

# **A preliminary assessment of the economic value of the goods and services provided by dryland ecosystems of the Aïr and Ténéré**

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2007



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**List of abbreviations**

CNEDD	Conseil National de l'Environnement pour un Développement Durable (National Environmental Council for Sustainable Development)
CSE	La Compensation des biens et services environnementaux (Compensation for environmental goods and services)
EIE	Etude d'Impact Environnemental (Environmental Impact Study)
F CFA	Franc / Commission Financière pour l'Afrique (Franc/ Financial Commission for Africa)
PAGRNAT	Programme d'Appui à la Gestion des Ressources Naturelles dans l'Aïr et le Ténéré (Support Program for the Management of Natural Resources in the Aïr/Ténéré)
PAN	Plan d'Action National (National Action Plan)
PAN/LCD/GRN	Plan d'Action National de Lutte Contre la Désertification et la Gestion des Ressources Naturelles (National Action Plan for Combating Desertification and for the Management of Natural Resources)
RNNAT	Réserve Naturelle Nationale de l'Aïr et du Ténéré (Aïr/Ténéré National Natural Reserve)
UBT	Unité Bétail Tropical (Tropical Livestock Unit)
UICN	L'Union Mondiale pour la Nature (The World Conservation Union - IUCN)

## Summary

This study examines the possibility of identifying the real economic value of environmental goods and services for the Agadez Region of Niger.

This region is exceptional in a number of ways. With an estimated population of 310,000 inhabitants, Agadez Region contains only 2.9% of Niger's population but covers more than half the national territory and has the lowest population density of any region in Niger. The region of Agadez specializes in pastoralism, which is the single largest source of income for local households (46.5%), which receive only 4.4% of their total income from crop agriculture. Agadez has the highest literacy rate in Niger and is also relatively prosperous. Average incomes in Agadez are second only to those in the capitol of Niamey and are well above the national average. Finally, the region is spectacularly well-endowed with natural resources. Within the region and at the heart of the Sahara lies the Aïr and Ténéré National Nature Reserve, mainly composed of the Aïr mountain massif and the western part of the Ténéré plain. The reserve and associated areas total about 20 million ha and are the largest nature reserves in West Africa. In 1991 the reserve was listed as a world heritage site by UNESCO, relisted as an endangered heritage site in 1992 in the aftermath of a civil war, and in 1997 was declared a biosphere reserve.

Focusing on Agadez, the objectives of this study are to:

- Document regional physical, economic and social conditions
- Discuss national environmental policies with a view to valuing environmental goods and services
- Discuss concepts about the economic value of goods and services
- Present some of the economic values of regional environmental goods and services
- Propose a project to capitalize on the value of environmental goods and services.

The study demonstrates that although the Aïr/Ténéré is an arid region, the regional environment provides many goods and services that have high economic potential. These natural resources include the native flora (used as fuel, fodder and for medicinal purposes), water and land resources, unique local fauna, and paleontological sites. Apart from being exploited for tourism, the economic value of these goods and services is not widely recognized.

Further studies are needed to quantify the use and estimate the value of these goods and services, based on rigorous criteria. This will require statistical surveys among urban households as well as rural sedentary and nomadic households. The economic value of these goods and services must be accounted for, to justify sustainable development of the natural resources. The present study also identified the legal instruments and institutional frameworks necessary for this intervention.

Finally, the study proposes a project to value the region's goods and services, which could be entitled "The valuing of environmental goods and services in the Aïr/Ténéré." The project would have two main components:

- Economic compensation for environmental goods and services (CSE). The CSE approach can help protect the environment in a sustainable manner by rewarding those who protect the environment and requiring compensation from those who use its services.
- Valorization of paleontological and prehistoric sites. The region's ancient sites will be able to express their potential only when they help generate financial resources for the benefit of local populations.

## **1 The Study and Study Area**

Located in the heart of the West African Sahel, Niger covers over 1.27 million km<sup>2</sup>, and contains four climatic zones:

1. a Sahelian-Sudanian zone representing about 1% of the country's total surface area, with an average annual rainfall of 600-800 mm;
2. a Sahelian zone representing 10% of the country, and with 350-600 mm annual rainfall;
3. a Saharan-Sahelian zone covering 12% of the country, with an average annual rainfall of 150-350 mm;
4. and a desert Saharan zone covering 77% of the country, with less than 150 mm annual rainfall.

Within Niger, the administrative region of Agadez is the study area reported on here. Agadez encompasses the Aïr and Ténéré and covers 667,800 km<sup>2</sup> which is about 53% of the country's total area. The Agadez Region is composed of 3 districts (Arlit, Bilma and Tchirozérine) and 15 communes, and has about 314, 000 inhabitants or an average density of 0.36 inhabitants/km<sup>2</sup>.

In terms of agro-ecology, the Agadez study region consists of four zones:

1. An eastern and northeastern zone comprising the Ténéré desert and the rocky and desert plateaus of Djado, Mangueni, Afafi and Tchigai in which vegetative cover is concentrated in oases valleys
2. The Aïr massif zone, which receives more rainfall than surrounding areas because of its higher elevation and contains both underground and surface water sources that support forests and gardening
3. The southern and southwestern plains where there are exist extensive grazing lands, particularly in Irhazer, Tadress and Talak
4. The northern and northwestern zone of the Aïr massif, including Tamesna in the extreme north, which is dotted with mobile sand dunes.

Because Aïr/Ténéré is not a separate administrative entity, most of the data available concern the whole region of Agadez. As a result, in some parts of the study, there may some confusion between the Aïr/Ténéré and Agadez region.

In the heart of the Sahara zone stretches the Aïr and Ténéré National Natural Reserve (RNNAT), mainly composed of the Aïr mountain massif and the western part of the Ténéré plain. The reserve and associated areas total about 20 million ha and RNNAT is the largest nature reserve in West Africa. In 1991 it was listed as a world heritage site by UNESCO, relisted as an endangered heritage site in 1992 in the aftermath of a civil war, and in 1997 was declared a biosphere reserve.

The reserve has a predominately desert climate with an average annual rainfall below 100 mm and a long dry season with temperatures on average higher than 35°C. The reserve also has a steppe area that supports *Acacia ehrenbergiana*, *Acacia raddiana*, *Balanites aegyptiaca*, *Maerua* and *crassifolia*. This is an exceptional habitat considering the latitude, and it harbours a remarkable fauna with species such as addax (*Addax nasomaculatus*), Dorcas gazelle (*Gazella dorcas dorcas*), and Dama gazelle (*Gazella dama dama*). The biodiversity value of the site is remarkable, as is its historical and cultural heritage value based on vestiges of very ancient civilizations and paleontological sites such as the excavation of dinosaur fossils at Gadafawa.

The main economic activities undertaken in the study area of Agadez Region are agriculture, pastoralism, tourism, and handicrafts. Pastoralism is based on goats, sheep, camels and donkeys. Farming is mainly practiced in gardens irrigated with water from wells and boreholes. Tourism is one of the main sources of income. All these activities put pressure on the region's natural resources. It would appear that rangelands and water supplies are overexploited and that deforestation for construction or fuel wood is increasing with population growth. Ecological degradation affects the habitats and endangers endemic animal and plant species, which are at risk or have already disappeared. The Dama gazelle (*Gazella dama dama*) has become rare in the entire reserve. The addax (*Addax nasomaculatus*) has not been seen in the reserve in a long time.

This process has adverse consequences on the productivity of environmental goods and services, as well as on agro-pastoral production. There are nonetheless very few projects operating in the region. Currently, out of more than two hundred development projects in Niger, only about ten operate in the Agadez region. The major problem for the region is the small size of its population which is distributed over a huge geographical area. The apparent lack of development activities in the region contrasts with its importance in terms of Niger's image. The Aïr/Ténéré region provides a positive image of Niger as a tourist destination, due to the presence of paleontological and prehistoric sites of exceptional value, biodiversity and spectacular landscapes.

Despite the fact that the region is poor and the State's presence is slight, the human development level of the population (living essentially out of environmental goods and services) is higher than anywhere else in Niger, outside the urban community of Niamey. This simply means that though it is arid, the Aïr/Ténéré region has much to offer in terms of natural resources. This level of development has been made possible by the economic conversion of goods and services produced by the environment. The living standard of the region can be increased through better taking these into consideration.

### **1.1 Objectives and methods of the study**

The present study seeks to explain the economic accounting data of the Agadez region's goods and services so as to foster their better exploitation. The main objective is to identify avenues for their economic valuation.

The specific objectives are:

- Present the physical, economic and social conditions of the region
- Discuss national environmental policies with a view to valuing environmental goods and services
- Discuss the concepts of the economic values of goods and services;
- Present some of the economic values of environmental goods and services; and
- Propose a project to capitalize on the value of environmental goods and services.

The methodology used for the present study comprised three phases:

- Meeting with the main officers:

In the course of the study, we met with the main officers of the environmental sectors concerned in the study (see Annex, List of people met). These are persons working at the central level in Niamey as well as agents operating in the field in Agadez Region. This phase lasted 3 weeks, during which time the main consultant was assisted by a local consultant.

- Desk research:

The key documents were studied on Niger's environmental policy as well as on its environmental goods and services, and the socio-economic situation of the region. We also

visited numerous internet sites offering information on the Agadez region.

- Presentation of draft, and revisions

The first draft of the document was presented at a workshop in January 2006 in Agadez, during which participants asked for amendments. The amendments concerned both the content and form of the document, which were taken into account by the consultant during the revisions.

The report has 5 parts: the first part presents the socio-economic situation of the region of Agadez. The second analyzes Niger's environmental policy in light of the concept of economic value of goods and services. The third part investigates the concept of economic value. The fourth looks at economic value in relation to the goods and services of the Aïr/Ténéré region. The last part outlines a project to consolidate the economic value of environmental goods and services.

## **1.2 The socio-economic situation of the Agadez region**

Though precarious, the social situation of the Agadez region is much better than that of other regions of the country, despite the weak presence of the State in the region. This indicates that this desert region has many advantages to offer through the environmental goods and services it possesses. The issue of how to value these goods and services is mentioned here and there in the national environmental policies.

The Agadez region is the least populated in Niger, and it has the lowest density per km<sup>2</sup>. With an estimated population of 310,000 inhabitants, it represents but 2.9% of the entire Niger population, while the region covers more than half the national territory. This results in a low density: an average of 0.34/km<sup>2</sup> against a national average of 6 inhabitants/km<sup>2</sup>.

**Table 1: Populations of the Agadez region and Niger, 2001**

<b>Niger</b>	Population	10,817,839
	Growth rate (%)	3.10
	Density (inhabitants/km <sup>2</sup> )	6.25
<b>Agadez</b>	Population	314,047
	Growth rate (%)	3.5
	Density (inhabitants/km <sup>2</sup> )	0.36

Source: National Institute of Statistics

The population of Agadez essentially depends on agro-pastoral activities, which produce a large part of its income, as the table below shows. The region of Agadez is principally specialized in pastoralism, which is the single biggest source of households' income (46.5%). Agricultural income from crops represents only 4.4% of households' total income.

The region of Agadez comes next after Niamey's urban community in terms of human capital development. Concerning literacy, Agadez remains ahead of all the regions of Niger. In 1999, the literacy rate was 46%, compared to 19.9% for Niger as a whole. The literacy rate for girls in Agadez was 30% compared to 60% for boys (Enquêtes MICS 1, MICS 2 and Bureau du Coordinateur résident du système des Nations Unies 2000).

It is noteworthy that there are big differences between rural and urban zones in the region of Agadez, especially as far as girls and women are concerned. Schooling rates are very low in rural zones, and in that respect Agadez is not better off than the rural zones of the rest of the country. It would seem that the rate of urbanization in the region of Agadez explains why

schooling rates there are high, compared to the other regions of the country.

The average national income was 870 CFA F per person per year in 1999. The inhabitants of Niamey's urban community have higher incomes with 1,884 CFA F per person, against 1,329 CFA F for the Agadez region, which ranks second nationally (4<sup>th</sup> RNDH in Niger, 2000<sup>1</sup>).

There are several development projects in the country, but very few operate in the Agadez region. The big projects operating in the zone are generally national projects with regional components.

Agadez is one of the regions in Niger with large concentrations of associations and NGOs. This reflects the observations of institutional experts who assert that when the State fails in its mission to provide certain public services, civil society organizations come in to replace it.

Associations and NGOs operate in all areas of development (education, environment, health, livestock farming, agriculture, humanitarian sector, etc.) in the region.

## **2. Environmental Policy in Niger**

More than 80% of Niger's population depends on agriculture and livestock, both of which depend heavily on environmental resources. As a result, the environment is a key development priority in Niger. The challenges are many: soil degradation, generalized decline in the productivity of natural resources, shrinking forests and vegetative diversity, reduction of animal biodiversity, sanding encroachment and land silting up, increase of invasive species, and various forms of pollution.

These challenges have received coordinated responses from the different intervening actors, that is, donors, the State, and civil society. Documents, programs and/or strategies have been proposed; those dealing with the environment and natural resource sectors may be split into three categories: general policy documents, conventions, and environmental policy orientation documents.

The two key documents on Niger's general policies are the Poverty Reduction Strategy Paper (PRSP) and the Rural Development Strategy (SDR).

The PRSP is now the reference frame for all the country's economic and social policies. It contains several strategies concerning the environment and natural resources. It asserts that "in the area of the environment, the Combat against desertification and environmental management for the purpose of integrated natural resource development will take place through restoring and protecting the environment to increase biomass and biodiversity, agricultural, pastoral and forest land development security." By relating this objective to the priority actions laid out in the PRSP concerning productive sectors, desertification campaign actions have been planned with a view to protecting the productive bases, lands (agricultural, pastoral and forest) and the development of eco-tourism.

However, out of the 1.157 billion CFA F representing the cost of the PRSP, only 18 billion (less than 2%) are directly earmarked for environmental sectors. Though indirectly the amounts thus dedicated are actually higher than this figure, there is a discrepancy between the government's public discourse and its actual policy.

The Rural Development Strategy (SDR) includes components relevant to the protection and valuation strategy for the environment and natural resources. The strategy raises a number of issues, including the problem of productivity in the production systems, and increased competition for access to natural resources, which is a source of conflicts.

The SDR has three complementary strategic axes with direct or indirect links to environmental management:

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<sup>1</sup> Bureau du Coordinateur résident du système des Nations Unies, (2000)

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- Promoting access of rural people to economic opportunities, so as to create the conditions necessary for sustainable economic growth in the rural area.
- Preventing risks, improving food security, and managing natural resources in a sustainable manner in order to safeguard the populations' living conditions.
- Reinforcing the capacities of public institutions and rural organizations to improve the management of the rural sector.

**Table 2: Funds dedicated to the environmental sectors in the PRSP**

Sector	Total cost in 2002-2005 (billion CFA)	% PRSP's total cost
Combat against desertification and natural resource management	14.55	1.26 %
Tourism (eco-tourism, development of new sites)	2.67	0.23 %
Identifying water resources	0.95	0.08 %
Total	18.17	1.57 %

Source: Secrétariat Permanent du DSRP

## **2.1 International conventions**

The importance of environmental challenges in Niger has the State to ratify almost all the key international conventions regulating the environment and natural resources:

- The Convention on Biological Diversity;
- The United Nations Framework Convention on Climatic Changes;
- The Convention to Combat Desertification;
- The Convention on Humid Zones (RAMSAR);
- The Convention on Migratory Birds.

The key conventions became operational through programs and action plans initiated by the National Environmental Council for Sustainable Development (CNEDD). This Council was put in place following the creation of the National Environmental Plan for Sustainable Development (PNEDD), which is the reference framework in terms of environment and sustainable development. PNEDD programs include

- **The national strategy and action plan for biological diversity (SNDB)**

Biological diversity is a major concern for a large part of Niger's population which draws the bulk of its needs from natural resources. For vegetative diversity, it is estimated that 210 species present a huge interest in terms of the population's food needs, especially during lean and famine periods. For animal feed, 235 species are exploited, while in the area of pharmacopoeia and traditional medicine, 270 species are used for different purposes. In the area of handicraft, more than 127 species are used to make various objects.

An inventory of Niger's biodiversity has helped to record 3, 200 species of animal and 2,124 vegetative species, as well as numerous ecosystems.

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The National Strategy and Action Plan for Biological Diversity (SNPA/DB) was designed to help better manage this potential.

- **The national Action Plan to Combat Desertification and for natural resource management (PAN/LCD/GRN)**

The major aims of this plan are to improve and perpetuate the productive capital (soil, water, etc.) and to manage the living framework.

- **The national strategy and action plan for renewable energies**

In Niger, wood fuel is the dominant source of energy (94%). The consumption of conventional energy is low: oil products represent 4.7% and electricity 1.3%. This is due to the fact that industry and purchasing power are weak in Niger. Firewood consumption is a serious problem for the country (200,000 ha of forest disappear annually) and this cannot be borne in the long term.

- **The national strategy and action plan for climatic changes and variability**

Niger ratified the climate convention in 2004 and began to enforce it in 2005. The national strategy has not been completed yet, but preliminary studies have taken place

## **2.2 Sectoral consultation on the environment and on combatting desertification**

To harmonize the contents of the different environmental initiatives with the poverty reduction strategy document, which is the reference framework for development programs in Niger, the government organized a Sectoral Consultation on the Environment and the Combat against Desertification in 2005. A national document was therefore proposed in this respect, as well as documents specific to each of the eight regions of the country. Each regional document contained action plans for environmental protection. The plans seek to take into consideration the concerns contained in the different conventions.

It is worth looking at what these documents say about the arid zones, including the study area of Agadez Region, and the valuation of environmental goods and services.

Most of these documents say nothing on the economic value of environmental goods and services, though their relation with the productive sectors has been clearly established. For example, the strategic plan on biodiversity does not provide any analysis of the economic value of biodiversity, yet this is a major issue at the international level.

The only service referred to in economic terms in most of the documents is eco-tourism. This has been much analyzed, and the PRSP contains a budgetary line in its respect. The other services provided by natural resources are totally ignored, in terms of their economic dimension.

Environmental issues cannot be fully considered without raising the question of the economic value of environmental goods and services. The National Environmental Council for Sustainable Development (CNEDD) has done much. In 2002 it launched a study to re-evaluate the contribution of the forest and fishing sector to the GDP. This is an innovative study which opens avenues for further reflection on how to take account of the economic value of goods and services. Such a vision will render certain degradation and regeneration problems more concrete.

Without a true economic evaluation, awareness of environmental problems will remain limited. This explains in part why the Aïr/Ténéré sub region is inadequately considered in the national development and environmental policies, excepting the natural reserves in Aïr/Ténéré.

The recent national consultation on the environment really took the economic dimension into

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account in a more systematic manner. The regional action plans had three goals:

- Environment: protect and develop the environment;
- Social: make populations take ownership of the management of the environment;
- Economic: contribute with the environment to the development of a flexible and integrated economic system.

In all the cases, the economic goals contained innovative items such as developing forest by-products. Concerning the region of Agadez, the following were identified:

**Table 3: Economic intervention axis in the Agadez region, following the national consultation on the environment (CNEDD, 2000)**

Priority intervention lines	Actions to envisage
Develop forest by-products	<ol style="list-style-type: none"> <li>1. Inventory of doum palm stands</li> <li>2. Develop doum palm stands for the sale of doum leaves</li> </ol>
Make pastoralism sustainable ecologically	<ol style="list-style-type: none"> <li>1. Maintain and organize environmental friendly transhumance practices</li> <li>2. Improve the coordination of water points</li> <li>3. Valorize herds</li> </ol>
Popularize mineral charcoal	<ol style="list-style-type: none"> <li>1. Organize the sales circuit to make it accessible</li> <li>2. Improve the quality of carbonization</li> <li>3. Reduce the price</li> </ol>
Develop alternative energies	<ol style="list-style-type: none"> <li>1. Promote the use of mineral charcoal</li> <li>2. Develop wind and solar energy for raising water</li> <li>3. Develop nuclear energy</li> </ol>
Develop eco-tourism	<ol style="list-style-type: none"> <li>1. Organize and regulate the sector to draw maximum revenues while preserving biological diversity sustainably</li> <li>2. Develop potential sites</li> <li>3. Improve the tourism reception system</li> <li>4. Reinforce the capacities of travel agencies</li> <li>5. Elaborate a regional tourism charter</li> </ol>
Develop handicraft	<ol style="list-style-type: none"> <li>1. Organize the doum palm leaves sector, and management of the resource</li> <li>2. Exploit the local leather sector so as to improve the exploitation of livestock, especially small ruminants.</li> <li>3. Reinforce the capacities of artisans</li> </ol>

### **3. The Economic Valuation of Environmental Goods and Services**

The specific nature of environmental goods and service requires that we explain the notion of economic value. For economists, value depends on individuals' preferences, which in turn depend on the relative scarcity of goods. Goods or services that exist in abundance and that we may consume at will have no economic value, though they may be aesthetically or morally important. Pure air, for instance, has no economic value as long as everybody has free access to it. Once the thing is no longer freely available, a potential economic value arises. If air is polluted, people will prefer to have pure air and will be prepared to expend resources to have that pure air. Consequently, we may then be able to estimate the value of pure air.

For goods that are traded, their rarity is indicated by their price. Normally, according to the rule of supply and demand, as a good becomes rare, its price increases, and vice versa when it becomes abundant. Untraded goods have no market price but they may still have value, and for many items of natural heritage, the market price may fail to reflect their full value.

Economic value includes both the market price and the rent received by consumers, which is the difference between the price that consumers are prepared to pay and the price they actually pay. If a consumer is prepared to pay 100F for a good and only pays 60F, the consumer rent is 40F. A comprehensive estimate of environmental values therefore depends in part on individuals' preferences. This means that economic value is not absolute and that the value of an environmental good depends on the appreciation society has for it, which may vary depending on the social group, region, or country.

The values of environmental goods may be split into several categories:

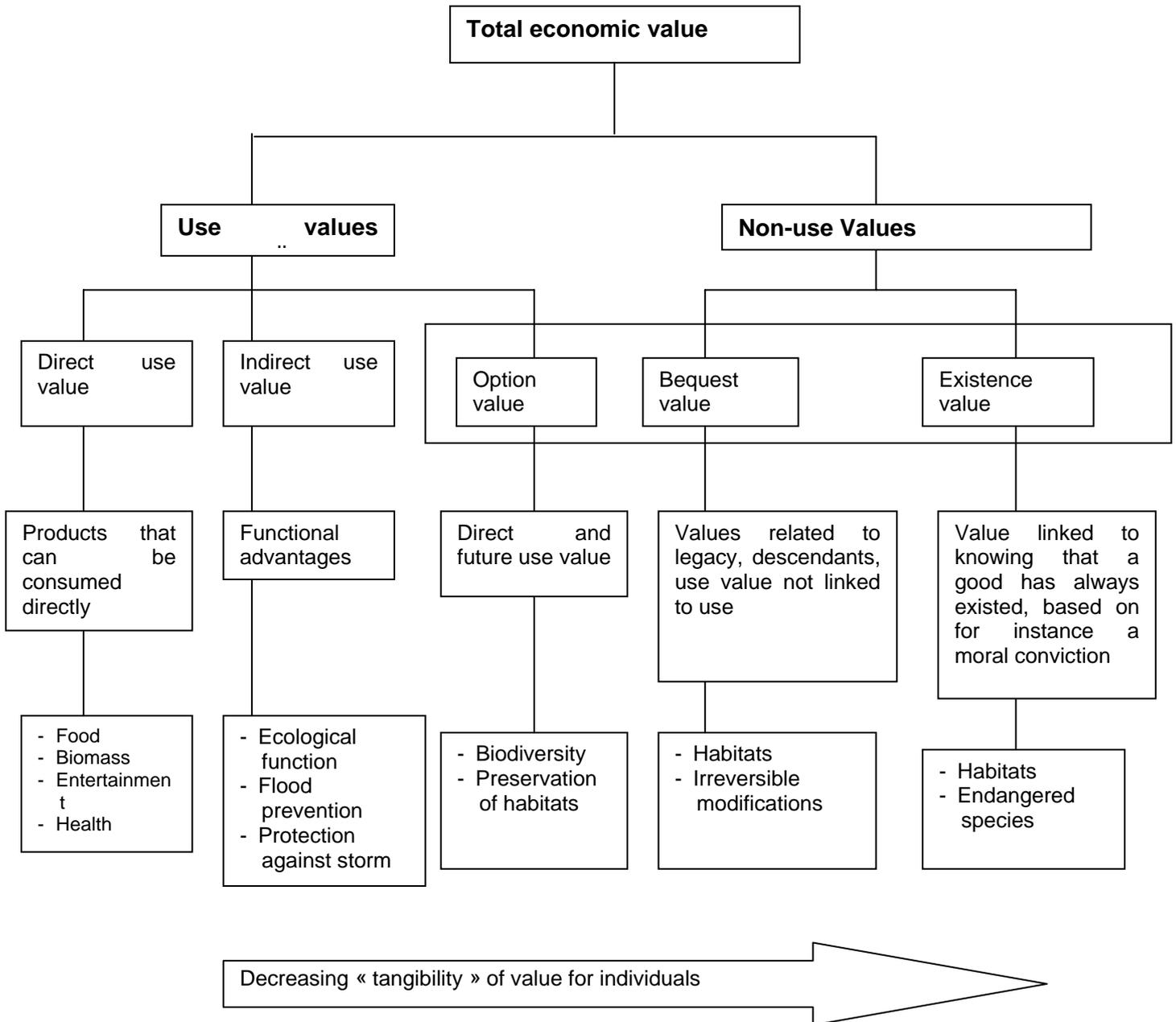
- *Direct use values:* These are values directly derived from the use of an environmental resource. In the case of a forest, this may be food, biomass, entertainment, and health.
- *Indirect use values:* These come from the functional benefit of an environmental resource; for instance, climatic regulation, soil protection, and ecological interactions.
- *Option values:* These are the direct and indirect values that people may derive from an environmental resource by refusing to exploit it now in order to retain potential future opportunities.

People may ascribe a value to a resource even though they are not using it directly or indirectly and do not attach any option value to it. In this case they may give it a:

- *Bequest value* arising from individuals' desire to transmit it to a future generation or to their descendants (heritage, legacy, family, habitat, etc.);
- *Existence value* resulting from pure pleasure drawn from the sheer existence of an environmental good.

This classification of economic value helps us understand the different motivations of social actors with regard to environmental problems, and the conflicts that arise. For instance, poor farmers living in a classified forest may be especially interested in the forest's direct use value but show very little interest in its option, existence, or bequest value. Or they may have no concern for the direct use value of a sacred forest but appreciate its value as a bequest. Alternatively, ecologists might be more concerned about the forest's existence and indirect use values.

**Figure 1: How to estimate the economic value of biodiversity**



Source: Munasinghe, 1997

### **3.1 Methods for evaluating the economic value of environmental goods and services**

There are three major evaluation methods:

- Monetary evaluation;
- Expressed preferences;
- Revealed preferences and market substitution.

#### **3.1.1 Monetary evaluation of physical effects**

The objective of this technique is to observe environmental changes and estimate the values of the goods and services produced by different environmental states. This involves three steps:

- Estimation of the physical effect of a modification on for example the level of erosion caused by highland deforestation in a particular area.
- Estimation of the difference this effect has on yields or production costs, e.g. the impact of a given erosion rate on crop harvests.
- Estimation of the monetary value of changes in output.

#### **3.1.2 Expressed preferences**

This method is based on the assumption that individuals who are well informed can express their preferences for particular goods (protection, preservation, development) by stating the value they are prepared to pay for them. In practice, people are asked to state the amount of money they are ready to pay for the protection or safeguarding of environmental goods and services, or their willingness to accept compensation for the loss of such benefits. These answers are then aggregated and weighted according to the size of different groups.

#### **3.1.3 Revealed preferences**

Often, people's behaviour can reveal their preference for environmental goods. For instance, let us consider two houses of the same category providing the same possibilities (accessibility, security, infrastructure, etc.). One person may choose to pay more for one particular house because of certain environmental advantages that house offers. These advantages may be linked to the low level of pollution in the neighborhood, or the micro-climate produced by nearby vegetation or river. The additional price that this person pays reveals his preference for the environmental good concerned.

Similarly, because of certain environment related nuisances, a person may need to spend money to avoid problems. For instance, he may glaze the house to avoid dust or noise in the neighborhood. Such expenses reveal that individual's preference for tranquility or for the absence of dust, and quantify the value of the environmental goods concerned.

Some people spend large amounts of money to have access to environmental goods available, for example, in natural parks or forests, or travel to other continents to see certain animals or natural sites. The resulting expenses incurred by these people constitute an estimate of their environmental preferences.

#### **3.1.4 Limitations to valuing environmental goods and services**

There are several limitations to the economic valuation of environmental goods and services:

- The basic hypothesis of monetary evaluation is that any preference may have a monetary equivalent. It is difficult for such an approach to be compatible with societies where business mechanisms do not predominate in the use of resources.

*A preliminary assessment of the economic value of the goods and services provided by dryland ecosystems of the Aïr and Ténéré, Niger, IUCN 2007*

- Because there is lack of information on the functions of ecosystems or of biodiversity, some services have only approximate values which do not tell much about their intrinsic potential.
- Not all values can be estimated in monetary terms, such as people’s moral or sentimental attachments. Concretely, the spiritual function of a sacred wood cannot have a monetary equivalent.

The choice of an evaluation method is crucial, since different methods may major discrepancies that are contradictory.

#### **4. The Economic Value of Environmental Goods and Services in the Aïr/Ténéré**

This chapter seeks to present the main goods and services of the Aïr/Ténéré region, as well as their values, and proposes ways to value some of them.

The main goods and services of the region are presented in Table 4 below.

**Table 4: Principal goods and services in the Aïr/Ténéré**

<b>Natural Resources</b>	Flora
	Fauna
	Mines
	Fossils and prehistoric sites
	Water resources
	Soils
	Mountains
	Thermal waters
<b>Goods</b>	Pharmacopoeia
	Animal feed
	Human food
<b>Services</b>	Construction
	Handicraft
	Irrigation
	Tourism
	Images, films, books
	Entertainment
	Culture, education, spiritual roles
	Purification and detoxication (for instance carbon sequestration)
	Regulation and stabilization (for instance fertilization)
	Habitat
	Genetic reservoir
	Relief
	Celestial vault
Landmarks (trees and stars)	

#### **4.1 Flora**

It is only possible to estimate the consumption value of woody products in this region. Information on the value of other flora is either unavailable or unreliable.

Though the Aïr/Ténéré region is desert, it harbors numerous plant species. Poilecot,(1996) listed about 300 species out the 1200 found in Niger. The region comprises three main habitat sub-types – mountain, inter-mountain and desert - corresponding to the ecosystems. A study on pastoralists within the Aïr/Ténéré National Natural Reserve (RNNAT) categorized six main uses of trees: grazing, tanning, utensil manufacture, pharmacopoeia, construction, and human consumption (Prat 2000).

**Table 5: The main uses of trees in the RNNAT**

<b>Species</b>	<b>Grazing</b>	<b>Tanning</b>	<b>Utensils</b>	<b>Pharmacopoeia</b>	<b>Construction</b>	<b>Human consumption</b>
<i>Acacia raddiana</i>	Fruits		Roots used for poles to bring down fruit	Barks	Dead tree branches and barks	
<i>Balanites aegyptiaca</i>	Fruits		spoons	Leaves+ barks		Fruits
<i>Maerua crassifolia</i>	Fruits + leaves			Fruits + leaves to stop bleeding on wounds	Branches and barks	Leaves used with millet
<i>Salvadora persica</i>	Fruits					
<i>Aacacia nilotica</i>	Leaves	Barks +Fruits for tanning water skins		Leaves + barks		
<i>Acacia ehrenbergiana</i>		Barks + fruits		Fruits		
<i>Hyphaene thebaica</i>					Branches and leaves for construction	
<i>Ziziphus mucronata</i>	Fruits			Barks + fruits	Branches for construction	Fruits
<i>Acacia albida</i>	Fruits		Mortars + Hoe handles			
<i>Phoenix dactylifera (date palm trees)</i>					Branches used for making beds	

Prat (2000) also described the livestock preferences for certain ligneous and herbaceous species as feed (Table 6).

**Table 6: Feed preferences of different livestock species in the RNNAT**

Feed preference species (local or scientific name)	Goats	Sheep	Donkeys	Dromedaries
<i>Achliah</i>	x			x
<i>Allouat</i>	x			
<i>Amaranthus graecizans</i> (Tizlinghatay)	x			
<i>Aristida funiculata</i> (Alamouss)	x	x	x	x
<i>Aristolochia bracteolata</i> (Aghalgham)				
<i>Aristolochia bracteolata</i> (Ajalghoum)				x
<i>Baerhavia rupens</i> (Ebdebel)	x			
<i>Borreria stachydea</i> (Tamaerkoess)	x			
<i>Boscia senegalensis</i> (Tadan)				
<i>Cymbopogon sp.</i> (Tébarent)			x	
<i>Acacia raddiana</i> flowers (Amoul)	x			
<i>Giurfis</i>	x			
<i>Panicum turgidum</i> (Afazo)			x	x
<i>Paranichia sp.</i> (Ogliss)	x			
Wild water melon	x	x	x	
<i>Polygala erioptera</i> (Amastédak)	x			
<i>Portulaca oleracea</i> (Tamsselle)	x			
<i>Schouwia thebaica</i> (Alouat)	x		x	x
<i>Tagalat</i>	x			
<i>Tapinanthus globiferus</i> (Akawat)	x			
<i>Tchimirkas</i>	x			
<i>Tergarof</i>	x			
<i>Tibulus terrestris</i> (Tagarouf)	x			

All these resources are under threat, thus jeopardizing the goods and services they provide. Generally speaking, the various successive droughts in Niger combined with human action, since the late 1960s have led to a reduction of the herbaceous biomass, as well as to an alteration of the flora in grazing lands. This has caused certain palatable forage plants to become rare or even disappear. As a result, there is a deficiency of fodder plants. Shrubs have been significantly reduced, especially around water points. Shrubs can provide fodder all year round, unlike the herbaceous layer which tends to lose its value over the 10 month dry season (Secrétariat permanent de la SRP, 2006).

The woody cover of the Aïr/Ténéré and their adjacent regions has not been spared. There has been strong pressure of woodcutting for fuel and construction. Local people cut or collect wood which they sell to truck or cart owners.

In the past, cutting wood, whether for energy or construction needs, was limited to areas where wood was abundant. Nowadays, as wood is rare, truck drivers go into the reserve to buy or collect wood, for sale at high prices in the two big cities of the region, Arlit and Agadez. Firewood and charcoal consumption in Agadez in 2004 is shown in Table 7

**Table 7: Estimated quantity of wood consumed in Agadez in 2004, (cubic metre)**

Quantity of wood transported by the motorized sector	Quantity of wood transported by the non motorized sector	Quantity sold privately	Total quantity of wood used
54,120 m <sup>3</sup>	14,880 m <sup>3</sup>	540 m <sup>3</sup>	69,540 m <sup>3</sup>

**Source:** According to existing data available at Arlit and Tchirozérine Forestry Commissions and the Commune of Agadez.

The National Strategy and Action Plan on Renewable Energies figures on firewood consumption show that Agadez produces only 1,800 tons while it consumes 91,890 tons, giving a deficit of 90,180 tons. Generally speaking, the balance is met to the detriment of the environment.

With regards to the value of flora, including wild fruit, plants used in handicrafts or for medicinal purposes, or the state of biodiversity, no reliable information exists on the quantity of products involved or on their price.

How then can we go about evaluating the value of goods and services from the flora?

#### **4.2 Methods for estimating the value of services provided by the flora**

This is a process which would require many steps:

- a) Compile a list of the main flora species used in one manner or another in the region. In the case of the Aïr/Ténéré, 300 species obtain. Out of these, as an example we will identify ten corresponding to the list of species drawn by the Environmental Impact Study.
- b) For each species, compile a list of the services it provides in the form of a table. It is not useful to list all the services, but only those for which information can be gathered.
- c) For each service identified, the quantities involved should be indicated. For instance, concerning grazing, the consumption parameters are needed as well as the quantity of biomass consumed per year per animal. Such information is available.
- d) Conduct a household survey, using a representative sample to estimate the consumption parameters of a number of products such as pharmacopoeia, construction materials, use of other natural resources, etc.

The survey should distinguish between specific groups such as: women and men, richer and poorer, artisans, farmers concerning irrigation and pastoralists concerning grazing, so as to determine their level of usage.

- e) Conduct surveys or studies on specific groups such as tourists, to determine their readiness to pay for certain environmental services
- f) Obtain information from specialists, to determine the functions and parameters of particular environmental items such as the value and use of certain genes, the kind of pharmaceutical products, or the effect of forest clearing on soil fertility.
- g) Determine the unit of analysis in which the parameters are applicable. This may relate to animal or human populations, a surface area, etc.

Estimate the value of each unit used as a parameter. This is one the most sensitive aspects of the task. For services for which there is a price, we may choose the market price modulated according to existing market distortions. For instance, should

we take the market price of a cubic meter of wood as a basis for its valorization? No. The price of wood does not always reflect its relative rarity, and this explains in part the degradation of the vegetative cover, since the market price does not include the long-term loss of woody species. To determine the actual price of wood, we must calculate its replacement cost. The logic is: what are the costs to be incurred if we want to replace the wood which has been removed? Generally, these costs are higher than the wood's market price.

Concerning goods and services with no price, there are many other methods. For such cases, we should refer to specialized works on the issue.

Once this information has been collected, we may then calculate the value of each good and service provided by each flora species. The sum of the values gives the aggregate value of the goods and services. An example is shown in Table 8.

**Table 8: Example of calculation matrix for the economic value of flora goods and services**

Flora services	Parameters (consumption, production, function, etc.)	Scope of the study (size of population, animal, plants)	Value per unit CFA F	Total value CFA F
Pharmacopoeia <i>EXAMPLE</i>	<i>2 kg/person /year</i>	<i>100,000 persons</i>	<i>25 F/ kg</i>	<i>5,000,000</i>
Animal feed				
Human food				
Construction				
Handicraft				
Irrigation				
Tourism				
Images, films, and books				
Entertainment				
Culture, education, spiritual role)				
Purification and detoxication (for instance carbon sequestration)				
Regulation et stabilization (for instance fertilization)				
Habitat				
Genetic reservoir				

The methodology presented above generally requires a lot of time to obtain the different estimates. In most cases, resources are lacking. Therefore it is necessary to find appropriate proxies. The following section estimates one of the most important flora services in this dryland region: animal feed.

#### **4.3 The value of animal feed and pastoralism in the Agadez region**

The products of pastoralism are not directly derived from the environment, but from domestic

animals. Therefore, pastoral products are not addressed in the section dedicated to the fauna. However, livestock depend directly on forage from the environment.

Pastoralism is a key activity in the region of Agadez. It represents the main source of monetary income for the population (46.2% of the aggregate monetary revenue). However, it only represents 26% of the regional GDP, calculated in terms of cash and in-kind values.

In 2005, the Agadez livestock population was estimated at 109,858 UBT<sup>2</sup> or 1.7% of the national total of 6.36 million UBT. The region's livestock is made up of cattle, sheep, goats and camels.

**Table 9: Livestock population in the Agadez region**

Cattle	Sheep	Goats	Camels	Horses	Donkeys
18,800	200,400	332,200	38,200	292	9,892

Source: National Institute of statistics

There are three main forms of pastoralism based on grazing in the region:

- Nomadic pastoralism, the most widespread form. These pastoralists constantly move in search of grazing land and water. The herds comprise goats, sheep, and camels. Their milk serves as basic food for the nomads. With this system, it is possible to optimally exploit grazing lands all year round.
- Transhumance pastoralism: seasonal movement whereby, at the beginning of the planting season, pastoralists in agricultural zones move up towards green grazing lands.
- Semi-extensive or sedentary pastoralism: under this system, pastoralists take part of their livestock onto grazing lands all year round, in the form of small collective herds or free-roaming. In addition to natural grazing, animals here receive supplementary feed made up of domestic or agricultural by-products.

All three types of pastoralism are closely linked to natural grazing, which is practiced without much concern for pasture renewal. It is estimated that the pastoral zone represents 3% of the total surface area, that is, 1.85 million ha. However, the extent of pasture varies depending on the rainfall.

The fodder consumed certainly has an economic value, which unfortunately users do not always perceive. This value may be estimated based on a number of hypotheses on consumption and the price of fodder.

#### **4.4 Fodder**

Dry matter consumption may be determined according to animal categories. When the feed is about the same for several species being compared, the metabolic weight ratio is the best comparison tool. This relationship shows that smaller animals produce more heat and consume more feed per size unit than bigger animals. When the resources come from grazing, the average voluntary feed is remarkably similar for all species, about 1.25 times the maintenance needs (1 for maintenance, 0.25 for production = growth, reproduction, milk,

<sup>2</sup> 1 UBT (Tropical Livestock Unit) = 250 kg of live weight

1 bovine..... 0.71 UBT  
 1 sheep/caprine..... 0.13 UBT  
 1 equine..... 1 UBT  
 1 dromedary ..... 1 UBT

etc.). Metabolic weight is therefore considered the best unit to compare animals of different species, whether in terms of the volume of the aggregate consumed feed, manure produced, or the products created (<http://lead-fr.virtualcentre.org/fr/dec//Toolbox/Index.htm>).

In Niger's early warning system, dry matter needs for all livestock species are calculated on the basis of 1.7t of DM/UBT over 270 days. This is the basis applied in this study.

Fodder is already being traded. Some agro-pastoralists have specialized in cutting down the vegetative cover and selling it in urban centers to sedentary pastoralists. This same fodder is also being traded internationally because it is exported to neighbouring countries like Libya and Algeria. As a result, natural fodder is beginning to become a merchandize. As explained in earlier sections, the sales price of a good is not necessarily its economic value. However, it may indicate something about the good. The price of fodder ranges between 50 and 100 CFA per kg bundle. This price is certainly not what a nomadic pastoralist is ready to pay to have access to grazing land, but in the absence of any other information, it may be used to value fodder. However, we must bear in mind that this has several limitations.

Based on the preceding hypotheses, Table 10 below presents an estimate of the economic value of fodder in the Aïr.

**Table 10: Market value of fodder in Agadez**

	Number		UBT	Dry matter (kg)	Value of dry matter (50 CFA F/kg)	Value of dry matter (75 CFAF/kg)
Cattle	18,800	0.7	13 160			
Sheep	200,400	0.1	20 040			
Goats	332,200	0.1	33 220			
Camels	38,200	1	38 200			
Horses	292	1	292			
Donkeys	9,892	0.5	4 946			
Aggregate UBT			109 858			
Aggregate dry matter (1.7 ton/ UBT)				186 758 600	9,337,930,000	14,006,895,000
Value per UBT					85 000	127 500

**Source:** Author's own calculations

The table indicates that the value of fodder consumed ranges between 9.3 billion and about 14 billion CFA F, which corresponds to a level of consumption between 85,000 and 127,500 per UBT. The fodder costs per UBT are considerable, nearing half the market value of a cow. Pastoralists do not integrate the value of fodder in their production cost. The figures above simply indicate that fodder is more important than is apparent in its current usage—almost for free. The figures reveal that as things stand, the use of fodder resources does not reflect its value, given the current problem of overgrazing.

The value of fodder actually varies depending both on rainfall and other natural factors. When the rainfall is bad, as in 2004, there may be a very important deficit of dry matter, when the deficit for the entire country was estimated at 4.6 million tons. Such deficits cause the value of fodder to rise.

#### **4.5 Cropping and gardening**

Dryland farming is not very important in the Agadez region, which produces only a small fraction of the main food crop of millet in Niger, though maize is more important in Agadez.

However, garden production using irrigation is important and keeps a large portion of farmers busy. There are five agricultural valleys in the reserve and its vicinities: Iférouane by Tamgak, Tin Telloust and Zomo in the center, Timia and Tabelot in the South-West periphery. The Iférouane valley is the most important agricultural area of the reserve.

In the Aïr zone, irrigated gardening has been the main source of food and cash income, and the area of gardening is constantly increasing. Traditionally, food crop gardening was exclusively to produce cereals, dates and vegetables for home consumption. However, nowadays gardening is more oriented towards cash crops. Many crops are concerned, but the most widespread are wheat, dates, citrus fruits, barley, corn, millet, tomatoes, peppers, green peppers, garlic, and onions. With the advent of mechanical water pumps, the process has accelerated, and there is an increase in planted areas. The cash flows per ha are very significant, ranging from 185 000 and 4 million CFA F, depending on the type of crop involved. For example, high value crops like tomatoes can bring an income of up to 3 million CFA per ha, and lettuce up to 4 million CFA/ha, while cash income from maize is quite low at 185,770 CFA/ha.

#### **4.6 Land**

As an environmental resource, land offers numerous services, of which the most important in terms of agriculture is fertility. Agriculture is practiced on soil, and the level of production depends among other things on soil fertility. Where soil is not fertile, external inputs like manure or fertilizer are necessary to obtain an acceptable level of fertility. Where none of these is accessible to the producer, land is left fallow, giving it time for nature to regenerate.

This soil fertilizing function is a service provided by land but land becomes poor if this service is not valued at the right price. If the various market values of land products do not take the fertility service provided by nature into consideration, this may lead to overexploitation. It is necessary to estimate this service, on the one hand for the sake of comparison, and on the other hand, to be able to apply the values to make production-related decisions.

Several methods may be used for this evaluation:

- Production function method
- The cost of bringing the level of soil fertility to its initial state
- The rental cost of fully fertile land

The value of land may be otherwise be estimated by considering land as an input capable of competitive usages, for instance between agriculture and the environment. We may thus compare the net value of environmental usage to that of agricultural usage.

Each of these methods has its advantages and drawbacks. It is up to a researcher to determine which one is more appropriate to their analysis.

#### **4.7 Water resources**

The region of Agadez has no permanent rivers. However, it possesses some sloping basins characterized by fossil valleys. Rain-generated runoffs feed into these temporary flows which drain the western slope of the Aïr and converge toward three main collectors. The region also boasts some very important ground water sources, some not renewable, distributed over several aquifer systems:

- The intercalary continental aquifer, representing an important reservoir of good quality fossil water;
- The Aïr alluvial sheets, the main water resource of the region, which are fed by rainfall
- The Agadez sandstone sheet represents the main ground water resource of the zones located on the west side of the Aïr; it is a sub-fossil type
- The basins of Djado and Bilma are replete with ground water resources, but only the Kaffra sandstone aquifer is exploited at the moment.

Within the area covered by the study, the ground water resource is made up of fossil sheets and alluvial aquifers. More than 5,700 wells and boreholes are exploited for agricultural purposes, though this information needs to be updated. There is potentially an overexploitation of the groundwater sheets, caused by the use of power pumps for gardening.

Water resources in the desert Aïr/Ténéré region provide numerous services, the main ones being consumption and irrigation. Each of these services may be evaluated economically.

It would seem that irrigation is the most important service provided by the water resources. However, this service is not properly costed, which may be leading to an overexploitation of the water sheets. Things happen as if this water had no cost. In practice, the only cost that producers now bear with respect to water is the cost of extraction, whether by power pumps, traditional or modern wells. There is no water market, and there is no price paid for water. But because water has no price does not mean that it has no economic value. Gardeners spend between 132,000 and 395,000 CFA F per ha to irrigate their gardens. We may thus estimate the cost each gardener pays to have water (CFA F/m<sup>3</sup>). The rationale here is that if a gardener is prepared to pay so much money for a cubic metre of water, this means that he has interest in doing so, considering the expected output.

The value thus obtained is a minimum value, which does not reflect the relative scarcity of water. Another approach is needed to express the fact that water is scarce, and that if it is exploited without restraint, this is due to the fact that the water has no owner able to charge a cost. Here too, many methods obtain, including the following:

- Physical production costs of providing irrigated water
- Gardeners' readiness to pay for certain quantity of water
- The consumer's surplus, to be added to the production cost of water, to determine the difference between the supply cost and the demand price.

#### **4.8 Fauna**

The fauna of the Aïr/Ténéré region is varied and boasts several rare species, as the two tables below indicate.

However, according to the 2005 study by Anthelme et al. on the ecological and socio-economic conditions of the RNNAT and its connected zones, the situation of the fauna is very worrying. The study indicates that several species have disappeared or are in danger. At risk are the Dama gazelle, red necked ostrich, vultures, Nubian bustards, and striped hyena. The number of cheetahs, Dorcas gazelle and moufflon, for example, has been considerably reduced. The status of Leptocera gazelles, reptiles, amphibians, and invertebrates is poorly known. The population of jackals is expanding, causing serious problems for pastoralists. The population of some other smaller mammals (e.g. fox, hare, porcupine and monkeys) is also expanding.

Drought, military actions as well as poaching are the main factors for the scarcity of some animal species. There are secondary factors, including poisoning by strychnine, capture by

predatory species, lack of protective reserves, and disturbance by tourism or pastoral transhumance.

To estimate the economic value of the fauna, it is necessary first to draw a list of its possible usages and then to give each a value.

In his study, Pierre Poilecot (1996) provides a list of the main animals and their uses for local populations, including as food, pharmacopoeia, utility handicraft and art handicraft. The uses described by Poilecot are not sustainable and are not even to be recommended, because most of the species are now protected. It is therefore difficult to establish their value. However, it is worth mentioning that some people are willing to spend considerable amounts of money to hunt these species, though this is in defiance of Niger's laws and international commitments.

In addition to these immediate uses, the fauna may have biodiversity value, which includes existence value, as well as direct and indirect use and option values. Although the fauna has a very important biodiversity value, this is very difficult to estimate. The genes that have allowed these animals to exist in such an arid ecosystem may provide interesting research avenues to improve the genes of domestic species. Economically, this would mean more productivity and therefore more income. However, it is almost impossible to estimate this. We can only assert that its economic value could be important in the future.

In general, existence value is difficult to estimate; however, a proxy for this may be the international financial commitment for the reserve.

A general outline of how one might value the region's fauna is given in Table 11.

**Table 11: The economic valuation of faunal goods and services**

<b>Services</b>	<b>Gross value (without production costs)</b>
Consumption as food, e.g. honey	Consumption value
Pharmacopoeia	Part of the value of medicines derived from portions of animals
Handicraft	Value of the part used in making handicraft goods
Tourism	Amounts of revenue produced by tourism
Gene reservoirs	High but difficult to estimate
Existence value	In part: the amount donated by the international community for the protection and conservation of the reserve

#### **4.9 Tourism**

For sure, tourism provides one of the most obvious values that the environment produces in the Aïr/Ténéré region. There are various items in the environment of the region which are of interest to tourists, including: natural landscapes, aboriginal Saharan nomadic traditions, historic and paleontological sites of worldwide repute, remarkable and often unique wild fauna, and diverse flora with rare species.

According to a study on ecotourism by PAGRNAT (1999), the main motivations for tourists visiting the Sahara have to do with both the desert's mythical status and real possibilities for escapism in the desert. To tap these assets, some more or less coordinated initiatives have been developed to cater for international customers. Travel agencies, tourist guides, hotels and handicraft products now provide varied goods and services. For example, the airport of

Agadez has been reorganized and now ranks next nationwide after Niamey airport. Revenue from tourism grew between 2001 and 2003, providing 3.24 billion CFA F in 2003, according to the Ministry of Tourism.

Indirectly, tourism helps to develop other sectors such as the craft industry, ground and air transportation, restaurants and hotels. However, tourism-related data is deficient and not much is known about the relation between tourism and other sectors of activity. In order to assess the values of the ecosystem that attracts tourists to the Agadez region, there is a need for studies on the economic benefits derived from tourism.

Services provided by tourism are to be found at two levels: in the region of Agadez and internationally (tourists' countries of origin).

The services of tourism at the national level are relatively easy to estimate, but less easy to ascribe to the natural resources of the Aïr/Ténéré region. We have tourism revenue (all forms, not just the revenues of hotels or travel agencies, but also that of the craft industry, urban transportation, etc.) minus intermediary consumptions. This gives the added value, which while is a general proxy for the services of tourism, cannot all be attributed to the natural and cultural resources of the region.

#### **4.10 Paleontology and prehistory**

The Aïr/Ténéré is rich in fossil and prehistoric sites. Some paleontological sites contain high value fossils as since the 1960s, numerous vegetative, animal, and especially vertebrate fossils have been discovered. Of especial interest are several dinosaur sites. The size of these first-class discoveries suggests that many others are still to come, provided excavations continue.

Besides its paleontological wealth, the region of Agadez also has prehistoric wealth in the form of materials, tools, pottery, cave paintings, monuments, habitat and burial places.

According to some experts, it is in the sites of the Aïr and Ténéré that middle Neolithic man brought one of the most brilliant Saharan Neolithic civilisations to its peak. Man in that era domesticated cows and practiced ritual burial. Widespread in the Aïr massif, cave art is also found in the National Natural Reserve and in the Tiguidit cliffs south of the fossil valley, stretching down from Takalouzet to the Iwelen fossil valley south of Mount Temet. The paintings depict animals such as rhinoceros, elephants, hippopotamuses, lions, and especially giraffes, as well as horses harnessed to carts and/or mounted by a cavalier holding a spear and shield.

Pottery, monuments and burial places containing pottery items are found almost everywhere in the Aïr/Ténéré. Some of the items discovered are of exceptional value. The Iwelen fossil valley site contains habitats, tumulus necropolises and cave engravings. The habitats contain copper and bronze armatures, and the cave engravings represent men armed with spears and javelins. This is the only site in the southern Sahara testifying to copper metallurgy at that period. Other notable sites include the Tagalagal site which has yielded ceramics that seem to be the oldest in the world.

The more recent history of the region from the Islamic period has produced important historic vestiges. Dating from the creation of Agadez in the 15th century A.D. with the advent the Sultanate, there has been political, cultural, economic, religious and intellectual development. There are for instance 150 mosques, religious centers and cult sites.

Paleontological objects constitute a case where it is difficult to determine economic value, as the objects are irreplaceable, and are therefore priceless as they cannot be substituted. In theory, the types of value applicable to cultural goods are clearly known; these are heritage and existence values.

The value of cultural goods presents the following characteristics:

- Cultural goods appreciate with time, so by selling them today or depreciating them in some way, we deprive ourselves of future revenues whose value can but increase. Hence, it is of absolute necessity to protect cultural goods, avoid direct sales, and favour temporary exchanges and rentals.
- The consumption of cultural goods increases with time and the purchasing power. As south-east Asian countries and China gradually become the planet's economic pole, this opens up new potential for cultural tourism and fruitful possibilities for exchanges with these countries as well as Europe and America.
- Though heritage is not meant for direct sale, the fact of having a heritage increases Niger's power to negotiate with a number of museums. Niger could negotiate to rent objects instead of lending for free.
- European museums are increasingly gaining financial resources through management strategies such as obtaining commercial patronage. As part of its partnership with European museums, Niger should seek to transfer successful management methods to its own museums and cultural centers.

Niger's policy in terms of protecting and valorizing its cultural heritage has evolved considerably since independence. In the 1970s, there were no regulatory texts for the management and protection of this heritage. One result was that a large part of Niger's heritage is now based in the Paris Museum of Natural History.

The first sign of better national heritage management came with the creation of a Department of Cultural Heritage. Other signs of the authorities' rising awareness of the value of cultural heritage were the State's initiatives to have certain fossil objects returned to Niger. Actions are underway to have the site of Gadoufaoua put on the UNESCO list of world heritage for humanity. This will help generate additional resources to valorize and protect the site.

Beginning in 1997, Niger passed a law on the protection, conservation and development of the national cultural heritage. That same year, the enforcement decree of the law was passed, thus testifying to Niger's willingness to take full control of its archaeological and cultural heritage.

Plundering is a major threat to Niger's cultural heritage, and it is encouraged and/or organized by local populations who are either not sufficiently aware of the cultural value, or are motivated by greed. This has led the Department of Cultural Heritage and Museums to organize activities to sensitize local populations and institutions such as the army, the customs, and Forestry Commissions. The economic logic behind this sensitization is to reduce the costs of control and improve its efficacy.

#### **4.11 Documentary films, images, documents, and books**

One important service provided by the Aïr/Ténéré zone is that the region is used for the production of audio-visual works, photography books and Internet sites. This is a very important service because it is particularly through this role that most people come into contact with the region. This is also true for the people of Niger themselves, who generally only know the Aïr/Ténéré through documentary films and images.

However, there is no reliable information available on the number of documentary films and books produced on the region. In principle, the ministry in charge of the audiovisual sector grants authorization for filming, but the reality is different. The authorizations granted are not centralized, making it practically impossible to know their number.

There are more than one hundred books on Niger's desert and paleontological wealth. Photo exhibitions on Niger's desert are organized throughout the world, to the satisfaction of the public.

The importance of the region of Agadez is such that there are tens of internet sites dedicated to its image or promotion. Thousands of people visit these internet sites, and this is one service that the region provides to the rest of the world. According to Samuel Gaze, promoter of the Internet site <http://www.agadez-niger.com>, there are about twenty French-speaking sites dedicated to the Agadez and Air/Ténéré region. His own site receives 100 000 visitors annually; and the visitors marvel over the region's beauty. This is an entertainment value that the region provides.

Documentary films represent a form of non-consumptive direct use; that is, value deriving from the fact that environmental goods and services exist without being directly used.

This value may as:

- The benefits that media companies and producers gain from the films
- The satisfaction that viewers have in watching the films

It is noteworthy that, as mentioned earlier, value is the materialization of people's satisfaction or the use that consumers make of a particular good. Since people can rank goods and services depending on their preferences, it is quite possible in principle to calculate the value of such goods and services. Based on a representative sample of viewers of documentary films on Niger's desert, it would be possible, using a well designed questionnaire, to determine the monetary value of the films. The value thus determined represents what Niger offers humanity (at least as far as images are concerned), by the fact that it hosts and maintains exceptional sites on its territory. If Niger could effectively charge rent, it should receive the equivalent of these monetary resources for the service it provides.

Concerning the commercial exploitation of images, we could argue that Niger must set duties on the production of images that deal with sites presenting exceptional goods and services. The level of such duties should be at least equal the services that the sites provide. However, in practice, there are several obstacles to this:

- Because of the size of its territory, Niger does not have the means to control all its sites
- Though filming is subject to authorization, very few filming projects go through this official channel
- The State of Niger is not as yet aware of the revenues it may draw from such a policy

The world market for environment-related documentary films is huge. Charging for the economic value of environmental goods and services should help to better protect the environment, because it raises awareness. This could have an impact on Niger's GDP through the added values generated.

#### **4.12 Impact of valuing environmental goods and services on Niger's GDP**

GDP is the sum of current incomes derived from the entire capital stock or wealth of a country. GDP calculation requires the use of all the added values produced all year long. However generally, this calculation does not include the environment. In 2003 CNEDD and PRIPAN conducted a study to try to correct this problem by integrating some goods and services. According to this study, only six products including wood, fish, gum, honey, tamarind, and doum palm are included in the calculation of the GDP.

The GDP underestimated the total values of environmental goods and services for several reasons. Firstly, only six products are used, whereas it has been shown here that many other environmental goods and services could be included. Secondly, there are some deficiencies in the methods used to evaluate the six products; for instance, the forest GDP is determined using relatively old data. With demographic growth and the various pressures exerted on the environment, some economic and cultural products and by-products have been revalorized, and they need to be included. The CNEDD study takes the example of a

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forest product called *gao* (*Faidherbia albida*), which only a few years back was not traded at all, but currently its fruits are sold between 1 500 CFA F and 3 000 CFA F for a bag, depending on the regions. Lastly, there is no monitoring to update the parameters used for the different measurements.

The study chose to recalculate the value of eight products, and provided a new estimate of these products to the GDP, estimating their contribution to be 7.13% in 2002 compared to the national records value of 4.2% for 2002.

The study estimated the value of six wild products and pharmacopoeia which could also be included in the GDP. Table 12 presents the values found by the study.

**Table 12: Added value of some environmental goods**

Scientific or common name	Value (billions) CFA F
<i>Cassia tora</i>	0.31
<i>Baobab leaves</i>	1.47
<i>Ziziphus fruits</i>	1.05
<i>Balanites fruits</i>	1.05
<i>Palmyra fruits</i>	1.50
<i>Moringa</i>	2.11
Pharmacopoeia	28.04

Source: CNEDD, 2003

Based on the values and the re-evaluation of the products already used, the contribution of the forest and fishing sector may be estimated at 9.16% for 2002 against 4.2% in official figures.

Even a very partial analysis of environmental goods and services indicates that natural resources make an important contribution to GDP. In future, efforts such as the CNEDD study need to be strengthened. The estimation of products needs to go beyond consumption and production, and there is no reason to set restrictions. Additional different uses such as grazing, tanning, fabrication of utensils and craft items, pharmacopoeia, construction, and consumption of natural products must be listed and valorized.

## **5 What future for the Aïr/Ténéré?**

The future of the Aïr/Ténéré in terms of valorizing environmental goods and services very much depends on the interactions between the actors and stakeholders managing the ecosystem. This chapter examines the perceptions of the different actors, their needs, their capacity for intervention and the tools necessary to achieve optimum management of the region's goods and services.

### **5.1 The main actors**

There are many actors involved in the management of goods and services of the Aïr/Ténéré region. They include the resident populations, composed of loosely defined groups, and institutional actors. The residents include urbanites and rural residents (both nomads and sedentary groups). The institutional actors comprise the State's decentralized services in charge of rural development and the environment, advisory structures, NGOs defending and protecting the environment, land commissions and Communes. There is also the private sector, represented by tourism and mining companies. Besides these key local actors, some

members of the international community also play a crucial role in the management of the Aïr/Ténéré and must be included.

Each of these actors has specific needs, but their interests may be conflicting. Their needs shape their perceptions of the region's environmental resources.

### **5.1.1 Residents**

According to a recent census, the population of the Aïr/Ténéré comprises 61.6% rural groups and 39.4% urbanites. There are actually a number of sub-groups, as follows.

Rural sedentary groups depend on agro-pastoral activities, practicing irrigated gardening which is the main source of wealth in the region. The land they use is concentrated in valleys around wells, oases, surface or ground water. As such they directly compete with other land and water users, particularly nomadic pastoralists.

Some sedentary groups are handicraft workers who may live in urban or rural zones. As part of their activities, they use woody products found in their immediate environment.

Nomads are pastoralists who need large areas of grazing lands for their animals. They move depending on the situation of fodder and water points.

Another important group of actors are the wood exploiters who cut wood in some parts of the Aïr, and resell in urban zones. Their operations may be legal, but in most cases they operate illegally with the complicity of some rural populations. In any case, the rural populations are highly dependent on firewood for their energy needs.

Urban populations principally are actors operating in the informal sector (trade, handicraft, etc.). This group has a higher purchasing power than that of the rural group, and tends to use environmental products in larger quantities, especially firewood for domestic energy needs. A significant cause of deforestation is due to the high demand for wood products among urbanites.

Besides these residents, there are incoming tourists. But only a few thousands of them come to visit the beauties of the Aïr/Ténéré region with its more than 100 natural sites. Tourists help to develop one of the most important economic sectors of the region.

### **5.1.2 Institutional actors**

Institutional actors are many and operate in different environmental areas. They are found in State institutions, civil society organizations, decentralized structures and markets.

*State structures* at the local level include regional directorates in charge of Environment, Agriculture, Pastoralism, and Hydraulics, as well as development projects. These services implement the State's policy through enforcing relevant laws, sometimes by coercive means as in the case forest commission agents.

Development projects generally originate from the central State and address specific aspects of environmental protection which are inadequately covered by the State's local services. Generally, they involve interactions between the State and local populations.

At the regional level, there is an important advisory structure: the Regional Environmental Council for Sustainable Development (CREDD). CREDD is the local representative of the National Environmental Council for Sustainable Development (CNEDD), which at the national level is responsible for implementing the national environmental program for sustainable development. CREDD is responsible for designing a regional environmental plan for sustainable development and for ensuring its implementation. It comprises the regional State structures as well as civil society organizations.

*Civil society organizations* are very active in the region. Many of them carry out sensitization activities on environmental protection, and they are also contracted by projects or State services to provide some services. They operate on the principles of cooperation and

persuasion. As a result, they are often more efficient in their interventions than State structures or even development projects.

*Local government structures* include the Regional Council, the District Council, Communes, municipalities, and land commissions. Ongoing decentralization has conferred certain powers to the regional council, communes, and municipalities, in terms of managing the environment of their jurisdictions. This is necessary for efficient management of the environment at the local level.

Land commissions and the Permanent Secretary for rural code constitute a framework for implementing natural resource management policies. The law confers upon them considerable powers in terms of transferring undeveloped land to third parties, controlling land development, establishing and recognizing land tenure rights, and transforming rural concession rights into property rights.

Environmental services like tourism are promoted by *the private sector*, principally travel agencies and hotels. The private actors here are both nationals and expatriates; they are the ones who mostly benefit from tourism.

The environment is also affected by the activities of mining companies. Three companies exploit uranium and charcoal in the region of Agadez. Their activities have a great impact on the environment in terms of pollution, water consumption and destruction of certain habitats. Despite the legal terms and conditions on the protection of the environment, profitability seems to mostly motivate these companies. As a result, without some strong constraints, we should expect to see them continuing to shun their responsibilities vis-à-vis protecting the environment.

*The international community* is represented in the region, via certain structures. Niger has signed most of the conventions about the protection and safeguarding of the environment, and this is a commitment for all parties operating in the country. The Aïr/Ténéré region harbours the Aïr and Ténéré reserve, which enjoys international recognition. In 1991, it was put on the UNESCO's list of World Natural Heritage sites, and in 1996 it became a biosphere reserve. These initiatives are monitored to make sure the terms and conditions adopted are observed.

For a good policy in terms of valorizing environmental goods and services, the interests of all these actors must be taken into consideration. This is not easy to achieve, because the different interests tend to conflict.

### 5.1.3 Conflicting interests

Environmental economics identifies five types of value for environmental goods and services. This categorization helps in understanding what is at stake, as well as the interests of the different actors. The five types of value apply whatever the environmental good concerned, but different actors are interested in different values. Let us take the case of the natural reserve of the Aïr/Ténéré. The table below shows the different ways in which actors position themselves depending on their needs or interests.

**Table 13: The different values of the goods and services of the Aïr/Ténéré reserve, according to actors**

	<b>Goods</b>	<b>Actors concerned</b>
Direct use value	Fodder, fauna and flora, tourism	Nomads, farmers, all other residents, tourists
Indirect use value	Biodiversity, ecosystem	State (forestry commission agents), international community
Option value	Exploitation possibilities for future	State, private sector

	generations	
Bequest value	Pleasure related to wide spaces and ownership	Nomad population, tourists
Existence value	Value related to the sheer existence of the reserve	International community, ecologists, tourists

Despite the possibilities for conflicts, there are several opportunities for coherent management of the natural resources of the Aïr/Ténéré region.

## **5.2 Legal instruments for the management of environmental goods and services**

Niger's decentralization process may be perceived as institutional support for the management of the environment. Under the terms of the 11 June 2002 Law N° 2002-012 and Law N° 2002-013 of the same year, the central administration, which used to manage environmental issues, has transferred this competence to the new local governments (the region, district, and commune).

In this respect, Article 12 of the 11 June 2002 Law N° 2002-13, stipulates that "local governments may receive a transfer of competence in the following areas: land, economy, planning, national development, urbanism, environment and the management of natural resources, pastoralism, agriculture, fishing, etc."

If enforced, these laws should help achieve sustainable management of the environment, as a means of financing local environmental protection has also been created. The 11 June 2002 Law N° 2002-012 bearing on the creation of decentralized entities also grants local governments certain taxes. Articles 162 and 163 stipulate that "Within the boundaries and conditions determined by the finance act, the State grants the region, district, or commune all or part of the taxes and remunerating duties that local governments shall collect for the State, when all or part of the services paid for by such taxes or duties are provided local governments" and that "The regional council, district council, or municipal council may set additional cents to State taxes or duties for which a list and maximum rate are determined by the law. The additional cents are collected at the same time and under the same conditions as the principals. Their amount is directly handed to the region, district, or commune."

With such provisions, the way is open for an efficient management of natural resources through a tax system or creation of a fund for local protection of the environment. The law authorizes local governments to use such systems.

In addition to the above new laws, there are previous provisions of laws and decrees which indicate the State's interest in the value of environmental resources. For instance:

- The 7 December 1998 Law 98-41 bearing on water regulations, and which defines and determines water regulations in Niger, and lays out the conditions of use of water resources. Under its sections I, II, and III, the law clarifies the case of waters belonging to the public domain, provides measures for protecting the quality and quantity of surface and ground waters, and sets the conditions for public works, concession of public services, and usage of collective waters.
- The Law 93-16 bearing on mining. In compliance with its article 99, all mining and quarry operations must take place in such a manner as to ensure a rational exploitation of national resources and the protection of the environment.
- The 10 January 1997 Decree N° 97-07 defining regulations bearing on pastoralists' land of attachment defines the legal frame for national and regional development, the protection of the environment, and human development. However, some experts feel that enforcing this text may cause problems because two types of laws overlap: customary law and civil law. Ambiguities may arise when the two laws are

confronted.

- The 10 January 1997 decree N° 97-006/PRN/MAG/E bearing on the regulation of rural natural resource development. This decree defines the legal regime for the development of land, plant, hydraulics, and animal resources as determined by Article 2 of the 2 March 1993 Ordinance N° 93-015 bearing on the Orientation Principles of the Rural Code. Article 2 insists on sustainability in all cases of exploitation, and stipulates that “Development means any activity or action undertaken by man on natural resources with a view to exploiting them rationally and sustainably, using means likely to protect and restore them, while improving the productive quality and yield.” Article 3 states that “Natural resources are part of the Nation’s common heritage. Anybody holding rights recognized by the law regarding whatever resource has a duty to develop it.”
- The 29 April 1998 law N° 98-07 bearing on the regulation of hunting and protection of the fauna. This law defines the regulations on hunting and protecting the fauna. Its section II defines the hunting practice rights and determines the rights that traditional riparian communities may have in terms of hunting and capturing animals. Section III indicates the conditions for protecting the fauna and classifying species depending on whether they are fully or partially protected or subject to specific regulations.

The different laws and texts are legal instruments that the various actors must take ownership of and seek to enforce in the best possible ways.

#### **5.4 Compensating for environmental goods and services (CSE)**

For better implementation of the valorization actions of environmental goods and services, they could be capitalized through a project with two key components:

- Compensating for environmental services
- Valuing paleontological and pre-historical sites.

The importance of environmental goods and services in the Aïr/Ténéré zone leads to the recommendation that they be valued, as an economic justification for sustainable development. This is best achieved through a participatory approach, since we have noted that there are many interest groups who have a stake in those goods and services.

Three regulatory modes are generally used in environmental management: the market, the state or administrative authorities, and civil society, which may be the communities in more or less formal structures. Each of these actor groups has comparative advantages.

Two categories of action have been taken so far to protect the environment. On the one hand, there are legislative and control actions aiming to improve the exploitation of natural resources for the sake of sustainability. On the other hand, there are alternative measures aimed at reducing adverse effects of natural resource exploitation. In the latter case, this includes costly infrastructures like big dykes, large scale reforestations, green belts, the reintroduction of certain species, etc.

These actions have proved insufficient and inefficient. As a result, over the past decades, another approach considered as more promising has been gaining ground. It is known as compensating for environmental services (CSE), and operates on the following principles:

- First, the need to compensate for the work of people, who either through exploitation or through managing environmental goods in a sustainable manner, contribute to a long term preservation of ecosystems
- Second, it is normal and optimum for service beneficiaries to contribute to this compensation, which may take different forms.

The key objective in this new regulatory approach is to include factors external to the

immediate targeted environment, as this eventually leads to optimum protection of the target environment.

That CSE is relevant does not make it easy to apply. There is not one way of applying CSE; however, any successful application must involve the following steps:

1. Recognize the economic importance of ecosystem goods and services
2. The point is to convince the key actors that natural resources provide goods and services that also have an economic value. These goods and services may disappear if the environment is poorly managed
3. Identify and quantify the environmental services to be taken into consideration as part of the compensation
4. This is a difficult task requiring significant resources (material, human, and intellectual). The services provided are varied and some are difficult to quantify, for instance biodiversity and some environmental functionalities
5. Identify the actors and groups of actors and their respective roles. Who are the service providers? The users? And where applicable, who are the intermediaries in the CSE mechanisms? Who benefits and who pays?
6. Estimate the value of the services provided using the methods of environmental economy and alternative models taking the different actors into consideration
7. Institutionalize the CSE mechanisms by establishing adequate conditions and frameworks
8. Implement the mechanisms, based on concrete arrangements on the nature and volume of the services to be provided and the forms and amounts of the compensation.

### **5.5 Valuing paleontological and prehistoric treasures**

This is the weak link of Niger's cultural heritage policy. To make the protection of paleontological and prehistoric objects credible and to create incentives for protection, it is necessary to valorize them. This means creating an economic value for the paleontological and prehistoric resources, from which a local population can benefit. Some ways could include:

- Developing paleontological and prehistoric sites and vestiges
- Managing the sites in collaboration with local populations
- Creating museums at the discovery sites
- Making paleontological and prehistoric collections available for tourism
- Promoting tourist routes to view sites of paleontological and prehistoric heritage
- Coordinating and controlling tourist activities in the region.

This valorization process requires financial resources. However, some historians and curators may distrust markets, whereas markets are necessary to raise the funds needed, if not supplied by the State. The point is not about selling artistic objects or heritage items, but rather about conferring a market dimension on cultural heritage.

An example would be to create an organization to develop the economic benefits of the paleontological and prehistoric treasures in the Aïr/Ténéré. Such an organization should involve the State, local governments and populations, as well as international volunteers. The aim of the organization would be to seek and disburse funds for paleontological activities such as excavation, valorization of sites in the form of open sky museums, museums to exhibit objects, and internet sites dedicated to paleontology.

Some potential donors are known, for instance international institutions like UNESCO. Niger has been seeking to have the site of Gadouafaoua put on the list of humanity heritage. Another no less credible possibility concerns international patronage: foundations created by corporations or individuals as patrons of art, seeking to improve their own image as part of a global communication strategy. The uniqueness of Niger's paleontology is an asset to tap, as it perfectly meets the strategies of many foundations and patrons. If there are well-presented proposals from Niger, funds could be obtained for archaeological research and for the protection and valorization of the sites.

## **6 Conclusion**

The study has led to the conclusion that although the Aïr/Ténéré is an arid region, it contains many environmental goods and services that have high economic potential. However, so far most of these have not been valued and Niger's policies do not therefore take these entirely into consideration.

Apart from tourism, the economic value of these goods and services is not recognized. Yet, many among them are of great value; for instance fodder for livestock, or paleontological and fossil items.

Further studies are needed to quantify the use and estimation of the value of these goods and services, based on rigorous criteria. This will require statistical surveys among urban households as well as rural sedentary and nomadic households.

The economic value of these goods and services must be accounted for, to justify sustainable development of the natural resources. To do so, the help of all the actors in the zone will be necessary.

The present study has also helped to identify the legal instruments and the institutional frameworks necessary for the actors' intervention.

The study proposes an exercise to value the region's goods and services, through a project, which could be entitled "Valorization of environmental goods and services in the Aïr/Ténéré."

The project will have two main components:

- Economic compensation for environmental goods and services (CSE).  
The CSE approach can help protect the environment in a sustainable manner by rewarding those who protect the environment and requiring compensation from those who use its services.
- Valorization of paleontological and prehistoric sites

The region's ancient sites will be able to express their potential only when they help generate financial resources for the benefit of local populations.

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