

KEITA: THE IMPACT ON ENVIRONMENT AND LIVELIHOOD STATUS OF 20 YEARS FIGHT AGAINST DESERTIFICATION ACTIONS

Abstract

The Keita *Department* is located in the center of the Republic of Niger and cover an area of more than 4,860 km² composed of a plateau with rocky slopes and valleys, forming a complex system of watersheds subject to strong winds and water erosion. The Keita valley has always represented a border for the Sahara desert, allowing the development of a multiethnic community composed by peasants coming from Southern regions and nomads from the North.

The Ader Douchi Maggia Rural Development Project (PDR-ADM), known as Keita Project, was launched in 1982 in the framework of the Italian Initiative for the Sahel to reduce food insecurity in a region close to the environmental collapse. The main objective was to increase food security over a very large area, while combating desertification through the reduction of soil erosion and reforestation.

More than 20 years of soil conservation and land reclamation interventions make Keita an open air laboratory where is possible to carry out studies on the impacts of fight against desertification actions from the environmental and socio-economic point of view.

Between 1984 and 2002 woodlands increased more than 300% (10.000 ha in 1984 to 45.000 ha in 2002) against a reduction in the shrubby steppes of the 30% showing an upgrading in landcover quality. Wood production is estimated during the same period increased by 49% while leaf biomass by 57%. Finally cereal production has grown from 39.000 to 55.000 tons.

Keita has proven that desertification control and recovery is demanding projects lasting decade and not only years considering that reclamation is demanding twice the time necessary for degradation and prevention is extremely less costly than reclamation.

The Keita ecosystem

The Keita *Department* is located in the center of the Republic of Niger and cover an area of more than 4,860 km² composed of a plateau with rocky slopes and valleys, forming a complex system of watersheds subject to strong winds and water erosion. The soudano-sahelian climate with a short rainy season (June - September) and a yearly average between 400 and 500 mm, represents one of the main limiting factors due to the intra-annual and inter-annual variable rains. Between 1960-1990 a decrease of yearly average rainfall was observed, particularly during the month of August, with a latitude shift of 30 km from Northeast to Southwest. In 1962 the plateau slope were entirely covered by forest. Starting in 1972 evident signs of forest degradation appeared and in 1984 this forest had completely disappeared.

The decade ranging between the two last great dryness of 1973 and 1984 represents a kind of line of demarcation between two environmental and socio-economic systems with very different characteristics. A negative synergistic process, which seemed irrepressible, struck the ecosystem bringing it close to the break point. Crop productions dropped down and herds were decimated. In 1984 the area seemed directed to become again a zone with a reduced population as it was at the beginning of the century and without future.

The Keita valley has always represented a border for the Sahara desert, allowing the development of a multiethnic community composed by peasants coming from Southern regions and nomads from the North. The total population increased from 65,000 inhabitants in 1962 to 230,000 in 2003.

The Keita Project

The Ader Doutchi Maggia Rural Development Project (PDR-ADM), known as Keita Project, was launched in 1982 in the framework of the Italian Initiative for the Sahel to reduce food insecurity. It became operational in 1984 and since then it has been active through three phases ended in 2003. The main objective was to increase food security over a very large area, while combating desertification through the reduction of soil erosion and reforestation.

A new initiative (Fond Local de Developpement de l'Ader Doutchi Maggia, FLD-ADM) is starting with the objective to complete existing interventions, fund local investments and transfer the management and property to local institutions and organizations.

The PDR-ADM approach subdivided the project area into units, named Elementary Territorial Units (UTE), where the project intervening by:

- reclamation of the plateau and the abandoned land in the valleys for agricultural and pastoral purposes,
- reforestation of the slopes, of the *koris banks* and dunes,
- creation of wind breaks and forest areas,
- control of the water flow in the *koris* by banks consolidation and small dams.

Simultaneously the Project has also addressed the social and economic development by building schools, medical centers, wells and roads, and providing technical assistance and financial support for the creation of new economic activities.

The main interventions 1984-2003 of PDR-ADM are showed in the table below (MAE – DGCS, 2003):

INTERVENTIONS UNTIL 2003	
RECLAMATION AND IMPROVEMENT OF AGRICULTURAL AND PASTURE LANDS, REFORESTATION AND DUNE FIXATION	34,483 HA
TREES PLANTED	18,000,000
ROAD CONSTRUCTION	313 KM
DRILLED WELLS	5
EXCAVATED WELLS	708
RURAL BUILDINGS	28,000 M²
SMALL DAMS	40
DAMS	2
WEIRS	251

More than 20 years of soil conservation and reclamation interventions makes Keita an open-air laboratory where is possible carry out studies on the environmental and socio-economic impact of fight against desertification actions. The availability of long series environmental data and information concerning the age and typology of intervention allows the development of specific environmental analysis and indicators based on data rather than models. This extraordinary situation gives the opportunity not only to evaluate the impacts of PDR-ADM actions but also to model the behaviour of natural vegetation (trees and herbaceous) during the recolonisation of degraded lands and foster future development and potentialities.

Project results

The Keita project has played a major role in blocking the tendencies of ecosystem degradation mainly due to climate changes and human activities and improved the biophysical and socio-economic well being of the area. It has been proved by a scientific evaluation of the Project impact

(PEICRE¹, 1996, CeSIA). It was funded by Italian Aid with the aim to localize and date the different interventions, collect data, and review their effectiveness over time.

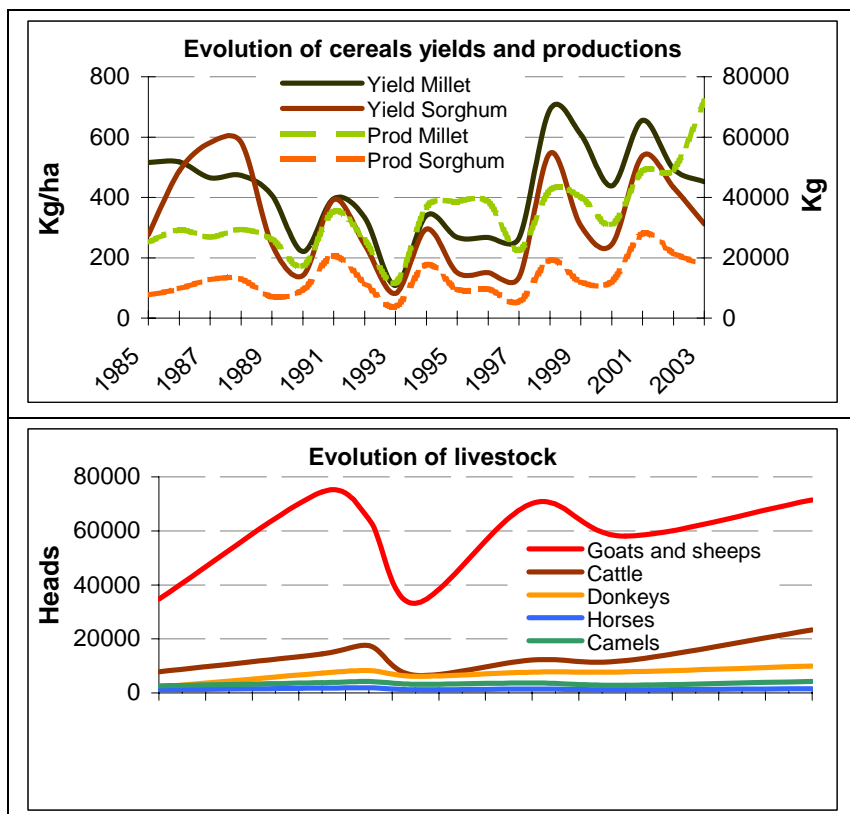
The project actions increased the availability of croplands, often by reclamation of unproductive areas, and to increase output and productivity. In the same time land degradation and desertification has been limited and large surfaces have been recovered. The project strengthened also the productive structure of breeding sector by introducing forage alternative to grass and improving the veterinary infrastructures and knowledge.

Moreover the productive structure of the area has been changed by the project presence, the traditional agro pastoral-system, based on rainfed millet and nomadic flocks, is getting more complex. Cash crops, as onions and sesame, have been integrated with cereals, irrigation is becoming more diffuse, fish farming has been introduced in the reservoirs, the commercialisation of non-timber forest products (Arabic gum, leaves, fruits) given by trees plantations was improved.

Keita reached at the end of the century a new environmental equilibrium, reversing the trend toward degradation and desertification.

Nowadays, Keita is indicated like an example in the Sahel region and becomes therefore a point of reference in the definition of policies and strategies to fight desertification in the Country and in the whole region.

A second study, promoted in 2002 (IBIMET-CNR) with the aim of evaluating the Keita Project 'contribution' in the framework of the three majors International Conventions² awoke the interest on the Keita system in relation to the potentialities of the zone in terms of carbon sequestration. It estimated that the Keita valley, thanks to the project interventions, sequestered approx. 132.000 tons per year of CO₂. This result shows the potential that semi-arid regions provide in carbon sequestration and the Kyoto protocol.



¹ PEICRE:

² UNCCD-UNCBD-UNFCCC

The effectiveness of the Keita Project has been confirmed further by the data collected on the three main types of intervention focused to soil conservation : *banquette de plateau*, *tranchée* and *banquette de glacis*

The *banquette de plateau* have transformed the plateau, from a marginal resource for breeding to a main resource with great potential, as demonstrated by the change in the existing practices of the local population and the arrival of nomads population. This resource played an important role in the establishment of a more flexible and less vulnerable economic system. Data collected in 1996 (PEICRE) and 2003 (PAFAGE) have shown that forage yields have increased by more than 90% .

The *tranchée* have proven extreme efficiency in eliminating, or at least strongly reducing, the water erosion on arable lands and in allowing agriculture activities on previously abandoned lands. The trees planted represent a valuable resource of wood for cooking and goat feed

The *banquette de glacis* have been effective in reclaiming arable land previously subjected to desertification and abandoned. Even though, the poor quality of the soil would not allow yields comparable to those coming from the best arable land in the valley. The trees planted in the area produced eight times more wood per plant, than the trees planted in the *tranchée* and yielded twice as much goat feed than the *banquette de plateau*.

Starting from 2003 Keita becomes a ROSELT³ environmental Observatory, operational by the means of PAFAGE Project (CeSIA & IBIMET-CNR), funded also by Italian Aid.

The Observatory becomes an opportunity to monitor the environmental and socio-economic changes in the area, in fact existent databases have been updated and environmental and socio-economic analyses have been carried out.

Environmental impacts

The impact of PDR-ADM interventions on the environment has been monitored by a multitemporal analysis of land cover⁴. Changes in land cover are the result of synergies of different factors (climate changes, interventions of PDR-ADM and demographic pressure). The environmental status before the beginning of the project testifies the negative impact of climate and anthropic pressure on the ecosystems. In 1962, the slopes of the highlands were forested but in 1972 some signs of degradation were already evident and in 1984 the forest completely disappeared. Between 1984 and 2002, we assist to a progressive recovery of the natural vegetation.

Approximately, the diachronic land cover study shows that between 1984 and 2002 woodlands increased more than 300% (10.000 ha in 1984 to 45.000 ha in 2002) against a reduction in the shrubby steppes of the 30%. This tendency is supported, besides the PDR-ADM intervention, also by the progressive increase of rainfall, which was recorded as from the years ' 90.

Type of land cover (hectares)	2002	1984	Variation
Woodlands	45,542	10,876	319%
Shrub lands	67,422	95,950	-30%
Grasslands	17,417	60,277	-71%
Rainfed croplands	150,730	84,102	79%
Irrigated croplands	1,006	968	4%
Bare	124,196	144,998	-14%
Dunes	21,847	32,441	-33%

Even if the same dynamics is observed in the whole sahelian part of Niger, this trend has only reached such results in Keita, because of the intervention of PDR-ADM and the control of the human pressure on natural resources. In addition of wooden natural vegetation recovery there is also an evident increase of agricultural surfaces (about 80%) resulting of the substitution of large grassland areas (decreased about 70%) and of

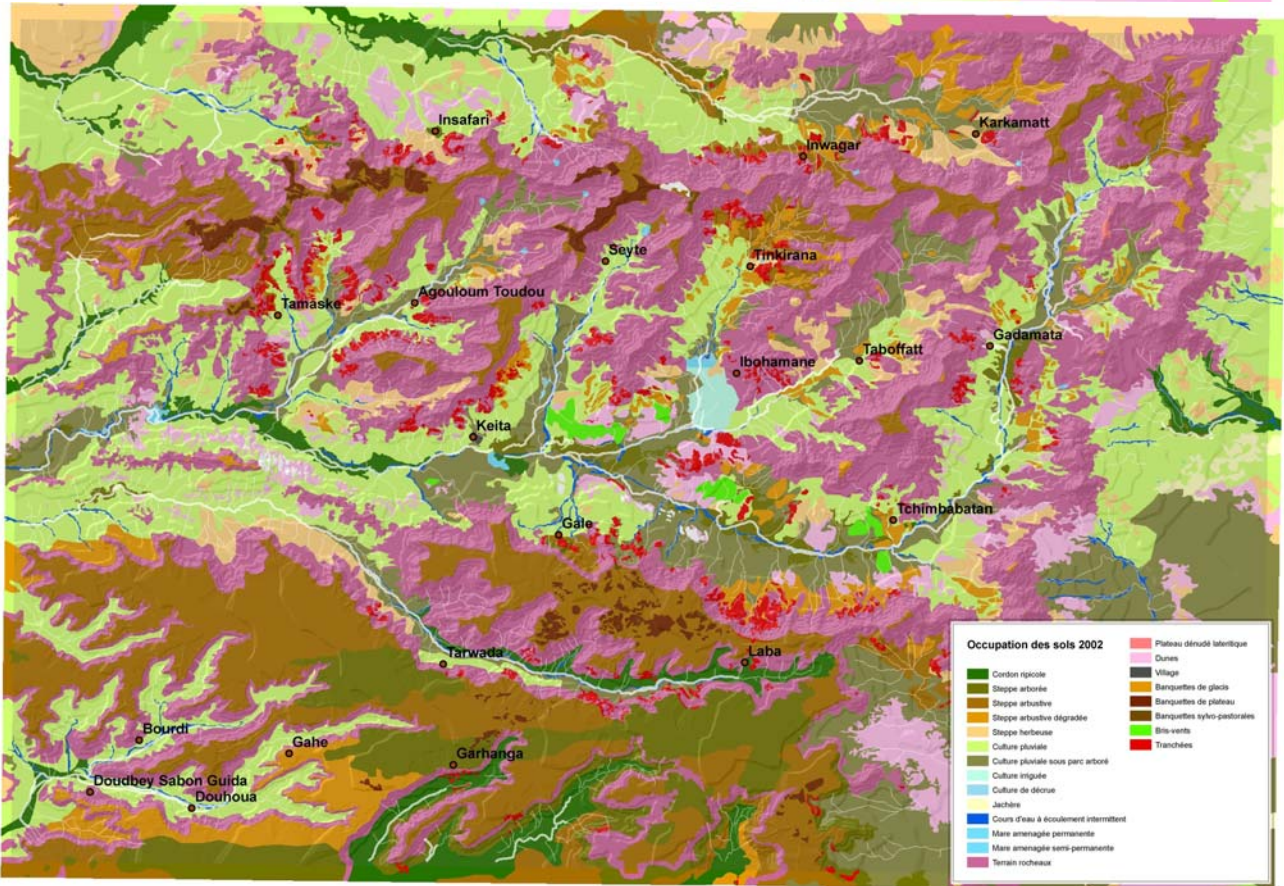
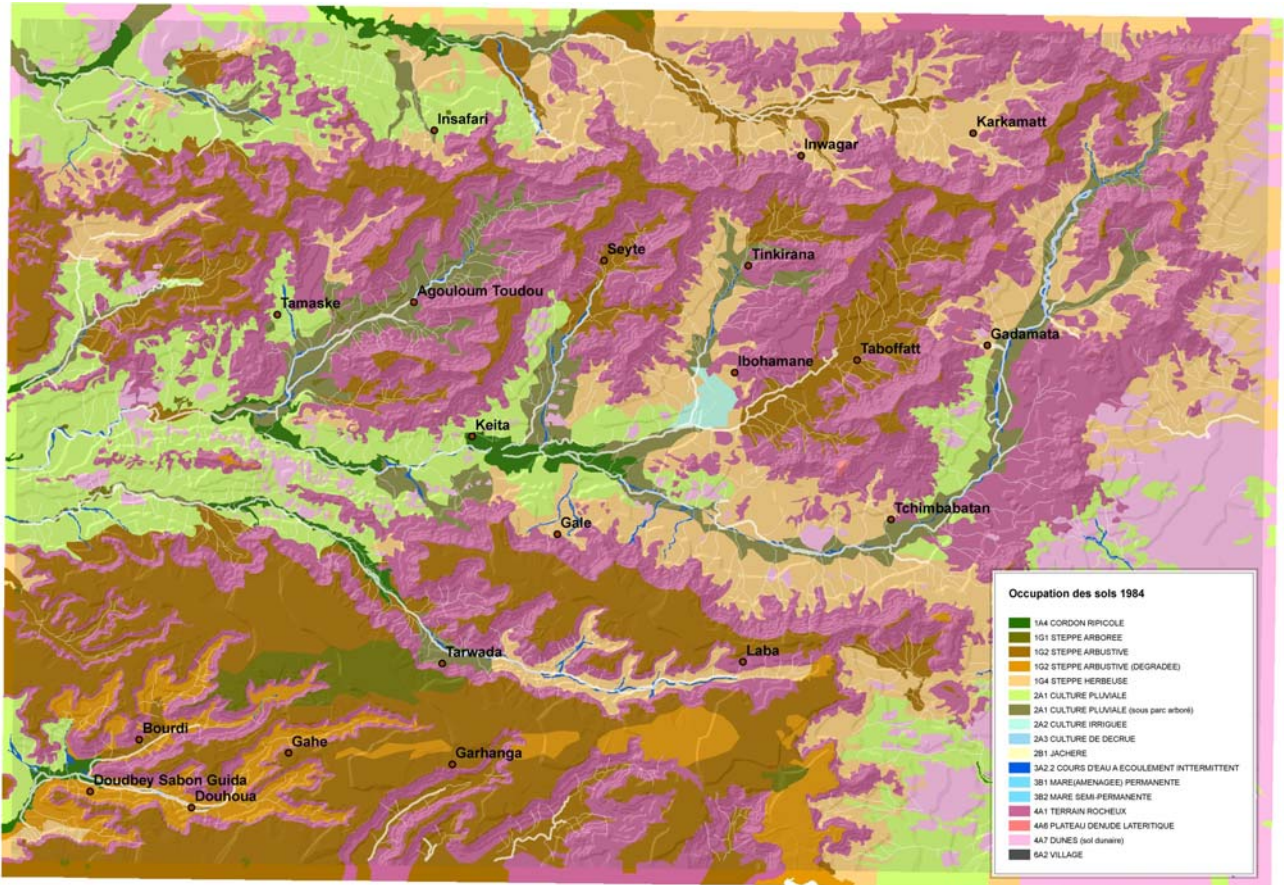
³ ROSELT:

⁴ Land Cover classification is expressed by the LCCS standards of FAO-Africover

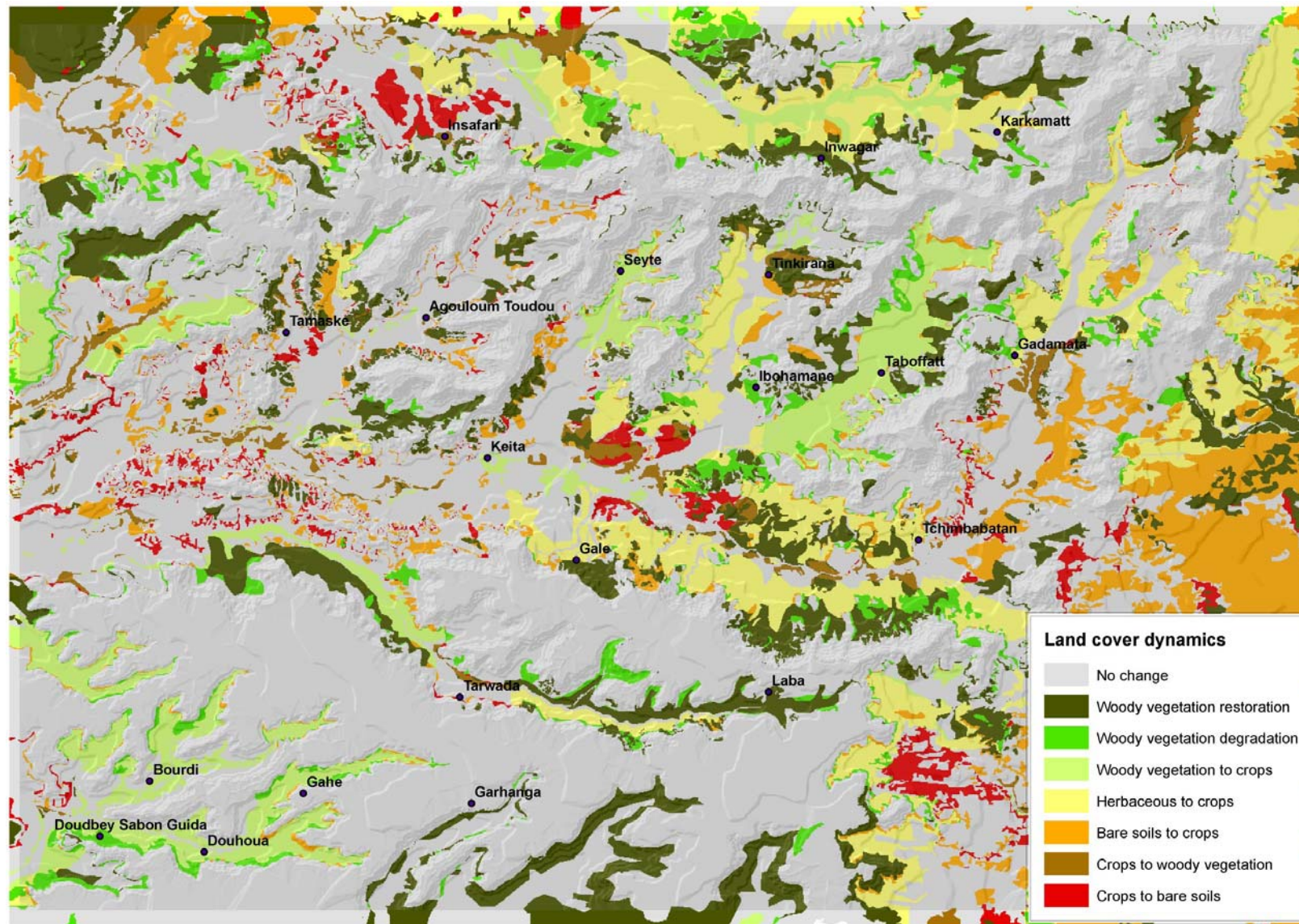
PDR-ADM land reclamation interventions (about 20.000 ha). These data confirms that the tendency of natural vegetation recolonisation is reduced by the increase of the human pressure.

More in depth, valley and glacia are exposed to higher agriculture pressure and the trend is to the extensification of croplands. This happens in three ways: by reclamation of degraded lands, by reclamation of grasslands or by clearing of woody vegetation. The first one, supported by the PDR-ADM, concerns the slopes of the Keita valley and also the sandy dunes of the eastern plateaux. Land reclamation of grasslands has been push by demographic pressure especially in the Keita and Insafari valleys. Woody vegetation clearing happens especially in the secondary valleys where demographic pressure was low before 1984 and strongly increased later. By the other hand woody vegetation restoration interests large areas on the slopes and also in the valleys as gallery forests. This trend on the slopes is particularly interesting where it is not directly due to Project interventions (plantation in trenches), because it shows the effectiveness of the watershed approach and the water management on plateaux and slopes.

Croplands degradation is also observed, due mostly to wind erosion and sand accumulation. It gives evidence to the fact that desertification is still active even if PDR-ADM interventions reduced its effects. In this context, the territory monitoring in the aspects that could indicate a reactivation of the desertification is very important especially in this phase in which the environment is slowly recovering equilibrium.



Keita valley, Land cover in 1984 and 2002 (with PDR-ADM interventions) - Interpretation of Landsat image



Land cover dynamics between 1984 and 2002

Improvement of land productivity

The pressure derived from the population growth is nowadays one of the main desertification factors, as consequence the classic environmental approach to fight desertification is doomed to fail if it is not joined with actions aimed to reduce the pressure through the creation and diversification of sources of income for the population.

In order to appreciate the project impact, not only the impact on environment but also the improved productivity of the territory due to the intervention has been studied. The productivity is assessed considering the main products contributing to population livelihood: agriculture, forestry, and livestock. In the domain of agriculture only rainfed cereals have been considered, no data being available about cash crops productions.

Concerning plantations, this study considers only bloc plantation as “tranchées” and “banquettes” but doesn’t consider linear plantations as on the banks of the koris. This choice is based on the methodological consideration that bloc plantations will be or could be easily and directly managed at household level⁵ and their production can directly enter in the livelihood estimation. On the contrary, linear plantations are of public utility and cannot be exploited for private purposes. Moreover, linear plantations are difficult to be inventoried and monitored.

Initially the study considered the whole project area and afterwards the analysis has been focused on the two more common interventions: banquettes de glacis (bench terraces) and tranchées (trench), expressed per hectare.

General results

The whole project area produced in 2003 about 25.000 tons of wood, that on the local market corresponds to about 450 millions of F-CFA. In 1984 the value of wood production is estimated (at the actual price) in 300 millions of F-CFA. The variation is therefore of 49%. The availability of leaf biomass is also increased, about 57%.

Products	2003		1985		Variation %
	Productions	Value K-FCFA	Productions	Value K-FCFA	
Wood tons/an	24,982	449,676	16,714	300,858	49%
Available leaf biomass tons/an	27,023	675,587	17,187	429,684	57%
Gum kg/an	225,000	112,500			
Available herbaceous biomass tons/an	34,154	341,539	51,126	511,257	-33%
Cereals (millet + sorghum) tons/an	54,853	4,895,588	39,131	3,492,482	40%
TOTAL		6,474,890		4,734,281	37%
Pressure	Units		Units		Variation %
UBT	42,064		27,706		
Population	231,860		153,508		51%
Needs of cereals	57,965		38,377		51%
Needs of wood tons/an	57,965		38,377		51%
Needs of forage tons/an	83,793		55,191		52%

Wood production is considered as sustainable exploitation of both natural formations and plantations. The value is established considering 25% of timber and 75% of fuel wood at the relative prices of 60.000 F-CFA/ton and 4.200 F-CFA/ton. Needs in fuel wood and cereals derive from the official norms (250 kg/person/year). The needs of forage are based on the consumption norms of fodder (1 UBT needs 6,25 kg/day of dry biomass).

⁵ One of the objectives of the PDR-ADM actual phase is indeed to transfer the management of interventions to local populations.

Cereals production of 39.000 tons in 1984 reached in 2003 about 55.000 tons for a global value of 4.9 billions of F-CFA⁶. Vis-à-vis with these variations, the pressure on the natural resources also strongly increased, population and livestock are increased about 50% during the period.

Specific results

In order to appreciate the improvement on the income generation capacity, the productivity of 1 hectare of glacis and 1 hectare of slope have been estimates both before and after the PDR-ADM intervention.

The *interventions on the glacis* (banquettes de glacis) had a yearly growth of production estimated about 1400% as consequence that in 1985 glacis were degraded and uncultivated land. Besides the agriculture, that offers the highest contribution (about 70%), forage produced by trees (fruits and leaves) and gums produced by Acacias constitute the second contribution with a net increasing of 1000% each.

On banquettes the incrementation of the yearly productions corresponds to 59.000 Francs-CFA. Considering that 2003 GDP per capita in Niger was 232 US\$ (WDI - World Bank) as 118.000 FCFA the increase of 50% of the GDP per capita seems to have a great importance.

Another important contribution to the economic productivity is represented nowadays by the possibility of income offered by the Carbon market in the framework of Kyoto protocol. In the table the CO₂ value is reported as CERs (Certified Sequestration Units) at the hypothetic European market value (if afforestation CERs could be accepted).

In the total value of productivity the CO₂ contribution is not considered because it is in concurrence with wood production whose value is, for the time being, higher. The CO₂ is evaluated on the basis of the carbon sequestered by woody aerial part and the root part of the tree. Carbon/wood ratio applied is 0.4974 (experimental value for Acacia seyal).

Estimation of the productions in 1985 and 2003 of 1 hectare realised in 1990					
BANQUETTES DE GLACIS					
Products	2003		1985		Difference
	Production kg/year	Value FCFA/year	Production kg/year	Value FCFA/year	
Cereals	384	42,262			
Wood	314	5,652	33	587	5,065
Forage	530	13,250	50	1,250	12,000
Gum	4	1,994	0.4	188	1,806
CO ₂	859	4,506			4,506
Herbaceous biomass			220	2,198	-2,198
Total		63,158		4,223	58,9354 (1396%)
Estimation of the productions in 1985 and 2003 of 1 hectare realised in 1990					
TRANCHEES					
Products	2003		1985		Difference
	Production kg/year	Value FCFA/year	Production kg/year	Value FCFA/year	
Wood	311	5,598	16	288	5,310
Forage	334	8,349	19	467	7,882
Gum	4	2,048	0.2	95	1,953
CO ₂	851	4,463			4,463
Herbaceous biomass	130	1,299	130	1,299	0
Total		17,293		2,148	15,145 (705%)
<p>Cereals: a reduction coefficient is applied to agricultural productions (0,85) holding account of the losses due to accidental factors Wood: A) banquettes density = 38 plants/ha; accumulation rate = 8.3 kg per plant per year B) tranchées density = 300 plants/ha; accumulation rate = 1.05 kg per plant per year Browse: banquettes production = 10 kg/plant/year; tranchées production = 1.1 kg per plant per year; price = 25 F-CFA kg-1 Gum: banquettes production = 0.1 kg/plant/year; tranchées production = 0.02 kg per plant per year; price = 500 F-CFA kg-1 CO₂: roots/shoot ratio = 0.5; ratio C/wood = 0.4972; CERs price = 8 Euro Herbaceous biomass: load factor of the fodder availabilities = 0.35; price = 10 F-CFA kg-1</p>					

⁶ Reduction coefficient of 0.85 is applied to agricultural productions holding account of the losses due to accidental factors

The *intervention on the slopes* (plantation en tranchées) gives a net growth of production value of about 700%. This growth is due mainly to forage and wood components. The CO₂, as for banquettes, is not included in the total value, and it is given as supplementary information. Anyway, the value of CO₂ is still less than the correspondent value of woodfuel.

In comparison, 1 hectare of banquette de glaci is more profitable than 1 hectare of tranchée due principally to the poor soil fertility and the low soil dept on tranchées. Of course, banquettes and tranchées have different roles in control the erosion, both necessary for an integrated management of the territory.

Globally 6.471 ha of banquettes de glaci and 8.097 ha of tranchées have been built up to now and assuming the average productivity, when all the interventions will be at normal running, a total value of about 500 millions of F-CFA per year will be reach. It means, transformed in cereals, the satisfaction of cereal needs for about 19.000 persons.

The population growth reached the 80.000 units from 1984 to 2003, exceeding four times the capacity of interventions to assure food security. This shows that the traditional approach focused on strengthening rainfed cereals productions is not sustainable on the long run and future intervention strategy should consider the whole range of agro-sylvo-pastoral productions and also their transformation and commercialisation chains in order to support the development of new sources of income.

Conclusions

20 years of PDR-ADM interventions allowed the natural and production systems recovery and stabilisation. For this reason, Keita became an example in the Sahel, one of more interesting and dynamic economic pole of the country and an attraction for the neighbouring populations.

Notwithstanding the efforts and the indubitable results of PDR-ADM, the traditional rainfed production systems are still reaching the saturation and the ecosystems is suffering the human pressure. PDR-ADM approach was designed to concentrate on the rapid recover from a decaying environment close to a physical collapse. Now even the ecological equilibrium is demanding a reviewed strategy, giving priority to the socio-economic dimension, based on developing alternative sources of income..

Important lessons have be learned from the Keita experience. Land reclamation and conservation practices for agriculture activities are very important but not sufficient to assure a perspective of development and the balance between population needs and productions.

Furthermore recovery for degraded territory, such was the case for Keita, is demanding projects lasting decade and not only years. Keita proved that the recovering phase to regain the previous environmental balance is demanding twice the time necessary for the degradation phase. It also provide basis to recognize that prevention is extremely less costly than the reclamation.

To assure food security in sahelian areas only by agriculture activities, with the present population growth, will be not probably possible and sustainable in the future. Considering that income produced by rainfed agriculture is not sufficient, the promotion of initiatives aimed to strength the local economic systems by the diversification of the production is necessary.

Future interventions to fight desertification need to join land conservation and rehabilitation practices with specific actions aimed to develop new income generation scenario in order to assure the sustainability and the success of the interventions in a long-term view.

Finally deeper knowledge of the non-conventional productions should be a starting point for the identification of a new and suitable approach aiming to valorise any possible 'means' able at

generating new sources of income with low environmental impacts. Trees are a good example; they are an important source of income for local population because traditionally they have multiple uses. Besides the underestimated contribution of secondary products (leaves, fruits, etc) to the domestic budget, trees are used for wood, other commercial products (gums, etc) and in the future years, the possibilities given by the Kyoto Protocol in terms of afforestation and trade of the Carbon credits could be considerable.