]	80-100% youth adopt	60-80% youth adopt	40-60% youth adopt	20-40% youth adopt	less than 20% youth adopt
Use of traditional medicines [3]	High use of medicinal plants	Major use of medicinal plants	Regular use of medicinal plants	Minor use of medicinal plants	Absence of use of medicinal plants

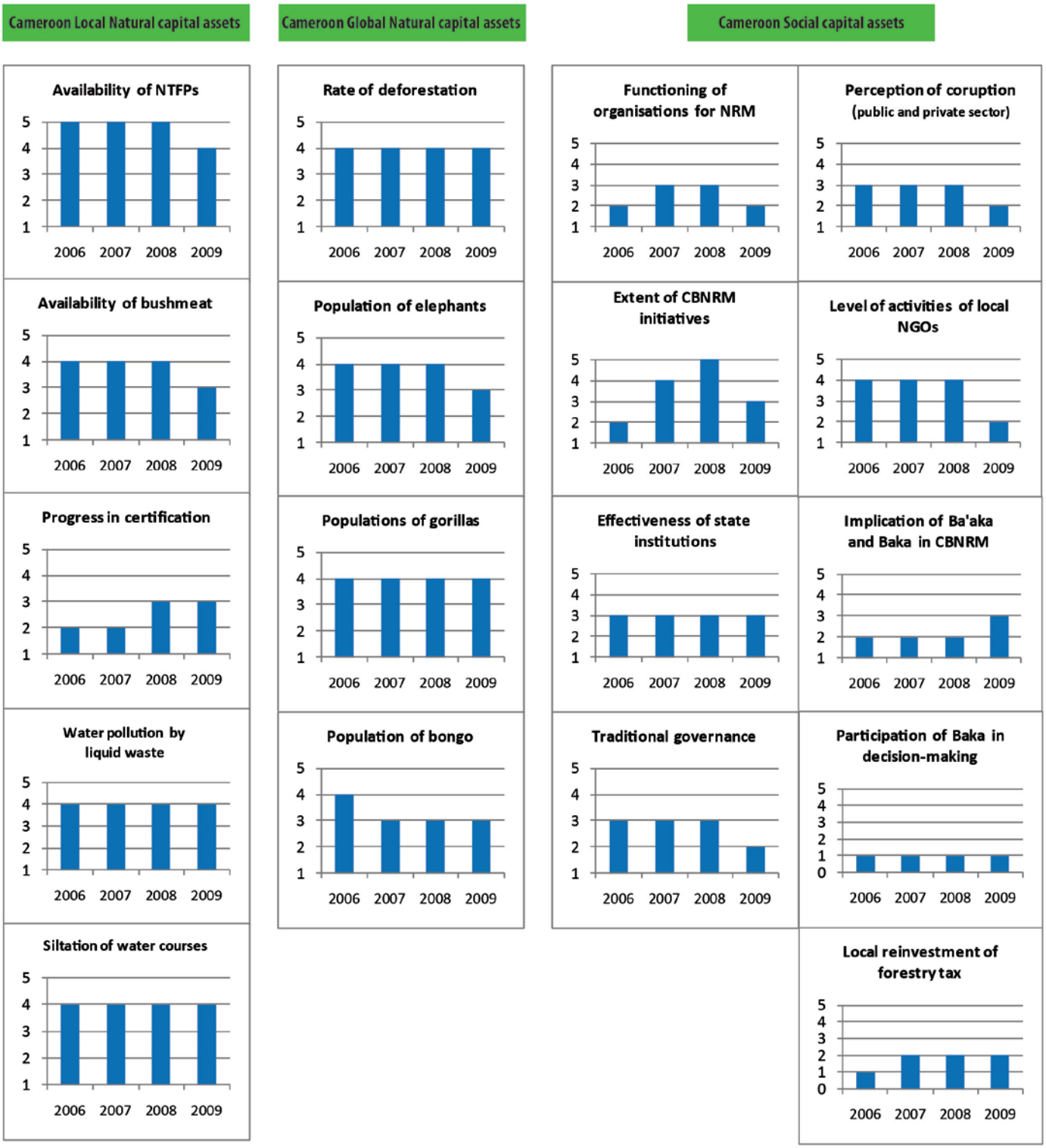
[1] Discussions with informants in a sample of villages; [2] Project Monitoring reports of WWF, IUCN and WCS; [3] Consensus figure from annual Sangha Group meeting

Appendix 2. Scores for capital asset indicators for the three national sectors and the entire Sangha Tri-National Landscape for 2006-2009

	Cameroon				Republic of Congo				Central African Republic				Tri-National Sangha			
	2006	2007	2008	2009	2006	2007	2008	2009	2006	2007	2008	2009	2006	2007	2008	2009
Local Natural Asset	**3.8**	**3.8**	**4.0**	**3.6**	**4.2**	**4.4**	**4.8**	**3.8**	**3.6**	**3.6**	**3.6**	**3.6**	**3.9**	**3.9**	**4.1**	**3.7**
Availability of Non-Timber Forest Products	5.0	5.0	5.0	4.0	5.0	5.0	5.0	4.2	4.0	4.0	4.6	5.0	4.7	4.7	4.9	4.4
Availability of bushmeat	4.0	4.0	4.0	3.0	3.0	4.0	4.8	3.3	4.0	4.0	2.8	3.3	3.7	4.0	3.9	3.2
Progress in certification	2.0	2.0	3.0	3.0	5.0	5.0	5.0	4.0	2.0	2.0	2.0	1.5	3.0	3.0	3.3	2.8
Water pollution by liquid waste	4.0	4.0	4.0	4.0	4.0	4.0	5.0	3.7	5.0	5.0	5.0	5.0	4.3	4.3	4.7	4.2
Siltation of water courses	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	3.0	3.0	3.7	3.0	3.7	3.7	3.9	3.7
Global natural asset	**4.0**	**3.8**	**3.8**	**3.5**	**3.8**	**4.0**	**4.0**	**4.0**	**2.8**	**2.8**	**2.8**	**2.7**	**3.5**	**3.5**	**3.5**	**3.4**
Rate of deforestation	4.0	4.0	4.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0	3.8	3.7	4.0	4.0	3.9
Populations of elephants	4.0	4.0	4.0	3.0	5.0	5.0	5.0	5.0	1.0	1.0	1.0	1.5	3.3	3.3	3.3	3.2
Populations of gorillas	4.0	4.0	4.0	4.0	5.0	5.0	5.0	5.0	3.0	3.0	3.0	2.5	4.0	4.0	4.0	3.8
Populations of bongos	4.0	3.0	3.0	3.0	2.0	2.0	2.0	2.0	3.0	3.0	3.0	3.0	3.0	2.7	2.7	2.7
Social asset	**2.3**	**2.8**	**2.9**	**2.4**	**2.3**	**2.3**	**2.6**	**2.6**	**2.1**	**2.2**	**1.9**	**1.7**	**2.3**	**2.4**	**2.4**	**2.3**
Functioning of local NRM organizations	2.0	3.0	3.0	2.0	2.0	2.0	2.0	2.8	4.0	4.0	3.0	1.8	2.7	3.0	2.7	2.2
Extent of Community-based Natural Resources Management initiatives	2.0	4.0	5.0	5.0	2.0	2.0	2.0	1.3	2.0	2.0	1.5	1.5	2.0	2.7	2.8	2.6
Effectiveness of state institutions	3.0	3.0	3.0	3.0	1.0	1.0	1.0	2.8	2.0	2.0	2.3	2.0	2.0	2.0	2.1	2.6
Traditional governance (conflict resolution, participation in community affairs)	3.0	3.0	3.0	2.0	4.0	4.0	4.0	3.3	3.0	3.0	2.3	2.5	3.3	3.3	3.1	2.6
Perception of corruption in public and private sectors	3.0	3.0	3.0	2.0	4.0	4.0	4.0	3.3	3.0	3.0	2.5	2.8	3.3	3.3	3.2	2.7
Level of activity of local NGOs	4.0	4.0	4.0	2.0	2.0	2.0	2.0	2.6	1.0	1.0	1.0	1.0	2.3	2.3	2.3	1.9
Involvement of indigenous people (Ba'aka, Baka) in Community-based Natural Resources Management	2.0	2.0	2.0	3.0	1.0	1.0	1.0	1.3	1.0	2.0	2.0	1.5	1.3	1.7	1.7	1.9
Participation of Baka in decision-making	1.0	1.0	1.0	1.0	2.0	2.0	2.0	2.0	1.0	1.0	1.0	1.5	1.3	1.3	1.3	1.5
Local reinvestment of forestry taxes in social infrastructure	1.0	2.0	2.0	2.0	3.0	3.0	5.0	4.0	2.0	2.0	1.3	1.0	2.0	2.3	2.8	2.3

	Cameroon				Republic of Congo				Central African Republic				Tri-National Sangha			
	2006	2007	2008	2009	2006	2007	2008	2009	2006	2007	2008	2009	2006	2007	2008	2009
Human Asset	**2.0**	**2.2**	**2.8**	**2.2**	**3.0**	**3.0**	**3.0**	**3.6**	**2.2**	**2.2**	**2.2**	**2.5**	**2.4**	**2.5**	**2.7**	**2.8**
Access to health care	1.0	2.0	2.0	1.0	1.0	1.0	1.0	3.0	1.0	1.0	1.0	1.0	1.0	1.3	1.3	1.7
Quality of education	2.0	2.0	3.0	1.0	4.0	4.0	4.0	4.5	1.0	1.0	1.3	1.0	2.3	2.3	2.8	2.2
Number of people with technical and professional employment	2.0	2.0	2.0	2.0	1.0	1.0	1.0	2.3	2.0	2.0	1.3	2.0	1.7	1.7	1.4	2.1
Adoption by youth of rites, ceremonies and traditions	1.0	1.0	3.0	3.0	5.0	5.0	5.0	3.7	4.0	4.0	3.0	4.0	3.3	3.3	3.7	3.6
Use of traditional medicines	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.3	3.0	3.0	4.3	4.5	3.7	3.7	4.1	4.3
Physical Asset	**2.3**	**2.5**	**2.4**	**2.8**	**2.8**	**3.0**	**3.0**	**2.7**	**2.0**	**2.1**	**2.5**	**2.7**	**2.3**	**2.5**	**2.6**	**2.7**
Number of cassava mills	4.0	4.0	4.0	3.0	2.0	2.0	2.0	2.8	2.0	2.0	2.0	2.8	2.7	2.7	2.7	2.9
Quality of housing	2.0	2.0	2.0	3.0	4.0	4.0	4.0	3.8	1.0	1.0	1.4	1.0	2.3	2.3	2.5	2.6
Number of water sources	3.0	3.0	3.0	4.0	2.0	2.0	2.0	1.8	4.0	4.0	5.0	4.5	3.0	3.0	3.3	3.4
Journey time to the capital by road	2.0	3.0	1.0	4.0	3.0	3.0	3.0	4.0	2.0	3.0	4.3	5.0	2.3	3.0	2.8	4.3
Number of tourist visits	2.0	2.0	2.0	2.0	1.0	1.0	1.0	1.7	4.0	4.0	3.7	4.0	2.3	2.3	2.2	2.6
Number of sport hunting permits	2.0	2.0	2.0	1.0	3.0	4.0	4.0	2.5	1.0	1.0	1.0	1.0	2.0	2.3	2.3	1.5
Employment of local people in wood processing industries	2.0	2.0	4.0	3.0	5.0	5.0	5.0	3.3	1.0	1.0	1.0	1.0	2.7	2.7	3.3	2.4
Price of 3 staple foods	1.0	2.0	1.0	2.0	2.0	3.0	3.0	1.8	1.0	1.0	1.3	2.0	1.3	2.0	1.8	1.9

Appendix 3A. Histograms showing changes in Local Natural, Global Natural and Physical asset indicators for Cameroon over the period 2006-2009.



Appendix 3B. Histograms showing changes in Human and Social asset indicators for Cameroon over the period 2006-2009