Economic valuation of protected areas:
The case of the Lopé National Park in Gabon

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Declaration

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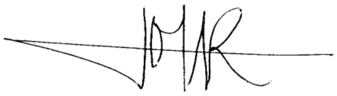

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Abstract

The purpose of this study was to estimate the economic value of the Lopé National Park in Gabon. The creation of the Lopé National Park (LNP) in 2002 aimed at answering international engagements of Gabon as regards conservation of the biodiversity. To be able to value this protected area, an economic valuation technique called the Total Economic Value was applied. Total economic value (TEV) is a valuation method which attempts to estimate monetarily some tangible and intangible environmental benefits.

After a brief presentation and an overview of legal aspects of the LNP, two management scenarios were considered: a scenario 'with the Lopé National Park' and a scenario 'without the Lopé National Park'. The former scenario takes in account the establishment of the park whereas the latter suggests the non-establishment of the park. A set of hypotheses was set to perform the valuation. Furthermore, the data used in this study was based on primary research and various telephone interviews to confirm their validity.

Based on various valuation techniques, selected tangible and intangible ecosystem benefits classified as direct use values, indirect use values, option values and existence values were quantified. The result of this study shows that the economic value of the scenario with the Lopé National Park produces a higher economic value than the scenario without the Lopé National Park. In other words, the decision to establish a protected area is a justifiably sound economic decision as it creates social welfare at local, national and international level. It is important to note that this valuation exercise is incomplete as this study does not take into account all the environmental benefits generated by any forest ecosystem due to the difficulty in valuing its intangible nature.

Key words:

Total economic value, use values, non-use values, protected areas management, discounting.

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BV	bequest values
CDM	Clean Development Mechanism
CEB	*Companie Equatoriale du Bois*
CERs	Certified Emission Reductions
CIFOR	Centre for International Forestry Research
COMIFAC	Central African Forest Commission
DFC	*Direction de la Faune et de la Chasse*
DUV	direct use values
EUETS	European Union Emission Trading Scheme
FIGET	*Fondation Internationale Gabon Eco-Tourisme "Giuseppe Vassallo"*
FORENET	Forestry Research Network
GEF	Global Environment Facility
GFW	Global Forest Watch
IRET	*Institut de Recherche en Ecologie Tropicale* (Tropical Ecology Research Institute)
IPHAMETRA	Institute of Pharmacology and Traditional Medicine
TERI	Tropical Ecology Research Institute
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
IUS	indirect use values
LNP	Lopé National Park
NTFPs	non-timber forest products
NUS	non-use values (existence and bequest values)
OECD	Organisation for Economic Co-operation and Development
OV	option values
PA	protected area
PSFE	*Programme Sectoriel Forêts et Environnement* (Forest & Environment Sector Programme)
SEEF	*Société Equatoriale d'Exploitation Forestière* (Equatorial Company for the Exploitation of Timber)
SP	stated preference (techniques)
TEV	total economic value
UNESCO	United Nations Educational, Scientific and Cultural Organisation
US	United States (of America)
UV	ultraviolet
WCPA	World Commission on Protected Areas
WCS	Wildlife Conservation Society

WTP	willingness to pay
WWF	World Wide Fund for Nature
XV	existence value

CHAPTER 1
ORIENTATION

1.1 INTRODUCTION

Few ecosystems can support diverse human activities and provide as many services as tropical forests. The activities of forest users are situated at various levels and have different motives: from the villagers who see the forest as a source of natural products to governments that want to preserve biodiversity; from the logging companies that consider it as a stock of timber resources to the Global Environment Facility (GEF) which sees an opportunity to store carbon, the tropical forest is fundamentally a multi-use and multi-user environment.

Tropical biodiversity, ecosystem functioning and ecosystem services are directly and indirectly threatened by a broad variety of man-made activities (Richards, 1976: 227). Among these human activities, tropical deforestation is considered the most harmful as it accounts for roughly 20 per cent of anthropogenic carbon emissions and destroys globally significant carbon sinks (Intergovernmental Panel on Climate Change (IPCC), 2001: 35). Tropical deforestation is the second largest source of greenhouse gas emissions second only to that produced by fossil fuel combustion, and is expected to remain a major emission source for the near future (Fearnside & Laurance, 2004: 982). Deforestation could have the effect of cooling the atmosphere, but it also leads to reductions in biodiversity, disturbed water regulation, and the destruction of livelihoods for many of the world's poorest. To successfully prevent the depletion of tropical forests, effective strategies for protecting natural habitats are needed. Protected areas are designated with the aim of conserving biodiversity, maintaining terrestrial carbon stocks, but also fulfilling an important role in providing economic profits to the forest-based communities.

Gabon is an African country located on the western side of the continent with about 80 per cent of its area covered by forest, which represents 20 million hectares. It is a tropical rainforest country *par excelle*nce with an estimated 8 000 to 10 000 species of plants (20 per cent of which are endemic), over 670 species of birds, and nearly 200 mammals including lowland gorillas, chimpanzees, ten species of monkeys, forest elephants, and even hippos that surf ocean waves (Mongabay, 2006). Gabon is one of the few places on earth where primary tropical rainforest extend all the way to the beach. Deforestation has been a critical concern in the country. Between 1990 and 2000, Gabon lost on average 10 100 hectares of forest per year. This amounts to an average annual deforestation rate of 0.05 per cent. Between 2000 and 2005, the rate of forest change increased by 1.5 per cent to 0.05 per cent *per annum*. In total, between 1990 and 2005, Gabon lost 0.7 per cent of its forest cover or roughly 252 000 hectares (Mongabay, 2006). Furthermore, non-timber forest products (NTFPs) are being depleted as local communities depend on them almost entirely for their subsistence and survival needs (Belcher, 2005: 83).

Thanks to the forestry potential of the country, the loss of forest cover and the steady decline of oil production, Gabonese authorities announced the establishment of 13 nature reserves situated across the country at the Johannesburg Earth Summit in 2002 in South Africa. These 13 sites, rich in biodiversity have been created following various discussions initiated by diverse international non-governmental organisations such as Global Forest Watch (GFW), World Wide Fund for Nature (WWF) and Wildlife Conservation Society (WCS) with *La Direction de la Faune et de la Chasse* (DFC), the Gabonese institution in charge of forest affairs. The Gabonese government remains until this day one of the few governments in Central Africa to have allocated a substantial part, namely ten per cent, of its land, to conservation areas. Percentage-wise, only Costa Rica has set aside more land for conservation.

1.2 PROBLEM STATEMENT

The Lopé National Park (LNP), one the 13 national parks established by the Gabonese government, aims to reply to the international engagements regarding biodiversity conservation. The Gabonese authorities consider these parks as a project of economic development, allowing the revitalising of rural areas still further removed from the economic and social progress of the country.

The objective of this study is to investigate in which measure the LNP constitutes effectively a source of wellbeing locally, countrywide and worldwide by estimating the economic benefits generated by the park. Its environmental regulatory framework precisely defines the legally authorised practices within the LNP: This park is aimed at the conservation of biodiversity and the protection of ecological functions. Therefore only authorised scientific and ecotourism activities are allowed, with little possibility of exercising certain customary rights. This set of activities constitute a particular scenario of land-use management, known as ‘scenario with LNP’. In contrast, the establishment of the LNP yields an opportunity cost which corresponds to the benefits relinquished by the economic agents due to forest conservation regulation. That is, it prevents the occurrence of a number of activities that would have taken place, for example forestry and fauna and flora exploitations by the logging companies and local communities respectively. Those alternative uses within the LNP constitute a second management scenario, the ‘scenario without LNP’. These two scenarios will produce different economic benefits. Identifying and then estimating monetarily these economic benefits boils down to calculating the Total Economic Value (TEV) of each scenario.

The objective of this dual estimation is to examine whether the economic value of ‘scenario with LNP’ is greater than the economic value of ‘scenario without LNP’. The concept of Total Economic Value (Fig.1.1) regroups all the economic benefits deriving from of a ‘natural asset’ and is composed in broad of several categories of values, namely:

- Values of direct and indirect uses which derive from the actual use of the environment, while non-use values are non-instrumental values which are in the real nature of the thing, but non-associated with actual use;
- The option value corresponds to the economic benefits of goods or services that are preserved for future use.
- The values of non-use capture those elements of value that are unrelated to a current, future, or potential use.

1.3 PURPOSE OF THE STUDY

The first objective of this study was to estimate the Total Economic Value of the Lopé National Park through the application of conservation policy (scenario ‘with LNP’).

Secondly, the economic value of this area was assessed based on the non-existence of the national park (scenario ‘without LNP’).

Finally, we investigated how the benefits derived from the use of the area are split among the various ecosystem stakeholders, namely local agents, national agents and international agents. The objective was to establish who the gainers and losers are in relation to the establishment of the LNP.

1.4 SIGNIFICANCE OF THE STUDY

The concept of Total Economic Value (TEV) is a framework for comparing the monetary value of the benefits of two projects, the ‘with’ and ‘the without’. This sort of economic analysis is a comparative tool, which assists decision-making processes where the benefits of different economic alternatives are compared (Lundgren & Bulov, 2007: 12). The study aims at reliably estimating the economic benefits related to the Lopé National Park with the intention of helping to improve the sustainable management of the park in the coming years.

1.5 RESEARCH METHODOLOGY

To fulfil the purpose of this study, the research methodology framework was mainly based on literature studies and technical reports. A wide range of literature was used, including books, relevant journals, published and unpublished papers related to the application of the Total Economic Value. In addition various studies undertaken by the Ministry of Forest, Water, Environment and sustainable Development, the Ministry of Tourism in Gabon, the Centre for

International Forestry Research (CIFOR), the Tropical Ecology Research Institute (TERI), the Forestry Research Network (FORENET) and the Wildlife Conservation Society (WCS) were helpful in providing previous environmental and anthropological surveys, and quantitative data collected within the Lopé National Park. A substantial amount of information was also obtained from the study of Stephane Ango (2007), *Forest depletion and food security in the Lopé National Park*. Telephonic conservations held with Joseph Ngowou (2009; 2010), manager of the LNP proved useful in relation to this study.

1.6 DEVELOPMENT PLAN

- Chapter 1 served as an introduction.
- Chapter 2 presents the theoretical framework on economic valuation and protected areas.
- Chapter 3 provides some background information on the Lopé National Park with a particular emphasis on the legal aspects of the park.
- Chapter 4 presents the methodology, management scenarios of the Lopé National Park and set of hypotheses.
- Chapter 5 examines the values of direct uses within the LNP.
- Chapter 6 focuses on assessing the values of indirect uses.
- Chapter 7 deals with the valuation of both option and existence values.
- Chapter 8 draws the results and conclusions.

CHAPTER 2
THEORETICAL FRAMEWORK OF ECONOMIC VALUATION AND PROTECTED AREAS

2.1 INTRODUCTION

The first section of this chapter provides basic concepts of protected areas and the challenges of economic valuation. The following section gives a description of the total economic value and the values that are included in it. The third section describes some of the most commonly used valuation techniques. Lastly, some common limitations to economic valuation are presented.

2.2 BASIC CONCEPTS OF ECONOMIC VALUATION OF PROTECTED AREAS

2.2.1 Protected areas and ecosystem benefits

A protected area is "an area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means" (International Union for Conservation of Nature (IUCN), 2008: 8). A protected area may be a tropical forest, a cultivated landscape of value, a wetland, a marine area, an alpine region, a savannah, or any number of other types of natural or partially modified ecosystems or any combination of types of ecosystems. Besides, protected areas are classified in different ways depending on the objectives and values for which they are managed. The International Union for Conservation of Nature (IUCN) (2008: 14) provides definitions of categories of protected areas as shown in Table 2.1.

Protected areas provide unduplicated and finite ecological goods and services that have a wide range of social, economic and ecological values. Boyd and Banzhaf (2007: 8) define ecosystem services or goods as elements of nature, directly enjoyed, consumed or used to produce human wellbeing. In addition ecosystem services provide large scale of benefits at several levels (local, regional and global) and to different groups (individuals, corporations and public bodies). These benefits could include recreation and ecotourism, biodiversity conservation, plant and wildlife habitat, carbon sequestration, genetic resources, water supply, protection against natural disasters and so on.

Table 2.1: Protected areas management categories

Categories of protected areas	
Category Ia	Strict Nature Reserve: protected area managed mainly for science. Area of land and/or sea possessing some outstanding or representative ecosystems, geological or physiological features and/or species, available primarily for scientific research and/or environmental monitoring.
Category Ib	Wilderness Area: protected area managed mainly for wilderness protection. Large area of unmodified or slightly modified land, and/or sea, retaining its natural character and influence, without permanent or significant habitation, which is protected and managed so as to preserve its natural condition.
Category II	National Park: protected area managed mainly for ecosystem protection and recreation Natural area of land and/or sea, designated to (a) protect the ecological integrity of one or more ecosystems for present and future generations; (b) exclude exploitation or occupation inimical to the purposes of designation of the area; and (c) provide a foundation for spiritual, scientific, educational, recreational and visitor opportunities, all of which must be environmentally and culturally compatible.
Category III	Natural Monument: protected area managed mainly for conservation of specific natural features. Area containing one, or more, specific natural or natural/cultural feature which is of outstanding or unique value because of its inherent rarity, representative or aesthetic qualities or cultural significance.
Category IV	Habitat/Species Management Area: protected area managed mainly for conservation through management intervention. Area of land and/or sea subject to active intervention for management purposes so as to ensure the maintenance of habitats and/or to meet the requirements of specific species.
Category V	Protected Landscape/Seascape: protected area managed mainly for landscape/seascape conservation and recreation. Area of land, with coast and sea as appropriate, where the interaction of people and nature over time has produced an area of distinct character with significant aesthetic, ecological and/or cultural value, and often with high biological diversity. Safeguarding the integrity of this traditional interaction is vital to the protection, maintenance and evolution of such an area.
Category VI	Managed Resource Protected Area: protected area managed mainly for the sustainable use of natural ecosystems. Area containing predominantly unmodified natural systems, managed to ensure long-term protection and maintenance of biological diversity, while providing at the same time a sustainable flow of natural products and services to meet community needs.

Source: IUCN, 2008: 14.

Brown, Bergstrom and Loomis (2006: 36) offer the following classification of forest ecosystem services and goods within a protected area: Ecosystem goods of forested ecosystems are composed of non-renewable and renewable goods such as mineral fossil fuels and rocks for the former and wildlife and fish (furs, food and viewing), plants (fuel, fibre, food, medicinal herbs), water air soils recreation, aesthetic (e.g., landscape beauty); and educational opportunities for the latter. Among ecosystem services, one can cite services such as:

- Purification of air and water (detoxification and decomposition of wastes);
- Translocation of nutrients;
- Maintenance and renewal of soil and soil fertility;
- Pollardation of crops and natural vegetation;
- Dispersal of seeds;
- Maintenance of regional precipitation patterns;
- Erosion control;
- Maintenance of habitats for plants and animals;
- Control of pests affecting plants or animals (including humans);
- Protection from the sun's harmful ultraviolet (UV) rays;
- Partial stabilisation of climate;
- Moderation of temperature extremes and the force of winds and waves; and
- Mitigation of floods and droughts.

Because ecosystems located within protected areas provide various benefits that have large social and economic impacts at several levels, i.e. local, regional and global, it is important to measure these benefits because they influence the establishment, sustainable use and management of protected areas, as well as the satisfaction of users and non-users. The point of contention with regard to environmental services and goods resides on the pricing of this type of services. Valuing ecosystem services have been the subject of various studies with each one highlighting the difficulty to price them (Pagiola, Von Ritter & Bishop, 2004: 1; Costanza & De Groot, 1997: 253). A number of ecosystem goods and services are not traded on commercial markets and consequently have no evident market value. Stated otherwise, some services and goods are not provided through the market because they are not quantifiable. That is, they cannot be owned therefore access cannot be controlled. This economic bias is referred to as a market failure and it generally occurs when markets do not include the full social costs or benefits of a good or service (King, Gans, Stonecash & Mankiw, 2000: 53). Furthermore, this condition creates an externality that prevents the market to allocate efficiently ecosystem services and the resultant inefficiency often reduces their provision. This situation tends to exacerbate the pressure on the environment and to increase its degradation. The market cannot recognise the economic impact of environmental degradation if ecosystem services do not have a price. The difficulty in measuring ecosystem services and the lack of information about ecosystem functions mean that ecosystem goods and services tend to be undervalued or not valued at all by governments, business and the public (Daily, Polasky, Goldstein, Kareiva, Mooney, Pejchar, Ricketts, Salzman & Shallenberger, 2009: 21). The values of non-market goods and services need to be measured and expressed in monetary terms, where possible, so that they can be weighed on the same scale as commercially traded components. Because society must choose the quantity of goods or services it wishes to conserve *vis-a-vis* other goods or services and within a set of goods, it must also select the desired quantity and quality of different environmental resources. These choices logically imply some form of valuation (Garrod & Willis, 1999: 4).

2.2.2. Issues and challenges of economic valuation

Economic valuation is a type of economic study often needed to determine the net economic consequences of human impacts to ecosystems. It provides a means for measuring and comparing the diverse benefits of a natural habitat and it is used as a powerful instrument to aid and improve their sustainable use and management (Barbier, Acreman & Knowler, 1997: 5). Hence, this method is an attempt to assign quantitative values to benefits generated by the direct or indirect use of environmental services or goods, whether or not market prices are available (Subade, 2006: 137).

The pricing of benefits resulting from the use of the goods and services provided by natural habitats has remained a major issue in ecologic economics. What is the monetary value of benefits provided by ecosystems such as wildlife food, wetlands, nutrient cycling, purification of air and water, soil formation ...? Economists have long recognised that values are measured by considering trade-offs between two situations. Hence, the economic value of a change in ecosystem services is based on preferences or the maximum amount of money that the individual is willing to trade to have the change occur. Economists refer to this amount as ‘willingness to pay’ or WTP (Huguenin, Leggett & Paterson, 2006: S17).

A common difficulty in understanding economic valuation is distinguishing between the intrinsic value and economic value of an ecosystem service or good. Bockstael, Freeman, Kopp, Portney and Smith (2000: 1385) provide the following example: “an economic value estimate is an answer to a carefully defined question in which two alternatives are being compared. For example, suppose a power plant is being considered for a location that would eliminate a swimming beach. Different people can have quite different values for this change, depending on whether they would use the beach, gain from the lower cost of electricity, or both. Economic value measures the amount a person would pay or be paid (in compensation) to be as well off with the power plant as without it. The compensation might be positive or negative. For a non-swimmer who benefits from lower electricity prices, the compensation will be different than for a frequent beach user. These answers do not ‘value the beach’ *per se*. Instead they measure for each person the trade-off that he is willing to make”.

Economists attempt to measure environmental values to understand what allocation of resources would make society ‘best-off’. Estimating quantitative values of ecosystem services helps society understand the trade-offs implicit in resource management decisions. For example, land committed to protected national parks provides biodiversity conservation and ecotourism activities and other services to a community, but at the potential expense of export earnings such as logging and mining.

2.3 TOTAL ECONOMIC VALUE

The term of Total Economic value is an attempt to overcome the traditional evaluation of environmental goods, utterly based on the use values attributed to environmental goods and services provided by ecosystems. The Total Economic Value has as an objective to assure an optimum use of environmental resources, i.e. to allocate resources where they are better used and produce the maximum welfare to society. This method corresponds to the loss of wellbeing that society would undergo if this environment disappeared. Peterson and Sorg first coined the term ‘total economic value’ in 1987 in an essay *Toward the measurement of total economic value*. Other environmental economists, among others Pearce and Turner (1996), then used the expression (Peterson & Sorg, 1987, cited in Cavuta, 2003: 285). The Total Economic Value is not only use value; it is given by the computation of use and non-use values referring to intrinsic benefits, i.e. those deriving from the plain existence of environmental goods. Kutrilla (1985) is the first economist, who identified the total economic value double feature. After Kutrilla various scholars interested in this topic centred their research on the theoretical analysis of the TEV and of its components, and on the empirical analysis to identify the main attributes particularly of non-use value and the different valuation methods (Kutrilla, 1985, cited in Cavuta, 2003: 285). The cost-benefit analysis requires the estimation of the benefits and costs for each expected scenario. Applied to a protected area, the sum of the benefits of every management scenario generates the TEV of this environment. Designing the economic optimal management scenario of a natural habitat requires estimating the benefits from different scenarios, i.e. to establish their total economic values. In theory, the task of valuing the TEV of a forest ecosystem is complex and exhaustive and includes measuring a variety of economic benefits that a natural asset provides to human society. Plottu and Plottu (2007: 52) propose the following definition of the total economical value: The concept of total economic value consists of its use values and non-use values. A protected area’s use values are in turn composed of its direct use values, indirect use values, and option values. Non-use values include bequest values and existence values.

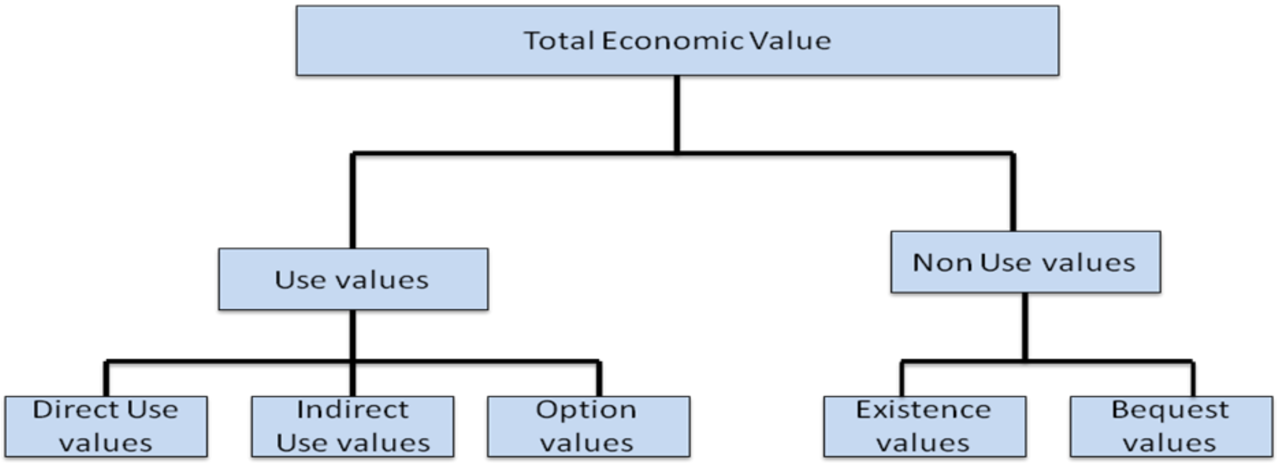


Figure 2.1: Total Economic Value

Source: Plottu and Plottu, 2007: 54.

TEV therefore can be summarised as:

$$TEV = DUV + IUV + OV + XV + BV \qquad ...(2.1)$$

Where:

DUV = direct use values

IUV = indirect use values

OV = option value

XV = existence value

BV = bequest values

The following are brief descriptions of these various economic value categories.

2.3.1 Use values

Use values are made up of direct use values, indirect use values and options values. Direct use values involve some form of direct physical interaction with the good or service (Brown *et al*., 2006: 345). The direct use values of a protected area are values derived from the direct or consumptive use of the protected area for activities such as recreation, tourism, natural resource harvesting, hunting, education and research. These activities can be commercial, meaning they are traded on a market (resource harvesting, tourism and research), or non-commercial, meaning there is no formal or regular market in which they are traded (fuel wood collection and informal grazing). The value of commercial uses will generally be a straightforward process of directly obtaining market-priced values.

The indirect use values of a protected area are values derived from the indirect uses of the protected area. Indirect uses are non-consumptive uses and are mainly comprised of the protected area's ecological functions such as carbon sequestration, watershed protection, breeding habitat for migratory species and climatic stabilisation. These values are often widely dispersed and thus are difficult to measure by markets. Alternative valuation techniques discussed later are necessary for measuring them.

Option value is the risk premium an individual is willing to pay to preserve the option of having an irreplaceable asset, such as a protected area, available for his or her own future use. Option value is estimated by asking people how much they are willing to pay for the option of having future access to a resource. It is relevant when there is uncertainty regarding use and/or availability of the resource, use of the resource is infrequent, and/or it is very costly to restore the resource to its original use once it has been damaged. Weisbrod (1964) used this valuation technique to estimate the cost of preserving Sequoia National Park. Weisbrod states that the social value of the park should be determined by comparing the sum of use value and option value of recreation to the value of harvesting the park's redwood tree. He argues that ignoring the option value of park recreation would result in underestimating the recreational value and increase the likelihood of activities that would degrade the park.

2.3.2 Non-use values

Non-use values, also called 'passive use' values, are values that humans hold for a protected area which are not linked to the use of the protected area. The interest that individuals show for non-use values does not result from the current use or future use but only from the satisfaction that these goods exist and will continue to exist. Non-use values are measured from individual preferences expressed on the market. Non-use values are more difficult to define and measure, and can be subdivided into existence (EV) and bequest (BV) values.

Existence value derives from the knowledge of a resource's continued existence, independent of any use. It represents how much people are willing to pay to ensure that a natural resource is preserved in a particular state beyond its direct use value or option value (Amirnejad, Khalilian, Assareh & Ahmadian, 2006: 666). Positive existence value provides the rationale for not harvesting humpback whales to the point of extinction, preserving Australia's Great Barrier Reef in perpetuity (Prato & Fagre, 2006: 446).

Bequest values relate to the benefit of knowing that others benefit or will benefit from the protected area. Brown *et al.* (2006: 345) define bequest value as the value of knowing that the resource will be available for others, including future generations.

Table 2.2 presents the services that are most likely to be particularly important to protected areas.

Table 2.2: Total economic values of protected areas

Use values			Non-use values	
Direct use value	Indirect use value	Option value	Bequest values	Existence values
Recreation	Ecosystem services	Future information	Use and non-use values for legacy	Biodiversity
Sustainable harvesting	Climate stabilisation	Future uses (indirect and direct)		Ritual or spiritual values
Wildlife harvesting	Flood control			Culture, heritage
Fuel-wood	Ground water recharge			Community values
Grazing	Carbon sequestration			Landscape
Agriculture	Habitat			
Gene harvesting	Nutrient retention			
Education				
Research				

Source: Adapted from Barbier *et al*., 1997.

2.4 VALUATION TECHNIQUES

Various valuation techniques are been developed over the last few decades to express ecological values in monetary terms. These techniques can be divided into revealed preferences and stated preferences.

2.4.1 Revealed preferences methods

Revealed preferences methods are based on actual information revealed in the market places. The term revealed preference is first attributed to Samuelson (1938). The economist suggested that an individual's behaviour could be seen as a series of choices. By comparing observed behaviour with available alternatives, Samuelson suggests that an individual's preferences (or utility function) are inferred (Samuelson, 1938 cited in Varian, 2005:2).These methods are used to identify the best possible option based on consumer behaviour. Essentially, this means that the preferences of consumers can be revealed by their purchasing habits. Some of the more common and widely used methods include:

2.4.1.1 Market prices approach

The market prices method is one of the simplest and most uncomplicated valuation methods. It consists of valuing protected areas goods and services by looking at their market prices, i.e. what they cost to buy or what they are worth to sell. This approach is most regularly relevant to consumptive use, where goods are extracted from ecosystems and traded on markets. Hecht (1999) used market prices to value the goods yielded by mangrove ecosystems in the Indus River

Delta, Pakistan. Fuel wood and fodder use rates by adjacent villagers were quantified, and values were ascribed according to prevailing commodity prices in local markets.

2.4.1.2 Replacement cost approach

The replacement cost approach is based on what it would cost to replace a natural asset that is damaged. Even where protected area (PA) goods and services have no market, alternatives or substitutes can often be bought and sold. These costs are next compared to the costs of preventing the damage. If the replacement costs exceed the prevention costs then the damage should be avoided. Denhardt (2007) estimated monetarily the ecological services of wetlands, more specifically the nutrient retention of river Elbe in Germany. Denhardt, using a replacement cost approach, found that the replacement cost would be in the region of €6.9 million and €20 million (Denhardt, 2006: 35:57, cited in Nunneri, 2008:41).

2.4.1.3 Opportunity cost approach

This method provides an estimate of the value of a protected area based on the foregone income of the best alternative use of the area. Measuring the opportunity cost of the protected area can provide an idea of the competitive threats to the area. In the case of potential threats from people living adjacent to a protected area, the relevant opportunity costs will be the value of alternative land uses they may prefer, such as farming or ranching. Other interest in the area may come from pressures for industrial or urban development, mining or logging.

2.4.1.4 Mitigating expenditures

It is usually necessary to take action to mitigate the negative effects of the loss of PA goods and services to avoid economic damage. These mitigating costs can be used as indicators of the value of conserving PAs in terms of expenditures avoided. Coastal marshes and mangroves are important in shoreline stabilisation, erosion control, flood and storm protection on Mahé Island in the Seychelles. The value associated with these functions was calculated by applying a preventive expenditure approach. In the absence of wetlands services, it would be necessary to construct groynes and flood barriers to offset or mitigate coastal erosion and damage to infrastructure, the cost of which was used as a proxy for the value of coastal marsh and mangrove services (Emerton 1998: 1).

2.4.1.5 Travel costs

The travel cost method is employed to estimate the demand or marginal valuation of recreation sites. Since PAs typically hold a high value as a recreational resource or destination, this technique is mostly used to value the income generated by ecotourism activities. Although entry into many recreation sites is free of charge to view or enjoy natural ecosystems and species, people still spend time and money to reach PAs. This spending can include transport, food, equipment, accommodation and time. The demand for the recreation site can be estimated by observing how the number of visits to the site varies according to the price of this private good. These travel costs reflect the value that people place on leisure, recreational or tourism aspects of PAs. Chen, Hong, Liu, Zhang, Hou and Raymond (2004) used the travel cost method to evaluate the recreational benefits of a beach along the eastern coast of Xiamen Island in China. Based on a visitor survey, the authors found that the total value for the beach and its associated recreation is in excess of US$53 million.

2.4.1.6 Hedonic price approach

The hedonic model assumes that market goods (e.g. houses) have values influenced, in part, by characteristics of neighbouring ecosystems (Wilson & Carpenter, 1999: 775). This approach compares the prices of similar goods to extract the implicit value that buyers or consumers place on the natural asset. The hedonic pricing method is used to estimate economic values for ecosystem or environmental services that directly affect market prices. It is most commonly applied to variations in housing prices that reflect the value of local environmental attributes. It can be used to estimate economic benefits or costs associated with environmental quality, including air pollution, water pollution, or noise, environmental amenities, such as aesthetic views or proximity to recreational sites.

2.4.2 Stated preference techniques

Stated preference (SP) techniques are a family of market research tools that allow researchers to uncover how individuals value PA goods and services. Stated preference methods consist of asking respondents to rank, rate or choose between different hypothetical service scenarios, which are made up of different attribute mixes. The choices made by the interviewees can be used to infer how they value different elements.

2.4.2.1 Contingent valuation

Contingent valuation is an example of a stated preference method. Despite the absence of market value, PA goods and services often have a high value to people. Contingent valuation techniques infer the value that people place on goods and services by asking them directly their willingness to pay to obtain them (or willingness to accept compensation for their loss) under the hypothetical scenario that they would be available for purchase (Portney, 1994: 5). The contingent valuation technique is one of the few methods used to measure option and existence values. Carson (1992) used the contingent valuation method to measure the loss of passive use values arising from injuries to natural resources caused by the Exxon Valdez oil spill. A survey was administered to respondents asking such questions as “Would you be willing to pay $100 (or more, or less) to contribute towards elephant conservation?” and “How much would the cost of your safari have to be reduced by if elephant populations decreased by a half?”

2.4.3 Benefit transfer method

Benefit transfer is a colloquial term referring to the adaptation and use of economic information derived from a specific site(s) under certain resource and policy conditions to a site with similar resources and conditions (Rosenberger & Loomis, 2001: 11). The site with data is typically called the 'study' site, while the site to which data is transferred is called the 'policy' site. Benefit transfer is a practical way to evaluate management and policy impacts when primary research is not possible or justified because of budget constraints, time limitations, or resource impacts that are expected to be low or insignificant.

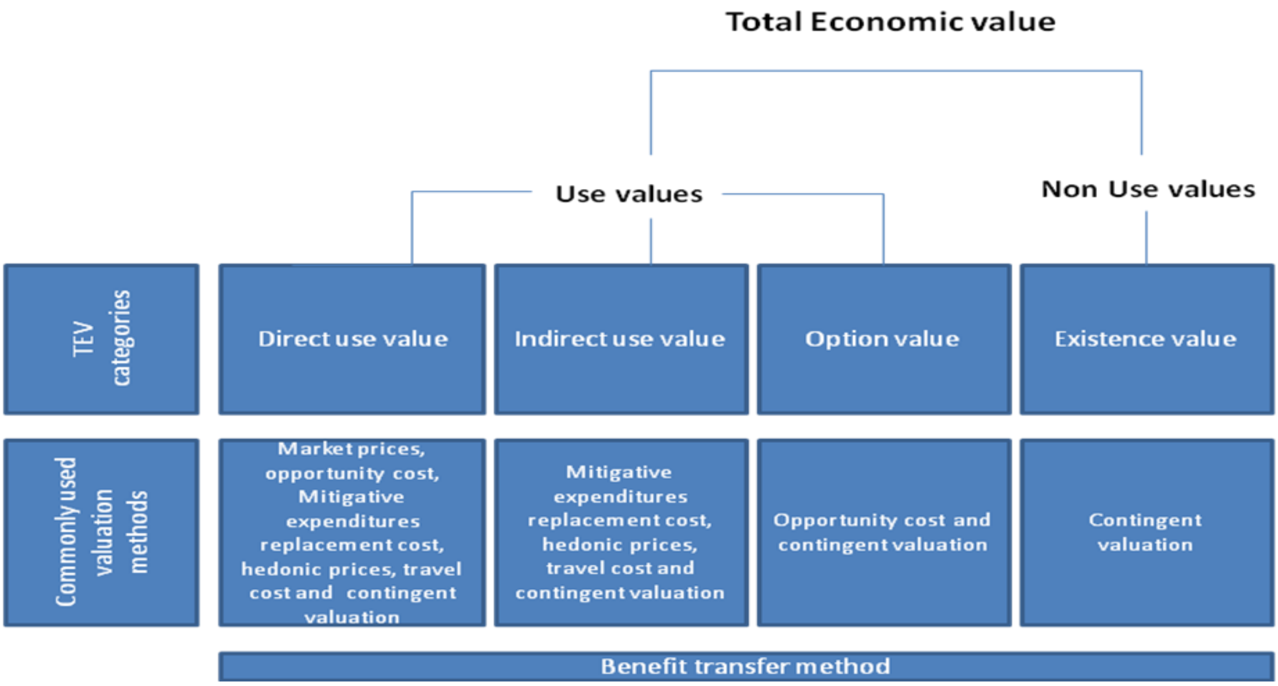


Figure 2.2: Total Economic Value framework

Source: Adapted from Plottu and Plottu, 2007.

2.5 LIMITATIONS OF ECONOMIC VALUATION

Despite the importance attributed to economic valuation in assigning value to biodiversity and ecosystems services as a prerequisite to an efficient resource allocation, it remains that various limitations seem to challenge its usefulness. The limitations of economic valuation occur in the manipulation of data, the choice of the use of ecosystem values and the valuation methods.

Several practical problems appear while applying economic valuation techniques. One that is recurrent is the large amount of data and human resource capacities that are lacking to perform a reliable economic valuation. Hatfield (2002:17) mentions the practical difficulties such as funding, time and capacity constraints in applying valuation techniques such as contingent valuation to protected areas. While valuing mangrove services in Pagbilao bay in the Philippines, Spaninks and Van Beukering (1997: 12-16) argued that the lack of data and quantitative knowledge hindered valuation. This lack of information often causes values to be underestimated (Daily, 1997). Some authors (Driver & Burch, 1988; Cameron, 1992) assert that it is not always practicable to translate environmental benefits such as the value of life or indoor air into dollar values as some information is most likely to be lost in the process. They argue that converting the benefits of ecosystems into a monetary value is complex and underestimates the importance of the environment.

Furthermore, economic valuation is most likely to provide incomplete results as some benefits derived from protected areas will always be unquantifiable, because either the necessary scientific, technical or economic data is not available or because they refer to attributes such as human life, ethical, religious or cultural significance that cannot be attributed a monetary value.

Hitchcock (2000: 23) argues that valuation can provide erroneous reasoning for protected area management when it focuses solely on market values at the expense of non-market values as some of these are difficult to quantify. The inability of valuation techniques to address adequately PA non-use benefits is a particularly debatable issue. Brown and Moran (1993: 1), for example, argue that economic valuation is essentially a utilitarian technique, and has shortcomings in terms of cultural, ethical, intrinsic and primary aspects of value. As a result, a valuation exercise is most likely to be incomplete and undervalued as not all data are taken into account.

Another limitation resides in the inaccuracy of the results and the omission of certain variables while performing an economic valuation. Valuation methods are mainly limited to account for distributional and social issues. Economic valuation is generally based on a particular person or group’s perception about the value of protected area services at a specific point in time. It may not be generally valid, or be able to be extrapolated to different groups, areas or species or over time. Adamowicz and Beckley (1998: 54) show the difficulties of valuing use of forest resources among indigenous communities, citing potential problems such as sacred or taboo goods, variations in property rights and difficulties in aggregating individual responses from indigenous and non-indigenous populations.

The choice of ecosystem services for the purpose of economic valuation is in reality arbitrary as these services are not independent and could not operate alone. This means that finding the total value of all services in a protected area is not as simple as valuing each category and adding them up (Daily, 1997). Moreover, valuation must be performed carefully to avoid double counting. Use of one service may exclude a different service, such as using wetlands for wastewater treatment limiting recreational uses, while some key services are essential to others (Turner, Adger and Brouwer, 1998: 62).

Another limitation of ecosystem service valuation is temporal and geographical specificity. A similar ecosystem could have different values in different settings due to differences in economic activities, cultures, and lifestyles of the local community. Ecosystem values also depend on people’s preferences and current market prices, both of which tend to change over time. Future generations may attribute a different value to a particular service than the current one (Daily, 1997).

The use of direct market values may seem to be the most reliable method. However, various problems subsist with this method. Values incorporating market prices may be unreliable, because many prices do not incorporate externalities or subsidies (the social cost of pollution, for example), thus underestimating the ecosystem services that support those products. Market prices only reflect the cost of using a product and do not take into account the free production of nature (Daily, 1997). In addition, many different markets may place different values on the same thing. Furthermore, markets do not deal with issues of distribution and equity (De Groot, 1992: 89).

There are also questions regarding the use of stated preference methods such as contingent valuation and willingness to pay measures. Bakker and Matsuno (2001: 103) affirm that willingness to pay to conserve a particular natural asset is flawed, as it will appear that income distribution is skewed especially in developing countries, which host the last remnants of biodiversity. That is, those with a lower income have less value for economic services and will therefore be willing to pay less to protect the natural asset. Another argument against stated preference methods is that preferences do not drive behaviour or imply wellbeing. Some think it is better to base decisions on actual behaviour, such as voting. Respondents are most likely to answer based on very little knowledge and may not change their behaviour towards the natural habitat.

Another economic theory issue is the use of discounting. Discounting is based on the principle that an individual would rather have something today instead of in the future. Discounting is a standard practice in economic analyses to determine the present worth of future benefits, but can be problematic with environmental issues. Many feel that ecosystem services, if used sustainably, can last eternally and should not be valued in the same way as man-made products that quickly lose value. Discounting ecosystem services does not consider future generations and may jeopardise the provision of a crucial resource in the future. In addition, ecosystems should not be discounted like man-made products because products can be replaced, while ecosystems generally cannot (Hawkins, 2003: 23).

CHAPTER 3

THE LOPÉ NATIONAL PARK: PRESENTATION AND LEGAL ASPECTS

3.1 INTRODUCTION

This chapter gives an introductory overview of the Lopé National Park. It proposes a brief description of the Lopé National Park and deals with the various legal aspects relevant to the management of the park. The intent is to identify a variety of customary man-made activities that are practised in this forested area.

3.2 OVERVIEW OF LOPÉ NATIONAL PARK

Situated on the equator in the centre of the vast Central African forest block, the LNP is one of the 13 protected areas in Gabon. The forested area is part of the second largest forest block remaining in the world.

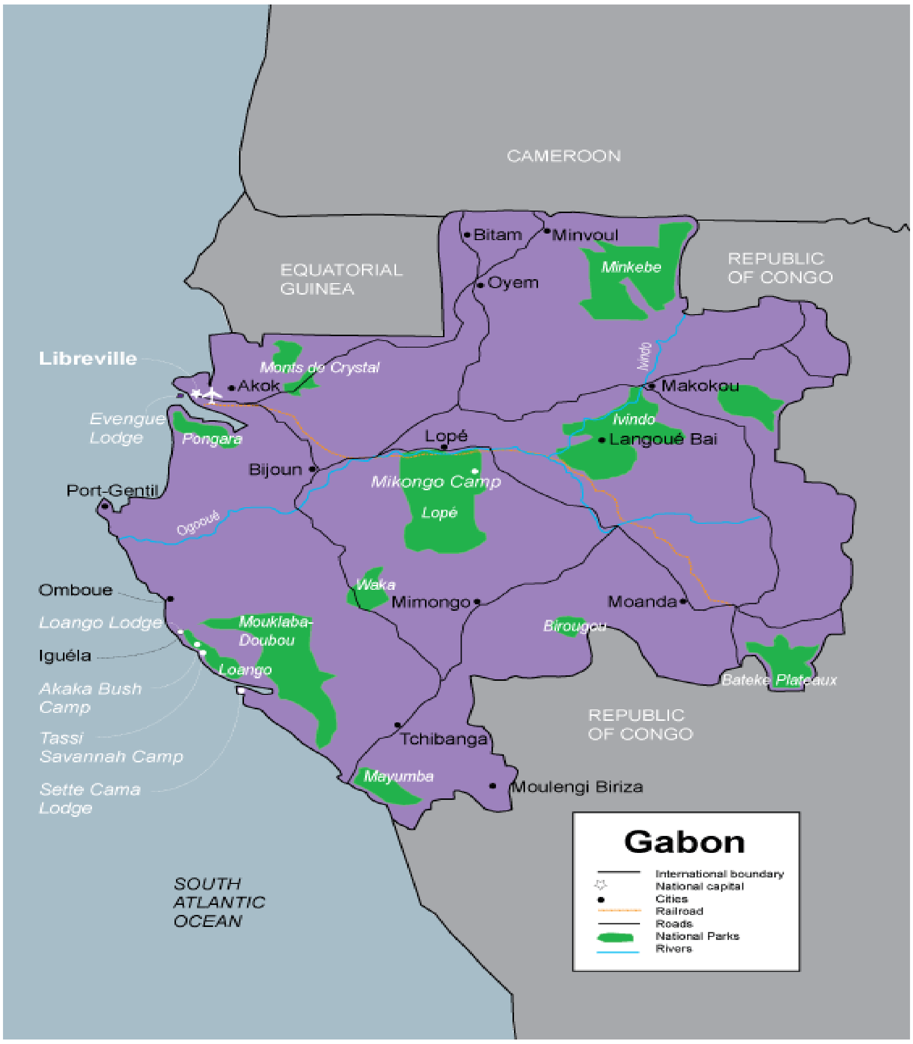


Figure 3.1: National parks in Gabon

Source: Mongabay, 2006.

The park was created in August 2002 by presidential decree and is the symbol of the Gabonese government to protect its tropical rainforest and the fight against global warming. It is recognised as a critical site for conservation by the IUCN and has been proposed as a World Heritage Site. The park covers 491 291 ha and is composed mainly of primary forests that constitute an intermediary type between the Atlantic forest, *Caesalpiniaceous*, and the Congolese forest, *Aucoumea Klaineana* (Vande Weghe, 2006). In 2007, the Lopé National Park was considered as one the most valuable assets and added to the World Heritage List by the United Nations Educational, Scientific and Cultural Organisation (UNESCO), which places it in the same category as the Pyramids, the Great Barrier Reef and the Grand Canyon. On the same token, it joins the small circle of prestigious national parks such as the New Zealand's Tongariro National Park, Peru's Machu Picchu and South Africa's Drakensberg Park.

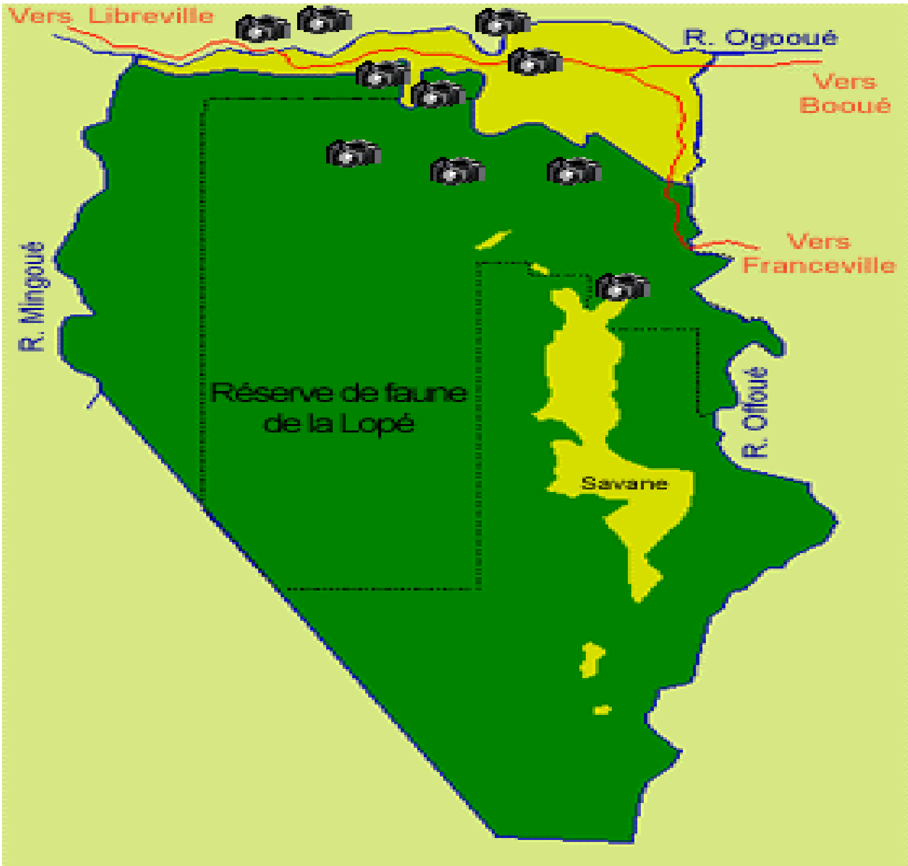


Figure 3.2: Map of Lopé National Park

Source: Mongabay, 2006.

The reserve extends some 120 kilometres south from the Ogouée, the major river of central Gabon. The park has an average width of 45 kilometres, narrowing towards the south. It is centred on the Lélédi river basin between the Mingoué river valley to the west and the Okanda Mountains, extending to the west slopes of the Ogouée river valley on the east, and the Mighakou river valleys in the south. Although the terrain is mostly rain forest in the north, the park contains the last remnants of grass savannas created in Central Africa during the last Ice Age, 15 000 years ago and this represents a unique record of the biological evolution of that time.

The equatorial climate is warm-humid with an equable temperature of around 26°C. However, the annual rainfall at Lopé of 1 502mm, that falls mainly between mid-February and June, is unusually low for its location because it is in the rain-shadow of the *Massif du Chaillu*. There is a three-month dry season between mid-June and mid-September and a shorter dry season from mid-December to mid-February. Within its natural limits and nearly 900m of vertical range, the park contains a large and complete enough series of ecosystems at all tropic levels to sustain its animal populations over the long term. The area is extremely rich with populations of about 4 500 forest elephants, 2 500 gorillas, 2 000 chimpanzees, 50 000 mandrills, 1 000 leopards, Sitatunga, Yellow-backed Duiker, Black Colobus, Grey-cheeked Mangabey, Putty-nosed Monkey, Red-river Hogs, and over 400 species of birds.

3.3 LEGAL ASPECTS OF THE LNP

Estimating the economic benefits of the Lopé National Park (LNP) requires identifying primarily the activities legally authorised inside the park. This boils down to briefly exploring legal texts governing the management of LNP. The LNP is a state-owned forest classified as a protected area. The status of the park is defined by the Forestry Laws Amendment Act 16 of December 2001 (Ministry of Forest, Water, Environment and sustainable Development, 2007). The act stipulates the following points: The national park is a portion of the Gabonese territory in which flora, wildlife, geomorphological and historical sites, as well as other forms of landscape, hold a special protection (art. 75). The LNP is subjected to certain revisable zoning conditions (art. 79). However, the exercise of custom practices such as fishery, hunting and wildlife is formally prohibited inside the conservation area and is subject to strict regulatory regimes. The classifying texts identify the waters and watercourses where the local communities can exercise their customary rights (art. 259).

More specifically, the LNP was classified by the decree 607/PR/MEFEPEPN of August 2002. Its article 8 stipulates, "inside the LNP, touristic activities are organised according to the land-use management plan. All other activities are forbidden within the limits of the national park with the exception of the activities resulting from the customary practices". The conditions of exercise of customary practices with regard to flora and fauna, hunting and fishing are expressed by the decree n°682/PR/MEFEPEPN of August 2004, that enacts chiefly that: the exercise of customary rights is only authorised inside the zones determined by the classifying texts in relation to forests and protected areas or the forestry management plans. These zones, including watercourses, must be sufficient to meet the population’s needs (art. 4). In any case, the exercise of customary rights with regard to hunting and wildlife is officially prohibited in the protected areas of the state-owned forest (art. 7). The exercise of customary rights with regard to fishery is forbidden when it is practised in the protected areas. Nevertheless, the classifying texts of the protected areas determine the waters and watercourses with regard to fishery favouring the exercise of customary rights by the riverside communities of these protected areas (art. 8).

Finally, a law relating to national parks should complete this legal framework before the end of 2009. Article 9 of the law defines a national park as "a protected area established on a portion of territory where land or marine ecosystems, geomorphological and historical sites, and other forms of landscape hold a special protection with the aim to maintain the biological variety and the regulatory processes of natural ecological environments by authorising regulated ecotourism activities, scientific and educational research while contributing to the socio-economic development of local communities". To this end, the law envisions the establishment of "a land management contract between the park manager and the rural communities within the aforementioned outlying zone, which defines the human actions necessary for conserving the biological diversity of the park or its outlying zone with a view to generate economic benefits for the local communities". Outside of these land management contracts, the exercise of customary rights is free in the outlying zones of the national parks (art. 16). Nonetheless, illegal hunting and fishing, chemical poisoning of watercourses and illegal settlements and camping within the national park are strictly punishable (art.60).

These different legal texts depict the activities authorised in a national park with the view to conserving biodiversity and protecting ecological functions, hence only touristic, research and educational activities are accepted. Hunting, fishery, picking and human settlement are strictly forbidden across all national parks. These different practices within the LNP will not be authorised in the medium/long term when a land-use management plan will be drafted and subsequently applied.

CHAPTER 4
METHODOLOGY AND MANAGEMENT SCENARIOS

4.1 INTRODUCTION

This chapter is concerned with the presentation of the methodology that was used for the economic valuation of the Lopé National Park, the management scenarios and the set of hypotheses relevant to this research study.

4.2 PRESENTATION OF METHODOLOGY

The concept of Total Economic Value (TEV) consists in establishing the expected benefits of a natural asset and giving them an economic value. Our approach was composed of four steps:

i) List the benefits of the two scenarios, i.e. to establish the set of benefits that the Lopé National Park (LNP) will bring locally, countrywide and internationally depending on whether the studied area be conserved (scenario 'with LNP') or exploited as prior to the establishment of the park (scenario 'without LNP').

ii) Estimate the economic value of each benefit. The difficulty to calculate the TEV is due to the non-existence of market prices for most of these benefits. It is therefore convenient to resort to specific techniques of economic valuation in order to give them an economic value.

iii) Aggregate the set of these benefits to quantify the TEV of the LNP according to the two management scenarios. This comparison set to analyse how the establishment of the LNP modified the stream of expected benefits due to the preservation of the forested area (Pagiola *et al*., 2004: 1).

iv) Do a global analysis of the distribution of the benefits to identify the groups of actors that are the winners and losers.

Step 1 of this methodology is approached in this chapter. The different types of services are next estimated in the following chapters. A final analysis based on steps 3 and 4 is proposed in Chapter 5.

4.3 MANAGEMENT SCENARIOS

The calculation of the TEV of the LNP contributed to identify the benefits generated by the park before evaluating the income shortfall due to the establishment of the park. It therefore appeared useful similarly to estimate what would have been the TEV of the forested area covered by the LNP if the park had not been created.

To allow this comparison, two scenarios were proposed, the one 'with LNP' where the LNP is set up according to the prevailing regulation, the other 'without LNP' where the protected area of the LNP is exploited according to the customary practices exercised before its establishment. Each of these scenarios generated various benefits and consequently produced different TEVs.

i) Characteristics of the 'scenario with LNP'

In this scenario, the LNP is managed effectively according to the terms of the law. This scenario therefore excludes hunting, fishing and picking inside the LNP. On the other hand, it envisions a number of specific benefits that are represented in Figure 4.1.

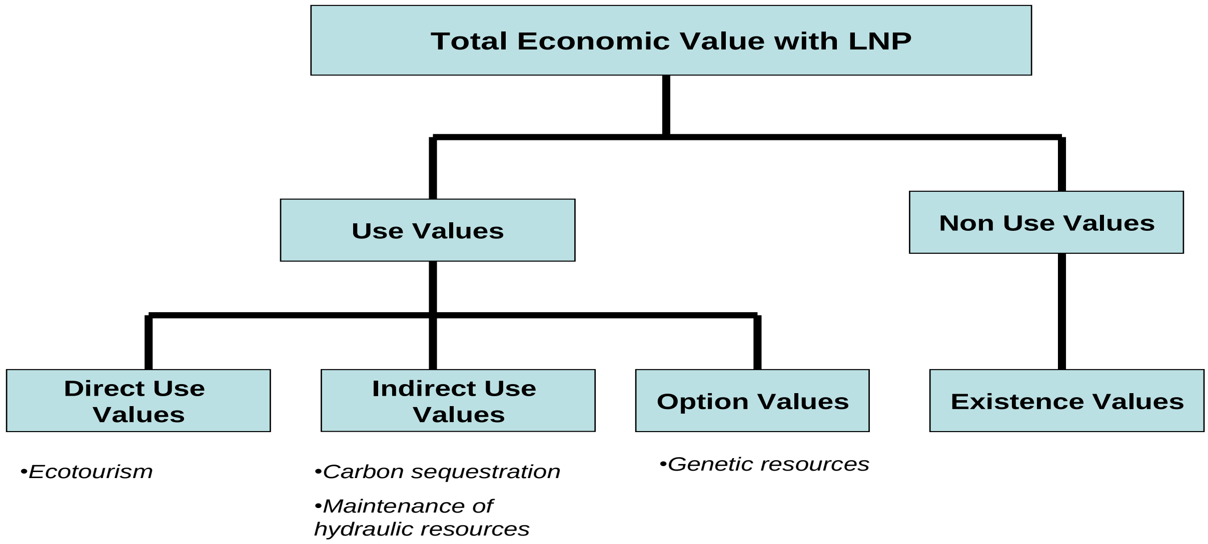


Figure 4.1: Total Economic Value of 'scenario with LNP'

Source: Adapted from Plottu and Plottu, 2007: 54.

ii) Characteristic of the 'scenario without LNP'

The forested area covered by the national park would have produced a number of benefits if the LNP had not been established. These benefits constitute the TEV of this forest space without conservation. It is composed of the following uses:

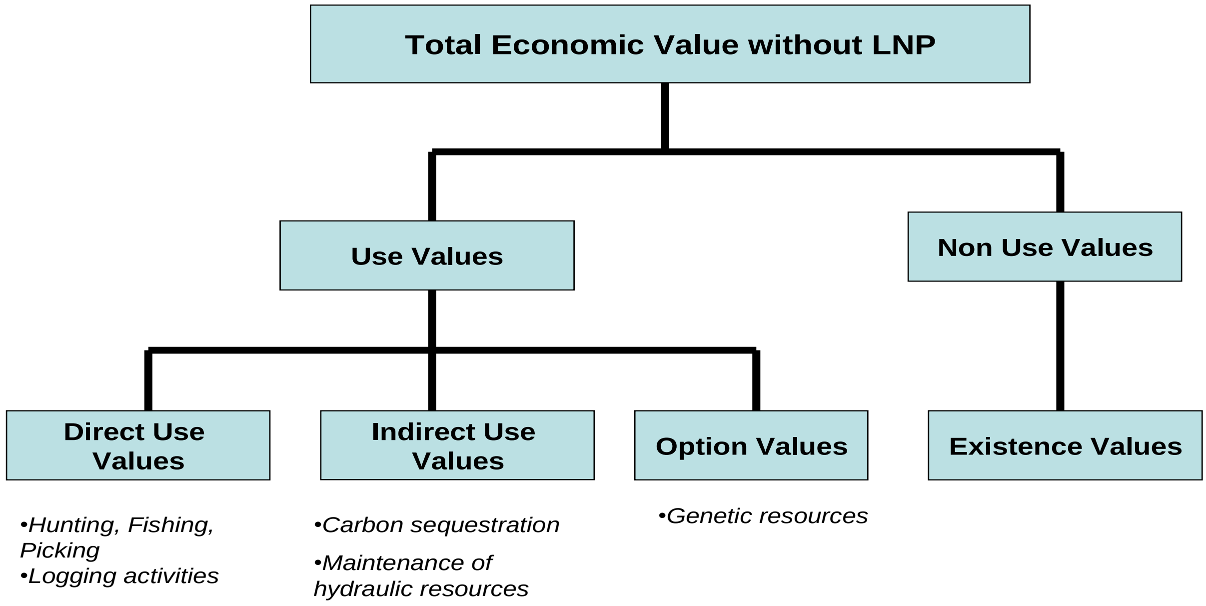


Figure 4.2: Total Economic Value of scenario 'without LNP'

Source: Adapted from Plottu and Plottu, 2007: 54.

In this scenario, we assume that before the implementation of a national park, this forest space would not have produced any benefit in terms of ecotourism and existence value.

4.4 HYPOTHESES

The estimation of these two scenarios requires considering a number of basic hypotheses:

4.4.1 Temporal horizon

It is imperative to set the analysis period during which the benefits will be estimated. One of the critical issues in quantitative research is how long the forecast period should be so that reliable inflow forecast in the period can be used for decision-making. Assuming a shorter period would underestimate the potential conservation benefits of this forest space that tends to occur rather in the long term. Nevertheless, it is equally cautious to avoid setting a longer period analysis since the longer the forecasting period, the more uncertain and less reliable the involved information (Hendry & Ericsson, 2001: 210). As a result, a temporal horizon of ten years is assumed that takes into account the long-term effects while avoiding excessive extrapolations.

4.4.2 Discounting

A $1 profit that happens in ten years does not have the same value today as a profit of $1 that occurs immediately. To reduce this bias, it is necessary to discount the expected benefits to the present time. The discount rate is set up at 12 per cent, based on the economic analysis of the Forest & Environment Sector Programme (*Programme Sectoriel Forêts et Environnement*) (PSFE) of Gabon (Bravi, 2005: 34). A benefit of $100 in year 1 brought back at a present value as of the end of the year zero will have therefore a value of US$112.

4.4.3 Economic and financial analysis

The difference between economic valuation and financial analysis should be made clear at this stage. Economic valuation, based on economic value, measures market and non-market values that people hold for a protected area. Financial analysis is a subset of economic valuation and measures the flow only of money through a protected area. This research study uses economic valuation as a framework because it captures a broader array of values.

This study consists of an economic analysis since it is concerned only with the change of wellbeing due to the creation of the LNP. The market prices used in the estimation of the TEV are based on competitive markets (international timber market, genetic resources, sequestrated carbon, tourism; non-timber forest products market) and have not been adjusted.

4.4.4 Gross or net benefits

The benefits derived from the forested area of the LNP have a 'production cost' that corresponds to the effort consented by an agent to produce this benefit (Pagiola *et al*., 2004: 18). For example, a person who spends a day hunting a *potamochoerus* will have a final benefit equivalent to the economic value of this game. This is gross benefit. To evaluate the net benefit of this activity, it would be necessary to subtract from the gross benefit the allocated time and equipment used to kill this *potamochoerus*. This applies to all the activities practiced within the LNP: the genetic resources must be removed, identified and transformed before being sold; lumber must be spotted, cut down and transported to the factory before being priced; the sale of tons of carbon supposes high transaction costs. However, if it already is difficult to evaluate the gross benefits originating from the management of a given environment, it is even more difficult to estimate its net benefits. This implies having an accurate knowledge with regard to efforts and expenditures engaged by the actors to produce such benefits. Being given the limited time and resource constraints, only an evaluation based on gross benefits was considered.

4.4.5 Estimating flows or stocks

Tropical forests abound with many natural resources used in various ways by humankind. Nevertheless, in comparison with the available quantity of resources in the natural environment, only a small part is removed: Godoy and Lubowski (1992: 426) show, for example, that only about three per cent of the available quantities of non-timber forest products (NTFP) in the Amazonian forest are collected. It is the same for the woody plants of which only a handful are removed for exploitation in Central Africa. It was then essential to specify what information would be useful for our valuation: the resource flows removed by human society or the quantities of available resources in the natural environment that are only potentially exploitable. Whether it is woody plants, NTFPs or genetic resources, this study focused on resource flows and not on stocks.

4.4.6 Measurement unit

The measurement unit that was used for this study is constant US dollar prices of 2009, i.e. without taking inflation into account.

4.5 SUMMARY

These different hypotheses frame and clarify the estimating calculations of the Total Economic Value of the Lopé National Park. This study, as most of the economic estimations in the southern hemisphere, was undertaken under time, resource, financial and data constraints. Furthermore, the study was made possible thanks to various conversations with specialists to debate the hypotheses, improve its quality and to make it credible but it remains largely perfectible. In any case, the calculation of the TEV of a protected area is already a difficult and delicate exercise. To reduce its subjectivity, a set of hypotheses are presented in the following chapters in order to allow the reader to understand how this approach was conceived.

CHAPTER 5
VALUATION OF DIRECT USE VALUES

5.1 INTRODUCTION

This chapter is concerned with valuing the direct use values in the Lopé National Park. Direct use values have been identified in the previous chapters and include all the human activities that occur within the protected area. The first section deals with the economic valuation of non-timber forest products (NTFPs). The second section determines the economic value of timber exploitation. The last section of this chapter deals with the economic valuation of ecotourism activities.

5.2 ECONOMIC VALUATION OF NON-TIMBER FOREST PRODUCTS

This first section is concerned with determining the economic value of NTFPs. NTFPs are considered as any commodity obtained from the forest that does not necessitate harvesting trees. It includes medicinal plants, game animals, nuts and seeds, fur-bearers, berries, mushrooms, oils, foliage, peat, fuel wood, forage, etc. This analysis is only concerned with valuing food resources such as bushmeat and fish depleted within the LNP. The value of direct use constitutes a benefit of the scenario 'without LNP'. Considering the lack of study in measuring NTFPs in Gabon, this valuation will be mostly based on the study conducted by Ango (2007), *Forest depletion and food security in the Lopé National Park*. The objective of the study was to collect exhaustively the different products extracted by the local community within the northern zone of the LNP and determine the daily income generated by these local communities. This study was carried out between January and June 2006.

5.2.1 Local communities and eating habits in the LNP

The zone covered by the LNP has been used as an emigration and settlement spot for human populations, especially the Bapounou, Myene and Fang (Perrois, 1970: 47). Those populations were progressively displaced outside the park and resettled nearby the city of Lopé. They preserve a familiarity with this customary land and still practise a number of wildlife activities, mainly on the shores of the Ogoueé River (Perrois, 1970: 51). The establishment of the LNP modified those local practices since, if one refers to the forest law and to the classification decree, food depletion inside the LNP henceforth is forbidden, even if traditional practices is granted to the local communities on certain waters and watercourses. Nevertheless, no definite measures were taken in relation to the LNP, but the current law still remains comparatively tolerant on the pursuit of fishing activities within the LNP. In the long term, the effective management of the LNP supposes that these extractive practices in the LNP are interrupted, and this income shortfall for the local populations constitutes a non-negligible opportunity cost due to the creation of the LNP.

i) The location

The LNP constitutes a former settlement area of the villages Bapounou that are located in the northern side of the LNP. Three settlement zones are concerned: Ogoulou, Mikongo and Ndoulou that were established alongside the river in the early twentieth century (Ango, 2007). Local communities in this particular area have practised long time activities such as fishing, picking and hunting mainly between the falls of Matandi and Magotsi. Ango identified 60 resource camps alongside the Ogoueé River located between the falls of Matandi and Magotsi.

ii) The exploited resources

A description of the principal resources depleted in the LNP by the local community is presented in Table 5.1.

Table 5.1: Main types of bushmeat depleted

Common name	**Scientific name**
Cane rat	*Atherurus aficanus*
Blue duiker	*Cephalophinae*
White-eyelid mangabey	*Cercocebus*
Guenon	*Cercopithecus*
Greater spot-nosed monkey	*Cercopithecus nictitans*
Water chevrotain	*Hyemoschus aquaticus*
Bush pig	*Potamochoerus*

Source: Ango, 2007: 33.

Table 5.2: Main species of fish

Local name	**Family**	**Scientific name**
Sondo	Characideae	*Alestes macrophtalmus*
Kokosso	Cyprinideae	*Barbus compinei*
Epaka	Characideae	*Brycinus kingsleyae*
Nchema	Characideae	*Brycinus macrolepidotus*
Mpolo	Bagridae	*Chrysichthys auratus*
Koune	Bagridae	*Chrysichthys thysi*
Ebundu	Cichlideae	*Cichlideae spp*
Impussi	Clarideae	*Clarias buthupogon*
Issome	Clarideae	*Clarias jaensis*
Ekuala	Distichodontinae	*Distichodus hypostomatus*
Bongomazoa	Cyprinideae	*Labeo annectens*

Source: Ango, 2007: 39.

Table 5.3: Main species of plants

Local name	Family	Scientific name
Filindji	Styracacea	*Afrostyrax lepidophyllu*
Niabe	Sapotaceae	*Baillonella toxisperma*
Sanga	Begoniaceae	*Begonia*
Pululu	Sapindaceae	*Chytranthus talbotii*
Ngomba	Olacacae	*Coula edulis*
Insia	Burseraceae	*Dacryodes buttneri*
Ihotsi	Euphprbiaceae	*Discoglypremna caloneura*
Ndabitombi	Melastomataceae	*Dissotris*
Ndjangala	Dracenaceae	*Dracena arborera*
Ilezi	Arecaceae	*Elaeis guineensis*
Kumu	Gnetaceae	*Gnetum africanum*

Source: Ango, 2007: 34.

iii) Presentation of the results of investigation

The investigations in the northern camps of the LNP between January and June 2007 permitted the construction of a typology of the camps and an estimation of the intensity of exploitation. During the investigation, only 14 camps were used, which can be classified into three categories shown in Table 5.4:

Table 5.4: Characteristics of the camps alongside the Ogouée River

	Number of camps	Number of collectors	Average income per camp
Short term camping	8	4	$85
Medium term camping	4	2	$45
Long term camping	2	3	$60

Source: Ango, 2007: 9

Both medium-term and short-term camps represent fishermen camps selling river-fish and sometimes bushmeat caught during the week. Those two camps are situated at a moderately short distance to Lopé and allow fishermen to catch fish for 2-3 weeks to sell it in Lopé. The short-term camps generally practise fishing and hunting intensively. These short-camps operate nearby the falls of Magotsi, where fish and bushmeat are in abundance. The activities within those camps contribute to the depletion of a great number of natural resources in the LNP. The various products collected in these 14 camps at the time of this investigation are presented in the following table. The results presented below provide a rather conservative estimation of the food depletion carried out by the local populations in the LNP (Ango, 2007: 38).

Table 5.5: List of depleted NTFPs

Product	Quantity	Unit
Arrowroot	37	Basket
Black-fronted Duiker	7	Piece
Blue Duiker	39	Piece
Bush pig	6	Piece
Chilli	6	Basket
Civet	1	Piece
Collared Mangabey	1	Piece
De Brazza's Monkey	1	Piece
Dwarf crocodile	1	Piece
Filindji	3	Basket
Fish	1 150	Piece
Hocheur	10	Piece
Ianda	1	Basket
Imbambu	45	Piece
Kumu	25	Basket
Lemon	6	Basket
Mandrill	2	Piece
Mouse deer	4	Piece
Mushroom	1	Basket
Nuts	2	Basket
Pangolin	2	Piece
Panther	1	Piece
Peter's Duiker	3	Piece
Porcupine	15	Piece
Prawn	2	Basket
Preuss's Guenon	3	Piece
Python	5	Piece
Turtle	1	Piece
Varan	1	Piece
White-bellied Duiker	12	Piece
Yellow-backed Duiker	3	Piece

Source: Ango, 2007: 36.

5.2.2 Estimation of the direct use value by local community in the LNP

The determination of use value depleted by local community in the LNP was carried out based on these investigation data. However, three main assumptions have been set as the investigation data covered only the second quarter of 2006 whereas our analysis required annual data. The extrapolation of these data is delicate being given the variation of resources and eating habits during the year. Based on the study of Ango (2007) and various interviews with managers of the Institute of Pharmacology and Traditional Medicine (IPHAMETRA), four periods were considered with regard to the seasons, as the local populations are most likely to change their hunting activities. The following hypotheses were formulated:

- The practices change little during the rainy season: the data collected in January to June are similar to the ones of September to November.
- During the dry season of July to August, all the camps are occupied and their practices are similar to long-term camps. Thus, data collected in January to June for the two camps are extrapolated to 60 camps for the period July to August.
- In December, the festive season brings the communities to set 16 camps close to the falls of Magotsi and Matandi. It is assumed that these 16 camps work as long-term camps during the month of December. No other camp is established during this period.
- The income generated by the camps remains the same for the other periods.

Table 5.6: Annual benefits of NTFPs depleted by local population

			Number of occupied camps				Benefit			
	Average hunting days/ month	**Average income/ camp**	**Jan – June**	**July – Aug**	**Sept – Nov**	**Dec**	**Jan – June**	**July – Aug**	**Sept – Nov**	**Dec**
ST camping	24	$85	8	60	8	16	$97 920	$244 800	$48 960	$32 640
MT camping	10	$45	4	0	4	0	$10 800	$ -	$5 400	$ -
LT camping	6	$60	2	0	2	0	$4 320	$ -	$2 160	$ -
Totals							**$113 040**	**$244 800**	**$56 520**	**$32 640**

The gross benefit of these activities in the LNP stands at $447 000. According to Sassen and Wan (2005), despite a significant number of hunting and picking activities within the LNP, there is little depletion of fish, game or plant species and the long-term anthropogenic or man-made pressure on these resources is kept at a reasonable level. However, any decrease of these resources could induce the displacement of hunting and picking activities around the park. The annual estimated benefit for the year 2007 is therefore supposed to remain the same over the next ten years.

Table 5.7: Economic value of the NTFPs depleted by the populations

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Annual benefit	$447 000	$447 000	$447 000	$447 000	$447 000	$447 000	$447 000	$447 000	$447 000	$447 000

5.3 ECONOMIC VALUATION OF LUMBER EXPLOITATION

The forested area of the LNP is a primary forest or old-growth forest with abundantly high quality woody plants that have sparked the interest of logging companies. Without the establishment of the LNP in 2002, this vast territory could have been exploited by logging companies. This section aims at presenting the major forest products that grow in the LNP, as well as evaluating the opportunity cost of logging operations, i.e. the economic valuation of the income shortfall that would have resulted from the continuation of logging activities within the studied area.

5.3.1 The main vegetable formations

There are three principal types of forest within the LNP:

i) Gallery forest with old planted groves in the extensive forest-savannah mosaic of the north and east;

ii) Young forest on former savannah on the forest edge; and

iii) Ancient mature forests on mountain tops in the north.

Forest species grow larger and denser in the succession from the savannah edge through open forests to dense mature forest (White & Abernethy, 1997: 22). This succession is categorised in several types differentiated by the dominant canopy and herbaceous species such as pioneer woodland, the forest edge marked by *Aucoumea kleineana*, a similar forest edge with a Marantaceous herb layer, and denser heterogeneous marginal forest. Towards the heart of the reserve mixed high canopy forest and mature forests occur. All these forests are old or very old. Besides these old forests, there are flooded and swampy forests, as well as some rare forests notably disrupted by former human activities.

5.3.2 Characteristics of former forest exploitation before 2002

The massive presence of okoumé (a specific tree species) and timber products in the spatial area of the LNP has sparked the interest of logging companies for years. Those companies were granted several forest permits in the early 1990s. Table 5.8 shows forest permits in 2002 in the LNP. Those forest permits authorised the industrial exploitation of this forest massif, orientated towards the logging of large-diameter high quality trees. This selective exploitation mainly targeted the okoumé as well as a handful of commercial woody products (padouk, kévazingo, moabi …) (Global Forest Watch, 2000). According to the production inventories, it is possible to estimate the harvest intensity on forests in the LNP over the last years. The logging activities of timber companies such as Rougier, *Société Equatoriale d'Exploitation Forestière* (SEEF) and Winnerpac in the western and southern sides of the LNP indicate an important presence of okoumé harvesting with high-volume production. To the southeast of the park harvesting by the *Companie Equatoriale du Bois* (CEB) is more orientated towards the exploitation of woody products (e.g. kevazingo, andoung, agba).

Table 5.8: Intensity of timber exploitation in the LNP

Main logging companies	Localisation	Exploited area	Exploitation density	Okoumé (%)
Rougier	ZAC 13 and ZAC 14	10 5000 ha	15 m^3/ha	80%
SEEF	PTE 30/99 and 31/99	20 500 ha	11 m^3/ha	80%
Winnerpac	PI 15/95/2	8 800 ha	8.2 m^3/ha	75%
Companie Equatoriale du Bois (CEB)	PI 10/99 (south east of LNP), UFA 2-UFG 2- lot 2- AAC 2	8 765 ha	6.7 m^3/ha	13%

Source: Global Watch, 2000.

5.3.3 Unexploited potential of commercial woody products

The LNP covers a surface of 491 291 hectares of primary forest rich in woody resources with high commercial value. The Ministry of Forest, Water, Environment and sustainable Development in its study *Sustainable Forest Management and Forest Certification in Gabon (2005)* estimated that the logging companies had already exploited about 147 500 hectares industrially in the LNP by 2002. Besides the exploited zones, a non-negligible forest space located in the northwest and southwest of the LNP had been conserved for ecological value since its establishment in 1964 (Chézeaux, 2006: 56). This area is estimated at about 125 235 hectares (Ngowou, 2009). If the exploited zones and the conservation areas are considered, about 218 556 hectares are obtained that would have been exploited in the absence of the LNP.

Table 5.9: Distribution of the forest use for the scenario 'without LNP'

Area of the LNP		
Exploited area	**Exploitable area**	**Conserved area**
147 500 ha	218 556 ha	125 235 ha

5.3.4 Economic estimation of the opportunity cost of forest exploitation

In order to determine the potentially exploitable area of scenario 'without LNP' a number of hypotheses are required:

i) The exploitation of woody resources is undertaken based on the Forest Management Planning Framework that consists of 25 equal annual cutting units: therefore, it is estimated that each year 8 742 hectares (i.e. 218 556 hectares/25 years) will be exploited. It is furthermore supposed that this exploitation is sustained and stable in the long term.

ii) The intensity of exploitation in the forest space of the LNP is presented in the following table.

Table 5.10: Intensity of forest exploitation of scenario without LNP

In m^3	Zone with okoumé (Rougier, SEEF, Winnerpac)	Zone without okoumé (CEB)
Intensity of exploitation/ ha	14	7
With okoumé	11	1
With other hardwoods	3	6

Source: Global Watch, 2001.

iii) The final destination of wood products is similar to current practices in Gabon. The okoumé logs are destined for milling operations whereas hardwoods are sold in their natural state.

iv) Without the creation of the LNP, it is probable that the first exploited zones could have been the ones located in the western side of the park, where previous logging activities occurred before 2002. This area is also rich in okoumé. This zone, with an estimated area of about 45 000 hectares, would be harvested for the first five years of exploitation (8 742 hectares * 5 years = 43 710 hectares). The exploitation could then move to the zone without okoumé for the next five years.

v) With a particular concern for the estimation of benefits of the two scenarios of the LNP, only gross benefits were considered in this study. Rather than the standing timber value that corresponds to gross margin, i.e. after deduction of cost of revenue, the value of finished wood products are used, which is composed of standing timber value added with logging tax. Bravi (2005) provides the values of finished wood products used in this study.

Table 5.11: Estimation of the value of finished wood products

	Okoumé/milling	Other hardwoods
Standing timber value (gross profit margin)/m^3	27	45.8
Management or operating expenses/m^3 (tax inclusive)	60.85	
Value of finished wood products/m^3	87.85	106.65

vi) The price of wood and the management or operating costs are considered fixed.

The consideration of these different hypotheses determines the direct use value of forest exploitation for the scenario 'without LNP':

Table 5.12: Economic value of timber exploitation

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Annual area	8742	8742	8742	8742	8742	8742	8742	8742	8742	8742
Annual volume/ Okoume (m3)	96162	96162	96162	96162	96162	8742	8742	8742	8742	8742
Annual volume/Other hardwoods (m3)	26226	26226	26226	26226	26226	52452	52452	52452	52452	52452
Value of finished wood product/Okoume ($)	87.85	87.85	87.85	87.85	87.85	87.85	87.85	87.85	87.85	87.85
Valueof finished wood product/other hardwoods ($)	106.65	106.65	106.65	106.65	106.65	106.65	106.65	106.65	106.65	106.65
Total value of finished wood products($)	11 244 835	11 244 835	11 244 835	11 244 835	11 244 835	6 361 991	6 361 991	6 361 991	6 361 991	6 361 991

5.4 VALUE OF ECOTOURISM OF THE LNP

5.4.1 Presentation of ecotourism in the LNP

The establishment of 13 national parks in August 2002 by the Gabonese government shows its determination to protect its biodiversity and tropical rainforest. These national parks, however, were also established with the potential to develop ecotourism activities to uplift rural communities financially. This section is concerned with estimating the economic value of ecotourism in the LNP. The park is endowed with a potential for ecotourism (Vande Weghe, 2006; Ango, 2007). With an abundance of primary forests, this forested area corresponds perfectly to the myth of the 'virgin forest' sought by tourists. The LNP possesses a number of tourist attractions including:

- The spectacular falls of Kongou, Mingouli and DjiDji;
- Wildlife and many species that can be observed on certain sites (the '*baï'* of Langoué, for example); and
- An amazing bird fauna that constitutes one of the first attractions around Lopé.

In addition, a certain number of operators are already operating around the LNP to organise tourist activities: The Wildlife Conservation Society (WCS) proposes visits to the *baï* of Langoué and the *Fondation Internationale Gabon Eco-Tourisme* (FIGET) "Giuseppe Vassallo" constructed a vision camp on the falls of Kongou. National and international tour operators such as Mistral Travels or Operation Loango operate these initiatives. However, at the present time, the touristic attractions are not numerous and largely inferior to international standards of luxury 'adventure' tourism.

5.4.2 Estimation of benefits derived from ecotourism in the LNP

Similar to our previous estimations, the economic analysis of these benefits are quantified over a ten-year period. The analysis is based on the current data of tourist attendance from 2006 to early 2008 provided by the FIGET for the falls of Kongou and by WCS for the *baï* of Langoué. In 2008, these two sites attracted about 250 people. On average, these visitors would spend four days on the site. Based on the tariff practised by WCS, it is assumed that each day is billed at 150US$ per person. Several hypotheses are formulated to forecast the ecotourism attendance of the LNP in the next ten years:

- There is no massive investment by foreign operators in the next ten years.
- The wildlife viewing tour of the LNP is only operational in 2010.
- As of 2010 the attendance increases progressively by 15 per cent per year until 2015 and then by 20 per cent until 2018. It is assumed that an improvement of the current camps of Kongou and Langoué would attract more tourists.
- The average duration increases to six days per person as of 2010.
- The daily tariff increases progressively by 15 per cent as of 2010 and by five per cent in the remaining years.

The table below presents the estimations of ecotourism income in the LNP based on the formulated hypotheses.

Table 5.13: Economic value of ecotourism activities

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Number of tourists	250	288	331	380	437	503	578	694	833	999
Number of days	4	6	6	6	6	6	6	6	6	6
Daily tariff ($)	150	173	181	190	200	210	220	231	243	255
Total ($)	150 000	297 563	359 307	433 863	523 889	632 596	763 860	962 464	1 212 704	1 528 008

CHAPTER 6
VALUATION OF INDIRECT USE VALUES

6.1 INTRODUCTION

Tropical forest ecosystems generally develop a number of ecological functions, such as microclimate, regulation of aquatic system, carbon sequestration (Whitmore, 1990: 204). In economic valuation, this comes down to estimating the value of indirect use of the tropical forest. This valuation of the ecological functions is often a difficult exercise due to the multi-complexity of the forest ecosystem, as well as the difficulty of separating these different functions to attribute each of them a monetary value. Various approaches have been created over the recent years to attempt to estimate monetarily the benefits of these ecological functions. In this study, attention was focused on two ecological functions generated by the tropical forest in the LNP, namely: carbon sequestration and the preservation of the quality of aquatic resources.

6.2 VALUATION OF CARBON SEQUESTRATION IN THE LNP

All forests store carbon since the vegetable biomass is roughly composed of 50 per cent of carbon. A biomass growth induces an increase of the carbon sink and inversely a decrease of biomass causes carbon emissions (Mongabay, 2006). In the first case, the forest constitutes a 'well' of carbon; in the second case, global warming increases (Lescuyer & Locatelli, 1999: 58). The Kyoto Protocol proposes several measures to incorporate forest management in the fight against climate change such as the Clean Development Mechanism (CDM). However, for the first Kyoto Protocol commitment period (2008-2012) only afforestation/reforestation projects resulting in a change of allocation of land are eligible under the CDM policy framework: These projects are permitted to obtain units of Certified Emission Reduction (CERs) that can be sold to buyers of the annex I countries. The debate currently is opened to establish whether, for the next period of commitment, the sustainable exploitation of forests will be eligible under the CDM. On this subject, the official position of the Central African Forest Commission (COMIFAC) and the Gabonese government in particular is to include 'avoided deforestation' projects in the CDM. It is therefore conceivable in the near future that forest conservation could benefit from international funding. In reality if this forested area was not protected, it could possibly have been exploited and ultimately have generated greenhouse gases that would have increased global warming.

The economic valuation of this ecological function of the LNP is based on two scenarios:

i) A scenario 'with LNP' where the forested area is protected and the carbon is sequestered in a constant way; and

ii) A scenario 'without LNP' where the forest is exploited for its lumber and generates greenhouse gases.

Due to deforestation, a forest ecosystem transits from a primary forest to a secondary forest, and this change is accompanied by a release of greenhouse gases. The challenge consists therefore to estimate the difference in quantity of carbon stored by the forest between these two scenarios and then quantify a monetary value to this ecological function.

6.2.1 Estimation of biomass carbon stocks

The first step is to estimate the reduction of carbon sink when the forest is subjected to timber exploitation and secondly to determine the actual carbon sink in primary and secondary forest ecosystems. Our hypotheses are presented below:

- Primary forest: It is generally admitted that the quantity of carbon emitted by the breathing of plants and the decomposition of organic matter is almost equivalent to what is required for the ecosystem to produce photosynthesis. A semi-deciduous forest is therefore at equilibrium in relation to entry and exit flows of carbon; it is not a ‘well’ of carbon *per se* but constitutes an important reservoir, which is evaluated at 275 t. C/hectares for the Central African region (Brown & Lugo, 1982: 175; Houghton, 1983: 251).
- Exploited forest: The exploitation of timber and alternative road investments in a primary forest will induce a degradation of this forest massif into a secondary forest (Palm; Tomich, Van Noordwijk, Vosti, Gockowski, Alegre & Verchot, 2004: 143). Very few scientific studies have been undertaken to estimate the level of carbon sequestered in a secondary forest in Gabon. Though studies carried out in southern Cameroon indicate that the carbon sink in this type of forest would stand at about 228 t. C/hectares after exploitation (Palm *et al*., 2004: 151).
- Regeneration in secondary forests: Forest regeneration is the act of renewing tree cover by establishing young trees naturally or artificially, promptly after the previous stand or forest has been removed (IPCC, 2002: 38). The growth of an ecosystem can be estimated from its net primary production, which corresponds to the net quantity of carbon sequestered by a plant thanks to photosynthesis. This will eventually increase biomass and, therefore store carbon. Furthermore, soil organic carbon perturbed by forest exploitation will progressively recover a major part of its carbon sink. Scientists generally estimate that a secondary forest will regain about 2 t.C/hectares per year (Melillo, McGuire, Kicklighter, Moore, Vorosmarty, & Schloss, 1993: 236; Brown & Lugo, 1982: 5).
- Since no studies have been undertaken to estimate the quantity of carbon stored in the primary forest and exploited forest of the LNP, the benefit transfer method that consists in transferring available information from studies already completed into another location was used (Turner, Paavola, Cooper, Farber, Valma & Stavros, 2003: 497). Benefit transfer is often used when it is too expensive and/or there is too little time available to conduct an original valuation study.

These estimations describe the dynamics of carbon sequestration according to our scenarios. In the scenario 'with LNP', the carbon stock is considered to remain constant. In the scenario 'without LNP', it is assumed that the exploitable area is managed under the land-use management policy framework. This exploitable area was estimated at about 218 556 hectares. This exploitation causes the transformation of 8 742 hectares of primary forest into secondary forest every year and releases carbon dioxide in the order of 47 tons per hectare. This differential in terms of carbon stock between the two types of ecosystem is lessened with the regeneration of the forest space (soil and biomass) at about 2 t.C/ha/yr. Applied to the two scenarios, the following estimations are obtained:

Table 6.1: Carbon stocks in primary and secondary forests

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Carbon stock: scenario with LNP	60102900	60102900	60102900	60102900	60102900	60102900	60102900	60102900	60102900	60102900
Carbon stock: scenario without LNP										
Non exploited area	209814	201072	192330	183858	175116	166374	157632	148890	140148	131406
Exploited area	8742	8742	8742	8742	8742	8742	8742	8742	8742	8742
Exploited Area in regeneration	0	8742	17484	25956	34698	43440	52182	60924	69666	78408
Carbon stock: scenario without LNP	59692026	59298636	58905246	58524006	58130616	57737226	57343836	56950446	56557056	56163666
Differential "with LNP"-"without LNP"	**410874**	**804264**	**1197654**	**1578894**	**1972284**	**2365674**	**2759064**	**3152454**	**3545844**	**3939234**

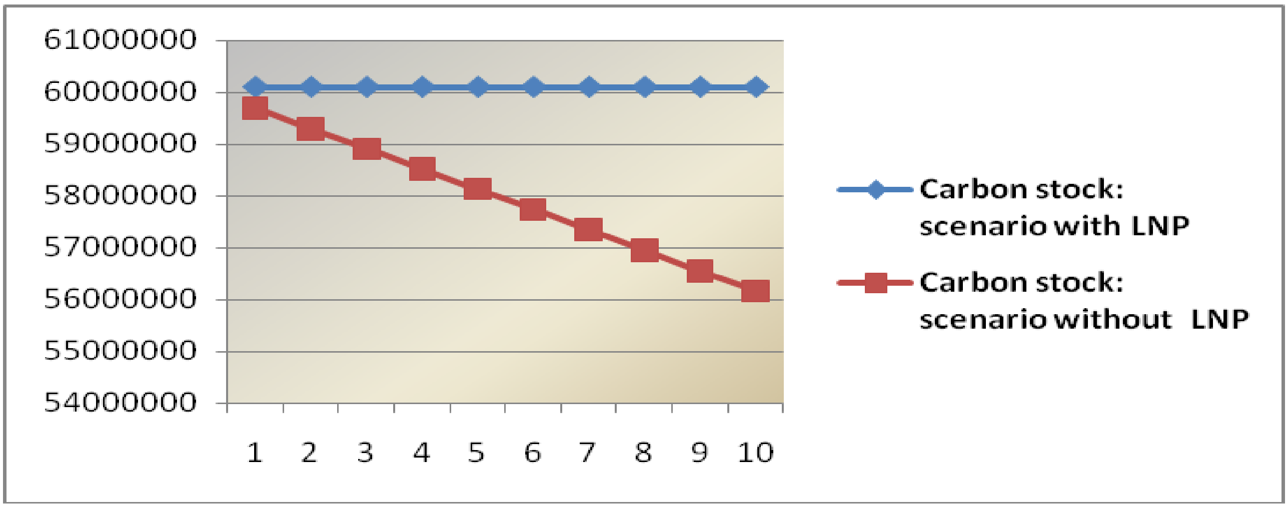


Figure 6.1: Carbon storage in the LNP

This brief representation of the dynamics of an ecosystem disrupted by forest exploitation shows the average quantities of carbon stocked by the forest area in the two scenarios. The differential between these two scenarios illustrates the additional quantity of sequestered carbon in the 'scenario with LNP' in comparison with the estimated carbon stock from an exploited area 'scenario without LNP'. The national park can therefore be assimilated as an 'avoided deforestation' project, potentially eligible to the CDM for the second period of commitment.

6.2.2 The price of a ton of carbon

To determine the value of a ton of carbon sequestered by a tropical forest, economists rely on two indirect environmental valuation methods: the 'dose-effect' method and the replacement cost method (Lescuyer, 2000: 2). The 'dose-effect' method assigns a monetary value to qualitative/quantitative change in the environment by observing the physical consequences of such change. The replacement cost method estimates the value of a natural asset based on what it would cost to replace it (Lescuyer, 2000: 9). Since the consequences of global warming are known, it is possible to establish a link between the current emissions of carbon and the damages it will cause in the future. The sequestration of carbon thus produces an economic value, which can be estimated monetarily. Lescuyer and Locatelli (1999: 11) estimate the marginal value of a ton of carbon at $7 to $30 based on a comparison between costs-benefits expected from greenhouse gas emissions reduction strategies.

Instead of estimating the carbon value from the future economic incidences of global warming, it can be calculated from the expenditures necessary to incur today so as to reduce greenhouse gas emissions in the future (Fankhauser, 1995: 111). Under the Kyoto Protocol, several simulation models of a global emissions trading market were carried out to estimate a global carbon price. According to this approach, the value of a ton of carbon varies between $25 and $60 (Nordhaus, 2008). Beyond these simulations, an important number of carbon transactions have been observed, for example, under the framework of the Kyoto Protocol to the United Nations Convention on Climate Change, officially launched in January 2005 the European Union Emission Trading Scheme (EUETS) the largest multi-national, emissions trading scheme in the world. The price of carbon has varied between €35 and €0.10 over the last five years. Furthermore, several emissions trading markets have been established outside the Kyoto Protocol such as the Chicago Climate Exchange and the New South Wales Greenhouse Gas Abatement Scheme with carbon prices oscillating between $11 and $13 in 2008. These different valuation techniques as well as the observed market prices result in a wide estimation of the 'price' of carbon. To avoid the risk of overvaluation, this study adopted a conservative approach by setting the carbon price at $10.

6.2.3 Economic value of carbon sequestration

The establishment of the LNP preserves a primary forest that would probably have been exploited for lumber. The scenario 'with LNP', while preventing the greenhouse gas emissions, generates an economic benefit. For this benefit to be valued economically, it is assumed that the Gabonese government sells on the carbon market the differential or additional sequestered carbon from the two scenarios. This hypothesis, which does not reflect current practices (the stock of carbon of carbon is sold only once for the whole length of a CDM project) nevertheless presents the advantage of adjusting the estimation of these benefits every year according to changes in the carbon volume and the carbon price.

The differential is calculated between the scenarios 'with LNP' and 'without LNP' and the assumed carbon market price to obtain the following economic benefit is obtained.

Table 6.2: Economic value of the function of carbon sequestration

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Differential "with LNP"-"without LNP"	410874	804264	1197654	1578894	1972284	2365674	2759064	3152454	3545844	3939234
Economic value of carbon sequestered	4108740	8042640	11976540	15788940	19722840	23656740	27590640	31524540	35458440	39392340

It appears in this table that maintaining the stock of carbon in the primary forest of the LNP constitutes a major economic benefit. Nevertheless, carbon offset projects have been met with mixed results for several reasons. The first is due to the fact that projects of 'avoided deforestation' are not currently eligible to the CDM and, being given the debate on this subject, nothing guarantees that this will be the case for the second period of commitment. The second reason is the complexity of structuring such carbon projects due to additional conditions and complexity in determining the appropriate baseline scenario that engenders high transaction costs (Karsenty, Blanco & Dufour, 2002: 48).

6.3 THE MAINTENANCE OF HYDRIC RESOURCES

The conservation of a primary forest supposes the preservation and continuity of many ecological functions that participate directly or indirectly to human welfare. Among these functions, maintaining the quality and quantity of water resources proves to be essential in assuring the pursuit of several human activities:

- Production function: (1) Certain forms of agriculture require an important supply of quality water; (2) the halieutic activities depend directly of the preservation of aquatic habitats; (3) good quality water reduces the rhythm of sedimentation and extends the life cycle of certain infrastructures such as dams or harbours (Lampietti & Dixon, 1995: 58);
- Household consumption function: Supply of clean water to urban and rural population.

By disrupting primary forest, human activities modify simultaneously watershed or catchment area and disturb the quantity and quality of hydric resources. The benefits of these hydric resources is estimated by quantifying the avoided losses of productivity or quality of the production or consumption achieved by the economic actors situated downstream of the catchment area. In the case of the LNP, these benefits are estimated from the environmental damages caused by forest exploitation (scenario 'without LNP') over the functions of production and household consumption of the economic agents situated downstream of the protected area.

6.3.1 A minor influence in the case of the LNP

The LNP is drained by two rivers Djidji and Langoué (Vande Weghe, 2006: 12). Djidji drains the whole central part of the LNP, by almost 50 per cent. The Langoué River drains only the northwestern side of the LNP and it is the most important affluent of the Ogouée on its upright shore. Its rate of flow is equatorial type, minimal in August during the dry season (100m3/s) and maximum in November during the rainy season (1 500-1 900 m^3/s). Waters of the Langoué River have little in sediments and in nutritious matters, but they are acid and saturated in tannins originating from wood decomposition. The quality of these water ecosystems is still almost intact, just as the forest ecosystem that assures its role of plug over flooding (Vande Weghe, 2006: 29). The creation of the LNP guarantees the continuity of these ecological services, at least within the park. The exploitation of the forested area inside the LNP, such as presented in the scenario 'without LNP', suggests an insignificant influence of this activity on waters originating from the watershed:

- The two watersheds in the LNP throw in the Ogouée River and constitute only secondary affluents. The Ogouée River forms the bulk of the hydric volume of the central region and is located outside the park (Hughes & Hughes, 1992: 17). In addition, the Ogouée River crosses regions that remain little inhabited. All degradation of these hydric resources would affect a small number of people.
- The watershed of Langoué covers 62 700 km² of which less than three per cent is located inside the LNP. The presence of human activities in the LNP would therefore have a marginal impact on the river.
- There exist few differences in terms of quality/quantity of the hydric resources between a primary forest and a secondary forest, especially when this one is little perturbed on the medium/long term (Bruijnzeel & Critchley, 1994: 34).

Hence, it is less probable that the continuity of forest exploitation in the LNP could significantly modify the hydrologic services provided by the forest. The two scenarios therefore produce identical benefits and, in our case, the integration in the economic analysis of this ecological function has no effect on the final result.

CHAPTER 7

VALUATION OF OPTION VALUE AND EXISTENCE VALUE

7.1 INTRODUCTION

This chapter discusses the importance of option and existence values in the valuation process of a forest ecosystem. Firstly, an economic estimation of option values is proposed based on the valuation of genetic resources produced within the study area. Secondly, existence values are estimated monetarily.

7.2 OPTION VALUE OR THE POTENTIAL BENEFITS FROM GENETIC RESOURCES

Option value is defined as the price that individuals are willing to pay to preserve an asset for possible use in the future (Plottu & Plottu, 2007: 53). This value is based on the assumption that even if an individual does not benefit directly or indirectly from a natural resource at the present time, he or she can wish to preserve the option to use this resource in the future. In order to keep this option open in the future, he or she is ready to pay a certain sum that corresponds to his or her subjective value of this resource.

Due to of its biological variety, tropical forests constitute the habitat of many known and unknown species that will produce future service or utility. Therefore an economic benefit exists to preserve the tropical forest. Two sectors are directly concerned by the conservation of the genetic resources of a forest ecosystem: The agricultural sector and the pharmaceutical sector, which remain dependent on plant genetic resources to increase the efficiency of their production. Plant genetic resources are, for example, present in a number of therapeutic treatments: about a quarter of the prescriptions of American pharmacies contain one or more ingredients originating from plants (Farnsworth & Soejarto, 1989: 28). The importance of medicinal plants is due to several reasons. On one hand, phytotherapy has had a commercial success over the last ten years. On the other hand, biochemical and pharmaceutical companies have relied on improving the chemical analysis of plant components in order to improve their information database (Swanson,1992: 253). Consequently, it is towards the acquisition of these plant genetic resources that the pharmaceutical industry relies to generate active principles. In 1991 the US company Merck & Co and the Costa Rica National Institute of Biodiversity (INBio) entered into a benefit sharing agreement to collaborate in the investigation of the existent biodiversity in Costa Rica's tropical forests in order to establish its potential applications to human health and animals. Similar agreements have been signed between pharmaceutical companies and countries with access to plant genetic resources (Trommetter, 2005). This is also the case in Gabon with the Non-Governmental Organisation (NGO) Pro International Natura.

7.2.1 Estimation of the economic value of genetic resources

It is difficult, from current market data, to estimate the economic value of the unknown plant genetic resources because the variety of the plant genetic resources in tropical forest has been the subject of only a restricted number of ecological and taxonomical studies. Nevertheless, several methods are proposed in the literature to evaluate the pharmaceutical future use of the plant genetic resources of tropical forests. Principe (1989) is the first one to have provided such estimations that aims to quantify the economical loss due to the disappearance of this type of resources for the pharmaceutical industry. He proposes to calculate the market value of future medicines derived from those genetic resources with the view of estimating the number of lives that these new treatments could save in the future. Principe concludes that valuing tropical genetic resources does not provide specific indication on the economic value of the ecosystems that contain these resources and are then of little use in helping the decision making by forest managers.

Other valuation methods were proposed in the literature. Ruitenbeek (1990) envisions the possibility of using the contingent valuation method in order to measure forest consumers' willingness to pay to preserve genetic resources. He estimates, for example, an annual revenue of $0.7/hectare that can be derived from the park of Korup in Cameroon for the future exploitation of its genetic resources. By varying assumptions on the number of threatened species, the number of medicines based on the vegetable types and the number of hectares to possess these medicinal plants, Pearce and Puroshothaman (1992) estimate the value of tropical forests for medicinal resources between $0.01 and $21/ha per year.

Adger, Brown, Cervigni and Moran (1995) quantify the value of pharmaceutical options of Mexican forests at $6.4/ha per year. Finally Southgate (1998) reviews most of the studies in South America on the value of genetic resources used by the pharmaceutical companies and indicates that this value is generally inferior to $15/ha per year.

There exists nevertheless an important controversy on the validity of these approaches. These authors point to numerous uncertainties in their analyses, with regard to the discovery rates of active principle carriers, the income generated by these new medicines or the sharing profit between producer and country of origin or source of genetic resources. To avoid such uncertainties, this study based its economic valuation of the genetic resources of the LNP on an existing development study of genetic resources in Gabon, namely, the Biodivalor project.

7.2.2 The Biodivalor project

The Biodivalor project was initiated in 1997 as a partnership between the NGO Pro International Natura and the Institute of Pharmacology and Traditional Medicine (IPHAMETRA). Its main objective was the establishment of contractual agreements with industrial corporations (pharmacology, cosmetology) likely to bring added value to the medicine manufacturing of genetic resources collected from the Gabonese forest. In this project, the IPHAMETRA was responsible for harvesting and manufacturing the genetic resources, while Pro International Natura, as the exclusive representative of the Gabonese republic, prospected the pharmaceutical companies and managed the trading contracts. The profits generated by the sale of botanical samples and the exploitation licence and the use of patents regarding the genetic plant resources were divided in half between the Public Treasury and a special ecological development fund. The cooperation between Pro International Natura and the IPHAMETRA ended in December 2003. Between 1998 and 2003, several trading contracts were established; the sales of these contracts are shown below:

Table 7.1: Sales of Biodivalor project

Contract pharmaceutical companies	Products	Total
Dior	420 kg of Okoume resin	$53 000
Aventis, Fabre, Novartis-Syngenta	2 100 samples	$125 000

Source: Pro Natura International , 2003: 26.

A major part of the samples was collected in the region of Lopé because of the quality of the surrounding forests and treatment capacity of the IRET station (*Institut de Recherche en Ecologie Tropicale* (Tropical Ecology Research Institute)).

7.2.3 Existence value or economic value of genetic resources in the LNP

The Biodivalor project showed that the forest around Lopé abounds with genetic resources with short-term and long-term values. At the request of Pro International Natura, in 2003 Calan Ramolino, a research department conducted a forecast on the sale of genetic resources based on the results obtained by the Biodivalor project. One of the scenarios was also to prospect these genetic resources in the zone of Lopé. The sale forecast of these resources is presented below:

Table 7.2: Projected sales of okoumé resin and genetic plant samples

	Year 1	Year 2	Year 3	Total
Sale of okoumé resin (250 kg/yr)	$27 500	27 500	27 500	82 500
Sale of plant samples (2 000 and then 400 samples/yr)	$120 000	24 000		144 000
Total	147 500	51 500	27 500	226 500

Source: Pro Natural International, 2003: 49.

These data contribute to determine the economic value of genetic resources in the context of the creation of LNP. This methodology was adopted based on interviews with specialists of the Institute of Pharmacology and Traditional Medicine (IPHAMETRA), which enabled the development of this valuation approach to genetic resources. Similar to the previous valuations, two scenarios are assumed: Scenario 'with LNP' and scenario 'without LNP'.

In the first scenario, the LNP appears to be in a position to carry out the extraction of plant samples since the station IRET has the technical resource to execute the task. On the other hand, the annual production of 250 kilogrammes of okoumé resin appears outside the reach of the administrators of the LNP since already, at the time of the Biodivalor project, the IPHAMETRA admitted that conducting such tasks widely surpassed its supply capacity (Pro International Natura, 2001). It was assumed that such a quantity of okoumé resin can only be produced in partnership with a forest company, that would integrate this activity in its exploitation plan.

Based on this methodology the following hypotheses were considered:

- A timber company can only do the production of okoumé resin. This assumption is attached to the scenario 'without LNP' and considers the sale forecast of the research department Calan Ramolino Gabon (250 kg per year sold each at $110).
- The prospecting and the sale of plant samples are carried out in the framework of the LNP that preserves an important pool of genetic resources. The sale forecasting of plant samples by Calan Ramolino Gabon are also considered for our study: 2000 samples in the first year and 400 samples in the second year (sold each at $60).

The table below presents the estimations of the sale of the genetic resources in the two scenarios with and without LNP based on the formulated assumptions.

Table 7.3: Option value of genetic resources with LNP

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Sale of genetic plants	$120 000	$24 000	0	0	0	0	0	0	0	0

Table 7.4: Option value of genetic resources without LNP

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Sale of okoumé resin	$275 000	$275 000	$275 000	$275 000	$275 000	$275 000	$275 000	$275 000	$275 000	$275 000

7.3 EXISTENCE VALUE OF THE LNP

The concept of existence value reflects the benefits people receive from knowing that a particular environmental resource, endangered species, or any other organism or thing exists. The interest that individuals show for the intrinsic value of these goods or services does not result from its current or future use, but only from the satisfaction of keeping these goods or services from becoming extinct or damaged. However, existence values are difficult to estimate because they suggest the use of contingent valuation methods that consist to know the willingness to pay to preserve these natural goods or services. However, because of its theoretical presuppositions and of its numerous hypotheses, the contingent valuation method is delicate to handle in the rural African context (Lescuyer, 1998: 119).

These empirical difficulties explain why most of the valuations concerning tropical forests were carried out in the developed countries. Kramer and Mercer (1997) estimated that the willingness of American households to pay on average to preserve five per cent of tropical forests amounted to $21 to $31. However, these results appear rather controversial since the effect size was not tested: It is likely that the responses would have been almost identical if the scenario proposed the protection of five per cent or of twenty per cent of the areas of tropical forests (Kramer & Mercer, 1997: 208).

Turpie (2003) used the contingent valuation method to measure the willingness of households in the Western Cape to pay for biodiversity conservation. Turpie found that the willingness to pay was relatively high: $58 million per year for national conservation and up to $15 million and $263 million per year when the predicted impacts of climate change is added in the survey. Nevertheless, the author concluded that the study may be limited by constraints and disparity of income levels in the Western Cape. In all, if such an approach can reveal the sensitiveness of populations over the fate of tropical forests and biodiversity conservation, the use of the results of existence values are increasingly difficult to quantify and to defend, particularly in developing countries, where basic human needs and economic growth are the overriding factors (Van Wilgen, Cowling & Burgers, 1996).

Despite the difficulty to use contingent valuation in rural settings, the existence value of a natural asset can be estimated from the funding that this asset is likely to receive (OECD, 1995). This approach is obviously not entirely conclusive since it only takes into consideration the value given by the economic actors, but this can be useful in determining a minimal estimation of this type of benefit. This method has been little applied in Africa because the estimations of the existence value of natural assets are not largely available. Moreover, these estimations have not yet been conducted in Gabon. It is therefore by identifying the funding granted by the international community to the LNP in favour of biodiversity and forest conservation that a minimal existence value is quantified.

The LNP was established without knowing with exactitude what species or natural sites constituted an intangible source of wellbeing for the local economic actors and non-residents. Yet, several animal species and landscapes in the LNP present an important existence value for both the local and non-native populations (Mazzocchetti, 2005; Sassen & Wan, 2005).

In addition, to embody the myth of the ‘virgin forest’, the LNP presents a number of symbolic natural elements: Old-growth forests and beautiful landscapes; and various animal species. The richness of flora and fauna mostly explain the international financial support of the last few years to strengthen biodiversity conservation in Gabon. The funds granted to the LNP can be assimilated to the international community’s willingness to pay to protect and increase knowledge of this tropical forest area. These specific funds are presented in the following table. They represent the current and expected funds to support Gabonese national parks in the long term.

Table 7.5: International funding of the LNP

International financings- International donors and projects	**Recipients**	**Duration**	**Total ($)**	**Share of LNP**
European Union: Rehabilitation and development of the Tropical Ecology Research Institute of Lopé	IRET-CIFOR	4 years	2 618 000	2 618 000
AFD: support to national parks in Gabon	ECOFAC	5 years	5 800 000	1 500 000
USAID-CARPE II – CBFP Landscape n°8	WWF-WCS	3 years	652 000	652 000
Financial contributions to International Gabon-Ecotourism Foundation	FIGET	3 years	250 000	250 000
MacArthur foundation: Assessing the human welfare effects of establishing protected areas for biodiversity conservation	WCS	7 years	405 000	100 000
US Fish & Wildlife Service: *Formation des écogardes*	WCS		40 000	40 000

Source: Ministry of Forest, Water, Environment and sustainable Development, 2008

On a ten-year basis, the international funding amounts on average to $516 000 per year, which represents about $1.05 per year for every hectare of the LNP. This estimation of the existence value by the international community as to the richness of the LNP deserves to be completed by more relevant estimation studies on the national and local population using a valuation contingent method.

CHAPTER 8
RESULTS, DISCUSSION AND CONCLUSION

8.1 ESTIMATION OF TOTAL ECONOMIC VALUE OF THE LNP

The different expected benefits based on the two management scenarios of the area covered by the LNP permit an estimation of the Total Economic Value of the park. In the case scenario with LNP, the main benefits result from ecotourism, carbon sequestration, genetic resources and non-use. According to the formulated assumptions, these benefits will fluctuate as indicated in the following table:

Table 8.1: Valuation of the benefits of the scenario with LNP

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Ecotourism Benefit	150000	297563	359307	433863	523889	632596	763860	962464	1212704	1528008
Carbon sequestration benefit	4108740	8042640	11976540	15788940	19722840	23656740	27590640	31524540	35458440	39392340
Genetic resources benefit	120000	24000	0	0	0	0	0	0	0	0
Non-use benefit	650000	650000	650000	650000	650000	650000	650000	650000	650000	650000
Total	**5028740**	**9014203**	**12985847**	**16872803**	**20896729**	**24939336**	**29004500**	**33137004**	**37321144**	**41570348**

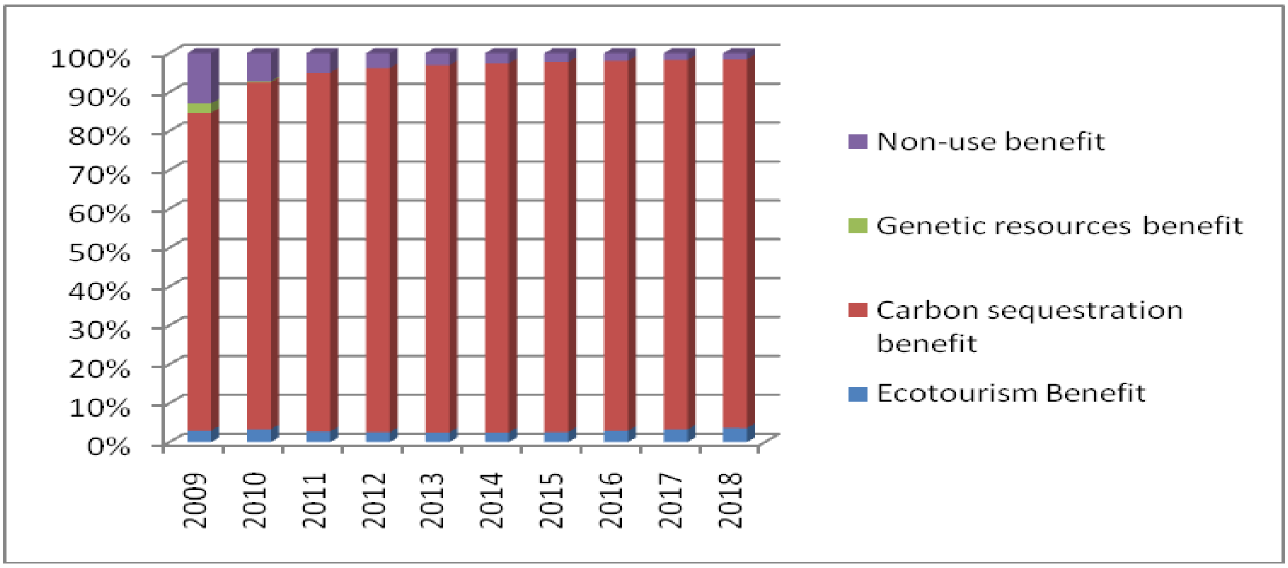


Figure 8.1: Evolution of benefits of the scenario with LNP

These benefits increase linearly to reach nearly $42 million in year 10. The discounting rate of 12 per cent per year of these benefits estimates the TEV of the LNP at $109 481 024. The bulk of the TEV results from the valuation of carbon sequestration.

The scenario without LNP presents the benefits derived from the study area if the LNP had not been created, i.e. the benefits derived from forest exploitation, the depletion of non-timber forest products and the sale of okoumé resins. These three types of benefits are presented in Table 8.2 and their evolution in the Figure 8.2.

Table 8.2: Valuation of the benefits of the scenario without LNP

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
NTFP Benefit	447000	447000	447000	447000	447000	447000	447000	447000	447000	447000
Forest exploitation benefit	11244835	11244835	11244835	11244835	11244835	6361991	6361991	6361991	6361991	6361991
Okoume resin benefit	27500	27500	27500	27500	27500	27500	27500	27500	27500	27500
Total	**11719335**	**11719335**	**11719335**	**11719335**	**11719335**	**6836491**	**6836491**	**6836491**	**6836491**	**6836491**

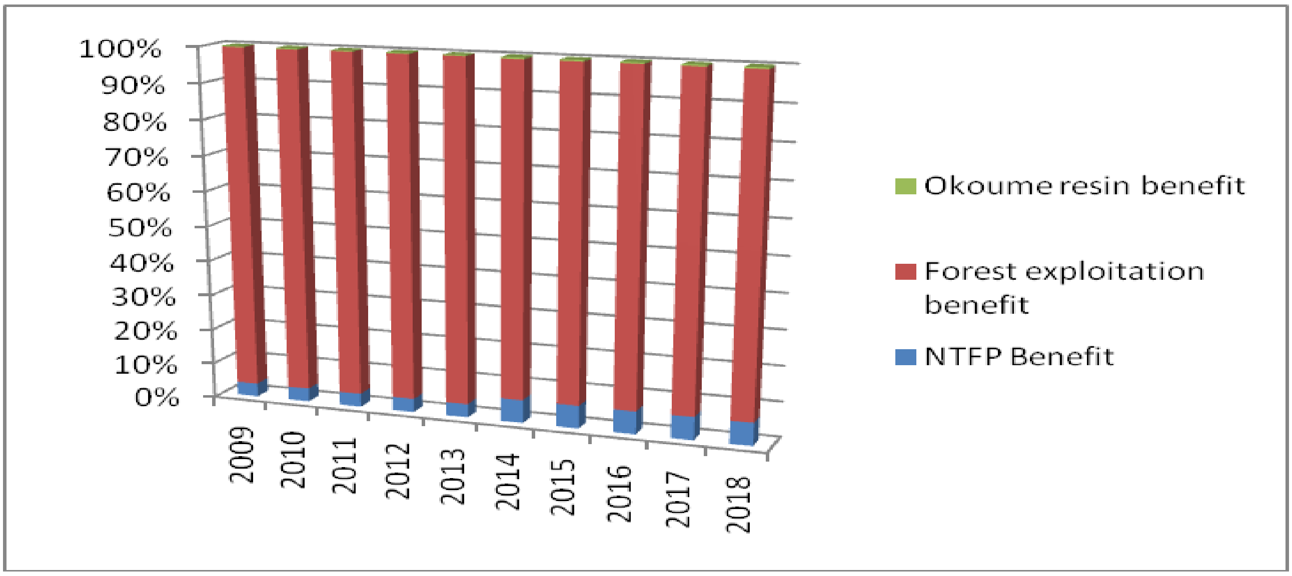


Figure 8.2: Evolution of benefits of the scenario without LNP

The benefits expected from the scenario ‘without LNP’ strongly depend on the forest exploitation: The transition from timber exploitation to hardwood products in year 6 significantly reduces the economic value of this scenario. If in the first two years the total benefit of the scenario without LNP is superior to the scenario with LNP, this is quickly reversed in the following years to produce a large difference between the two scenarios in year 2010. The discounting of the benefits of the scenario ‘without LNP’ estimates the TEV of the forest area of the LNP at $56 229 259.

The comparison of the two TEVs of the use of the area of the LNP clearly indicates a greater economic value of the scenario with LNP over the scenario without LNP. According to this analysis, the establishment of the LNP generates more human welfare than the option without LNP.

Table 8.3: Discounted benefits of the two management scenarios

Discounted Total Economic Values	TEV
Scenario with LNP	$109 481 024
Scenario without LNP	$56 229 259

These results show the importance of the benefits of the scenario with LNP, which is the result of the conservation of biodiversity and the fight against climate change. These benefits contribute in preserving a primary forest that captures greenhouse gases, while the exploitation of its lumber would generate a release of atmospheric carbon that is harmful to human population. Nonetheless, this global economic benefit is not yet integrated in any compensation mechanism under the Kyoto Protocol, which means that the economic wellbeing that it generates is not yet translated into a financial benefit. Consequently, it is interesting to simulate what the TEV would be of the scenario with LNP if this global benefit were not taken into account. This simulation is presented in Figure 8.3 below:

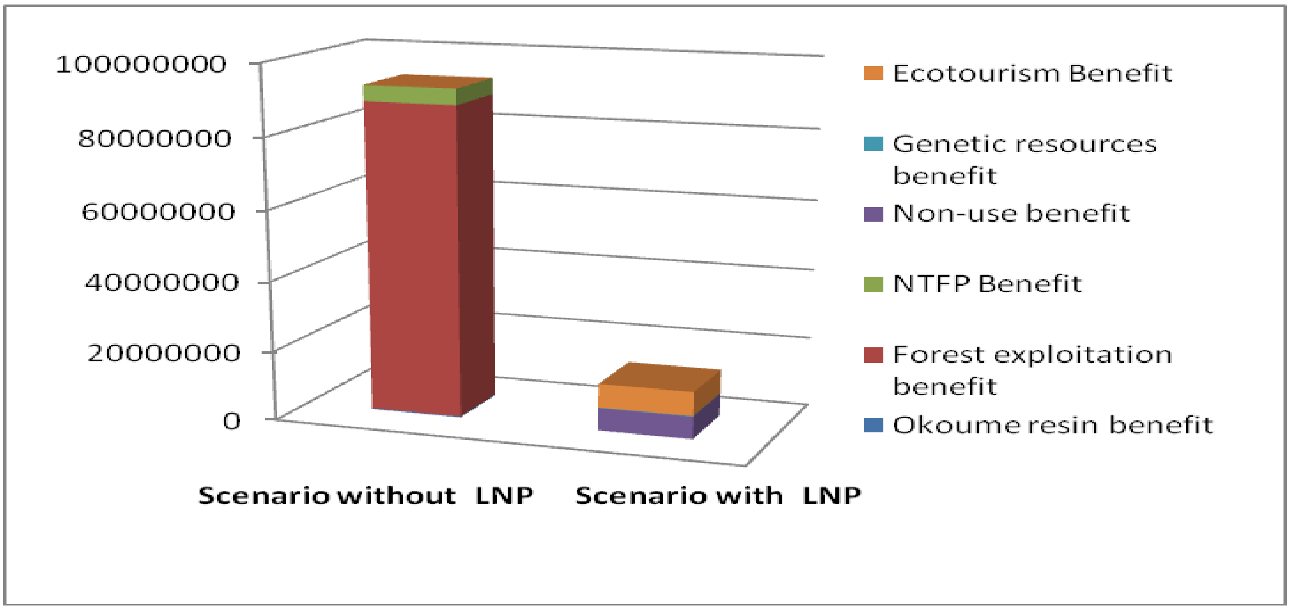


Figure 8.3: Total benefits of both scenarios excluding carbon sequestration

The comparison of the total benefits (without discounting) of these two scenarios indicates a reversal order: Without considering carbon sequestration, it is the scenario 'without LNP' that generates a greater economic benefit mainly due to timber exploitation. This observation is very frequent in economic analysis applied to tropical forests (Pearce & Pierce, 2001): Conservation is only economically attractive if the ecological functions, notably the capture of carbon, can be economically identified and, if possible, remunerated. Finally, we notice that in the scenario with LNP the value of non-use surpasses by far the value of ecotourism activities.

8.1.1 Benefit distribution

Four groups of actors take advantage of the benefits from the management the LNP:

i) The Gabonese state that receives a revenue from the exploitation or conservation of the LNP;

ii) The local populations that deplete the NTFPs;

iii) The private operators that use the LNP to produce goods and services;

iv) The international community that benefits from the sequestration of carbon.

The roles of these different actors vary according to the expected benefit. The objective is to give a short analysis regarding the distribution of these benefits. The benefits in this study are divided as follows:

- Ecotourism: The private tour operators that organise ecotourism activities in the LNP absorb half of the ecotourism benefits; 25 per cent of the benefit goes to the local communities working locally on the ecotourism circuits; and 25 per cent goes to the Gabonese state that collects taxes off ecotourism revenue.
- Carbon sequestration: The international community is the main beneficiary of this global service; 10 per cent of the benefits goes to the private operator that will set up the remuneration mechanism of avoided deforestation.
- Genetic resources: The international community receives 75 per cent of this benefit and 25 per cent goes to the Gabonese state who channels it to scientific personnel for the collection of genetic resources and transformation of genetic equipment.
- Non-use benefits: 100 per cent of this benefit goes to the international community.
- Village uses: 100 per cent of this benefit goes to the local population.
- Forest exploitation: The private operator receives 33 per cent of this benefit, the state receoves 33 per cent (in the form of a tax and concession), and the populations receive 33 per cent (job creation).
- Okoumé resin: 75 per cent of this benefit goes to the international community that purchases these products and 25 per cent goes to a private operator (exploiter) that provides these genetic resources.

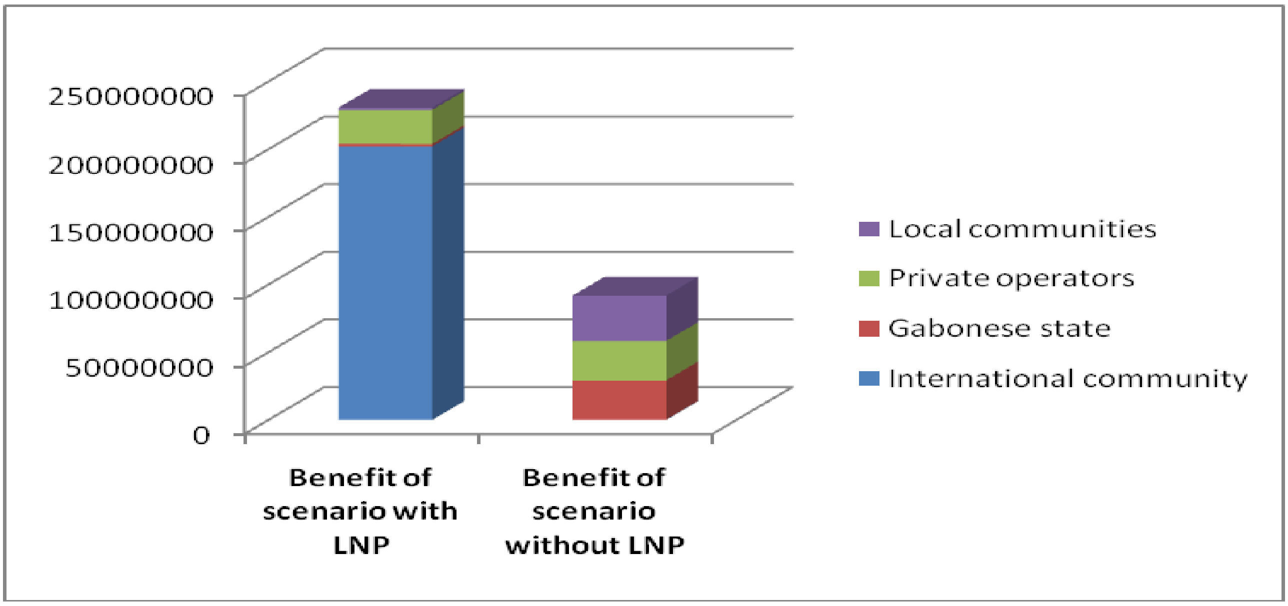
This distribution is presented in Table 8.4.

Table 8.4: Key distribution of benefits among stakeholders

	International community	Gabonese state	Private operators	Local communities
Ecotourism benefit	0%	25%	50%	25%
Carbon sequestration benefit	90%	0%	10%	0%
Genetic resources benefit	75%	25%	0%	0%
Non-use benefit	100%	0%	0%	0%
Local depletion benefit	0%	0%	0%	100%
Forest exploitation benefit	0%	33%	33%	33%
Okoumé resin benefit	75%	0%	25%	0%

Applied to both scenarios, the distribution grid produces an income distribution depicted in Figure 8.4.

Figure 8.4: Global benefit distribution of both scenarios among stakeholders



The scenario without LNP divides equally the benefits among the state, populations and private operators. The scenario with LNP benefits mainly from the international community. Therefore, if the scenario with LNP gives the higher TEV and consequently constitutes the economically optimal option, the distribution of benefits shows the necessity for the international community to financially support the functioning of the LNP.

8.2 DISCUSSION AND LIMITATIONS

The estimations of the TEV of the LNP under the proposed scenarios, consolidate the choice of the Gabonese government to promote biodiversity conservation. The decision to establish a national park proves to be economically justifiable since this option produces global welfare. The brief analysis of the distribution associated with benefits to the conservation of this forested area indicates that the main beneficiary is the international community. Compared to the benefits of non-use or those of carbon sequestration, the ecotourism benefits of the LNP are rather insignificant mainly due to the lack of physical infrastructure in Gabon to boost this industry.

On the contrary, the scenario without LNP, which is mainly influenced by forest exploitation and depletion of NTFPs, generates non-negligible short-term benefits to the national and local stakeholders. If the TEV of scenario 'without LNP' is clearly lower than the scenario 'with LNP's', it remains probable that despite the establishment of the LNP, certain unsustainable activities such as the depletion of bushmeat and fishing under the current regime could be practised in a sustainable manner to accommodate the population living in the forested area as they are mostly dependent on these resources for protein (Nasi, Brown, Wilkie, Bennet, Tutin, Van Tol & Christophersen, 2008: 10).

The estimation of the TEV of an ecosystem proves to be a delicate exercise especially when the data are scare and/or not fully reliable. This study does not escape the rule and can be subjected to two main limitations:

- Subjectivity with regard to the choice of hypotheses and the valuation techniques: Several steps in the determination of the economic value of a natural asset suggest a certain place for subjectivity. Most of the environmental benefits can be calculated based on a variety of valuation methods (Lescuyer, 2000; Pagiola *et al*., 2004). However, the choice of valuation techniques depends mostly on the researcher and is often unjustified. Similarly, the economic assumptions made in this study may not appear realistic as a conservative approach was used. This subjectivity of the economic valuation of ecosystem services may therefore produce unreliable results.
- Subjectivity with regard to the selected environmental benefits. As presented in the theoretical framework, the concept of Total Economical Value of a protected area supposes the aggregation of all ecosystems benefits. However, most studies concentrate only on selecting certain quantifiable benefits due to the limited capacities and available resources. Hence, TEV actually corresponds to the sum of some economic benefits and not to the whole ecosystem benefits.

8.3 CONCLUSION

Our economic analysis shows that the choice to preserve this forest ecosystem through the establishment of a national park contributes in maximising social welfare. To reach this conclusion, a number of hypotheses based on available data were proposed to assess the evolution of the LNP in the next ten years. It is likely that a number of these assumptions will be contradicted in further and more accurate studies. Yet, the interest of conducting an economic valuation is generally to avoid several problems that often plague policy debates. For example, valuation avoids the frequent false characterisation of some polices as being a choice between 'the economy versus the environment'. Moreover, valuation reminds everyone that although the environment is seen as 'free', this in no way implies that it is not valuable. The services provided by the natural environment directly affect human welfare in numerous ways, but are often overlooked by some policy makers who only focus on jobs and revenues. Although the economic valuation of the Lopé National Park is not a definite result, it should be combined with other types of economic valuation such as a cost-benefit analysis to inform complex management decisions. Though It remains an essential tool to orientate policy making in environmental issues.

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