



# INVESTING IN RECOVERY OF ARID LAND

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Its operating budget is financed by subsidies from the French Ministries of Foreign Affairs and for Ecology and Sustainable Development. CSFD members participate voluntarily to its activities, as a contribution from the Ministry for Research.

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## GENERAL INTRODUCTION

This document introducing the international workshop on the cost of inaction and investment opportunities in dry, arid, semi-arid and sub-humid areas was prepared by the *Comité scientifique français de la désertification* or CSFD (French scientific committee on desertification) with support from the Global Mechanism and the French Ministries for Scientific Research and Foreign Affairs. It is mainly based on an analysis of the socio-economic costs of desertification and a few benefits of anti-desertification actions, particularly in Africa. The work was done in 2005-2006 with backing from the French development Agency through the *Centre d'économie et d'éthique sur l'environnement et le développement* (Centre for economy and ethics for the environment and development) at the University of Versailles Saint-Quentin-en-Yvelines. The final report attempted to synthesize the studies available to date, in particular the study undertaken for the United Nations Environment Programme (UNEP) by Dregne (1992) and the more recent ones undertaken for the World Bank, the Global Environment Fund (GEF) and the Global Mechanism by teams working under L. Berry (2003 and 2006), G. Bjorklund (2004) and C. Reij (2003). Finally, it also took into account environment evaluations undertaken for many years for the World Bank in particular by J. Bojo (1996), S. Pagiola (2004) and M. Saraf (2003). It then examined the question of how international migrations and the desertification phenomenon are related, before suggesting several development scenarios<sup>1</sup>.

The document also considers the achievements of international events held in 2006 during the 'International Year of Deserts and Desertification' in particular those of the scientific symposium in Tunis on the future of arid areas and those of the international forum on 'Desertification and civil society' held in Montpellier<sup>2</sup> (France).

It tries to reformulate the objectives of the workshop by asking many questions which still have to be resolved. The workshop in its conclusions should consider what lines of action should be taken to find answers to these questions.

### \* The context

For more than thirty years, the natural resources of arid regions have been degraded due to the increased pressure of people on their natural environment as well as climatic crises such as prolonged droughts which have occurred in various parts of the world. This degradation of natural capital has led to the gradual desertification of several hundred million hectares on all continents and to increasingly serious poverty for hundreds of millions of people.

This is particularly true in that these people get most of their income from exploiting natural resources: water, soil and vegetation. The countries located in arid areas depend mainly on agriculture and livestock farming, consequently a very significant proportion of their natural wealth depends on exploiting their natural capital.

Furthermore, the ecosystems of arid regions provide services which go beyond simply providing soil, vegetation, water and nutrients for agriculture and livestock production.

The degradation of these ecosystems thus has a serious impact in economic, social and environmental terms. To comply with the Millennium Development Goals adopted in 2000,

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<sup>1</sup> Requier-Desjardins M., Bied-Charreton M., 2006. *Evaluation des coûts économiques et sociaux de la dégradation des terres et de la désertification en Afrique*, rapport AFD, 162 p. and annexes.

<sup>2</sup> *The future of drylands*, Tunis, 19-21 June 2006 :

<http://www.unesco.org/mab/ecosyst/futureDrylands.shtml>

*Désertif'Actions*, Montpellier, 21-23 September 2006 : <http://www.desertif-actions.org/>

conservation and restoration of the degraded natural capital should be made national and international priorities. In fact the issue of preventing the degradation of resources and desertification refers clearly to goals 1 and 2: reducing poverty and hunger (1) and ensuring a sustainable environment (2).

The *Desertification* section of the Millennium Ecosystem Assessment (MEA) shows that the degradation of dry arid, semi-arid and sub-humid areas will make it impossible to achieve these objectives<sup>3</sup>. Finally the report entitled '*Where is the wealth of the nations*' published by the World Bank emphasises the importance of natural capital to poor countries, in particular in Africa<sup>4</sup>. Moreover, most of the poor countries are located in arid areas.

#### **\* Valuation of the economic costs of degradation and desertification**

Not much analysis has been done of desertification costs and little valuation. Valuation methods for environment economics have rarely been applied to arid and semi-arid areas. Generally speaking these methods have proven too difficult to apply for such huge territories. Economic losses caused by degradation of land were first estimated for cultivated land using measurements of annual losses of crop soils per hectare and per year. The yields lost were evaluated by relating them to nitrogen losses due to erosion of soils and they were then converted into monetary values. This enabled researchers to correctly model erosion processes.

But, how can this modelling now be developed to include not only agricultural production but also all other services provided by these ecosystems? *This is a first set of questions.*

More spatially-based approaches also considered the costs of desertification in terms of lost rural production, focussing on agriculture, livestock production and forestry.

All of these methods have internal limitations, especially methodological ones and also external limitations such as, for example, the fact that the multi-functionality of the space is not taken into account. Finally, they generally do not taken into account indirect effects such as silting up of dams, the impacts of dust clouds or losses in biodiversity.

How can these indirect effects be better taken into account?

*This is a second set of questions.*

#### **\* Evaluation of the social costs of degradation and desertification**

Desertification and the decrease in productive capacity of soils is not new, consequently rural, agricultural and pastoral societies have developed strategies to adapt to them. But these strategies have generally not led to major changes in crop and livestock production systems, which on the whole are unable to adapt to the changes and in turn create new degradation. Specific crises such as prolonged drought lead to social adjustments, ranging from the least important to the most drastic ones involving changes in diet, the search for non-agricultural work and temporary work-related migrations. This may be followed by the sale of small animals and large livestock and then migrations to look for new land to farm, thus increasing the risks of degradation for new spaces which have been relatively unscathed up to now. Finally people may be obliged to sell their property and emigrate.

Ultimately, societies affected by desertification are often very disrupted by the loss of income and increase in food insecurity. There are not many studies of the social cost of desertification

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<sup>3</sup> <http://www.greenfacts.org/fr/ecosystemes/index/htm>

<sup>4</sup> <http://www.worldbank.org/sustainabledevelopment>

and the equating ‘desertification and migrations’ which is often put forward, appears to be fairly simplistic and obviously requires more research.

*This raises a third set of questions.*

#### **\* The rationale in favour of investment in arid land**

More knowledge of the economic and social costs may lead to a *rationale* in favour of investment in arid land. However this knowledge should be accompanied by an analysis of the profitability of anti-desertification investments. Unfortunately there is not much documentation available on this theme. The main references are the study by C. Reij and D. Steeds for the Sahel (2003) and that done by V. Hien for Burkina Faso (2004); some information may also be found in project reports which have sometimes not been published.

This document tries to show that the economic rates of return (ERR) of land rehabilitation operations are positive and encouraging. They are sometimes under-estimated, for instance, the social and institutional benefits are not taken into account in these evaluations.

Should one improve ERR calculations for anti-desertification projects and if so, how?

*This raises a fourth set of questions.*

On a higher level, how can information obtained on economic costs, social costs and the rates of return of some projects undertaken in arid areas be turned into a **rationale** to increase investment in dry regions?

*The first section analyses the valuation of macroeconomic costs of desertification in Africa by making an inventory and describing the main results.*

*The second section introduces the social costs of desertification, with the contributions and limitations of a migration-based approach.*

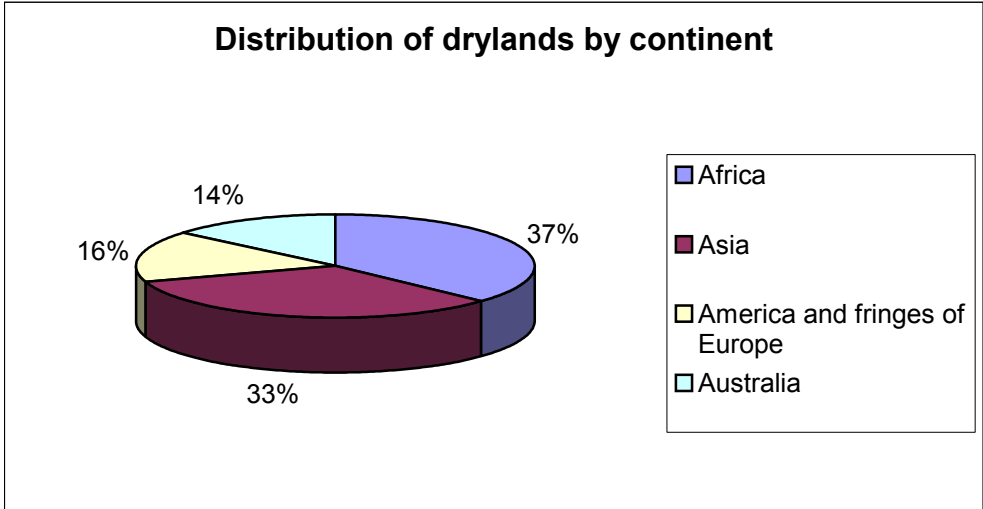
*The third section introduces data on profitability and the realities of investment in the fight against desertification.*

**SECTION I –VALUATION OF MACROECONOMIC COSTS OF DESERTIFICATION IN AFRICA: INVENTORY AND MAIN RESULTS**

Desertification has been defined by the United Nations Convention to Combat Desertification (UNCCD) as ‘land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors, including climatic variations and human activities’<sup>5</sup>.

This convention, which was drawn up and ratified in 1995 following the Rio Summit, was designed to draw world attention to the tragic situation of arid areas, home to more than a billion of the poorest people in the world (Dobie, 2001). In article 7, it emphasises the situation of the African region which is particularly affected, both from an environmental point of view and a socio-economic point of view: in fact 37% of the threatened dry areas are in Africa.

Figure 1: Distribution of dry lands by continent



Desertification is both a development and an environmental problem (Cornet, 2002). However, the proportion of official development assistance (ODA) devoted to the rural sector of dry areas has been decreasing continually for the last 15 years. In 2005, 5% of worldwide ODA was allotted to the development of degraded land (Berry *et al.*, 2006).

The economic costs of desertification and land degradation have not been analysed and valued much until now. Nonetheless, such a valuation would increase our awareness of the extent of the phenomenon and its impact on rural development and agriculture. Finally, it could be used for decision-making on sectorial orientations for development assistance.

The purpose of this section is to describe the principal methods used for macroeconomic valuation of desertification costs in Africa, to discuss their limitations and the potential usefulness of their results. For discussion of issues by panels, analysis of desertification was widened to include the degradation of land. The surveys of 9 African countries, often undertaken by the World Bank from the beginning of the 1980s and more recently by the

<sup>5</sup> UNCCD, 1994. *United Nations Convention to Combat Desertification in countries experiencing serious drought and/or desertification, particularly in Africa*. The text with its annexes was published by the Convention Secretariat, Bonn, Germany. Document available on line.

The arid, semi-arid and dry sub-humid areas referred to as dry areas are characterised by an evapotranspiration rate between 0.05 and 0.65; the polar and sub-polar areas have been excluded. Dry regions represent 40% of the emerged land of the globe.

Global Mechanism (GM) as well as the world-wide survey done for the United Nations Environment Programme (UNEP) in 1992 have been used as a basis for this inventory.

We shall distinguish between two categories of methods and their principal methodological limitations, before presenting and discussing the results as well as their potential usefulness for the rural development of dry regions.

### ***1 – Valuation of rainfall erosion by agro-ecological models from the 1980s to 2000 and beyond***

A great deal of work on modelling erosion phenomena has been done since the beginning of the 1960s. The initial reference for most of this research was the universal soil loss equation (USLE)<sup>6</sup>. It is used to estimate the loss of land or the annual mean erosion rate over the long term on the slope of a field. This rate (expressed in tonnes per acre) is a result of the configuration of rainfall, type of soil, of topography, of crop rotation and crop management practices. The USLE is thus used for forecasting and analysing erosion, particularly with respect to cultivated land. It has been developed in many different ways from the formulation of alternative equations for soil loss to the modelling of relationships between soil loss, nutrient loss in soils and productivity. Identifying these relationships makes it possible to calculate the economic cost of erosion.

For instance, in Mali, the USLE was used in 1989 to quantify the mean loss of cultivatable land per hectare (a hectare equals 2.47 acres)<sup>7</sup>. By using statistical decline coefficients for Niger, the data on soil loss is extrapolated to that of nutrient loss<sup>8</sup>. By extending the results on the plot level to all of the agricultural regions of the country, we obtain the mean annual loss of nutrients on a national scale. This is then valued in monetary terms according to the price of commercial fertilizer. The annual range for this loss, which varies from 2.6 to 11 million USD (American dollars, 1989), is then used as an approximation of the macroeconomic loss related to desertification.

The economic method used in this Malian example is that of replacement costs, in other words the monetary estimation of a loss in natural capital by means of the value of the artificial capital corresponding to identical functions (box 1). There is of course a debate as to the relevance of this type of economic valuation based directly on the loss of nutrients. Many specialists acknowledge that these losses are high in dry regions due to the rare but intense rainfall which strongly contributes to the loss of soil productivity and consequently to desertification or degradation of soils (Craswell *et al.*, 2004). At the same time, this method would lead to overestimating the costs of soil degradation (Pagiola *et al.*, 2004).

It should be noted that it was also applied to Zimbabwe in 1986. The results of statistical experiments at the time then related soil loss to that of nutrients for the two main types of soil in the country<sup>9</sup>. The four main agricultural production systems in Zimbabwe were then assigned a differentiated erosion rate, which made it possible to quantify the loss of nutrients on a national scale while taking ecological and agro-economic factors into account. Thus, the

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<sup>6</sup> For a synthesis, see Hilborn D., Stone R.P., 2000. Équation universelle des pertes en terre Technical sheet of Ministry of Agriculture, Food and Rural Affairs. *L'Ontario*. Canada. Document available on line at: <http://www.omafra.gov.on.ca/french/engineer/facts/00-002.htm>

<sup>7</sup> Bishop J., Allen J., 1989. Quoted by Bojő J., 1996. The costs of land degradation in sub-Saharan Africa. *Ecological Economics*. 16: 161-173.

<sup>8</sup> The main nutrients in soils are nitrogen and phosphorus. In many field studies and experiments, only nitrogen is taken into account. The organic matter of soils is mostly made up of carbon, nitrogen and potassium.

<sup>9</sup> Stocking M., 1986. Quoted by Bojő J., 1996. op. cit.

degradation of land each year costs Zimbabwe approximately 117 million USD at the 1986 value.

However, to return to the case of Mali, one might also argue that most of the land areas affected by desertification are in fact naturally arid grazing lands which by definition are not taken into account by the USLE and that consequently the estimate of losses related to desertification for this country on the basis of loss of cultivatable soils is much less than in reality.

*Box 1: Methods for economic valuation of the environment*

There are several categories of techniques for evaluating environmental resources. In practice, very few of them are used to evaluate the cost of desertification and degradation of land.

*Methods for monetary valuation of the environment*

Direct valuation			Indirect valuation
Preferences revealed		Preferences expressed	No preference
in the actual market	in a substitute market	for a fictitious market	
- change in productivity - expenses for protection - goods which may be substituted	- hedonistic prices - transport costs	- contingent valuation	- dose-effect method - replacement costs

Source: Lescuyer, 2005.

The direct valuation of revealed preferences in an actual market is a very simple matter. The change of productivity provides information on variations in the state of the environment; this information may be measured directly via variations in production of goods and market services. The value of the environmental resource is here estimated in terms of its contribution to productive activities by economic agents. The valuation by change in productivity is a two stage process, which involves: (1) determining the physical effects of a variation in the environment on the economic activity and (2) measuring the monetary value of the damaged ecological function. This valuation is the one mainly used for quantifying costs of desertification: measurement of the losses for agriculture, livestock and wood.

None of the direct valuation methods in a substitute market and a fictitious market are used for evaluating the costs of desertification. The transport costs method is however useful for tourist sites in dry regions as it can be used to calculate the loss of income, for instance related to desertification, from changes in the frequency of visits to these sites. It would also thus reflect a variation in the use value of the environmental goods in question.

The contingent valuation method reveals the preferences of individuals which are then used as a basis for evaluating environmental goods. In practice, a survey is made by asking individuals to determine the amount that they are prepared to pay or to receive to maintain the same level of well-being. Thus the cost of desertification is evaluated by evaluating the agreement to pay on the basis of efforts willingly made by economic agents, for instance in terms of working time rather than monetary payment.

All of these methods are used in standard economic analysis: they are based on the study of the behaviour of consumers and attempt to reconstitute a demand function for the natural goods (resources) in question.

The indirect methods assign a monetary value to the physical damage due to the degradation of the environment. Unlike the previous methods, they are not based on the behaviour of economic agents. The replacement costs method postulates, for instance, that it is possible to replace losses of productive functions of a natural environment by artificial capital which could restore the lost functions. The market price for this artificial capital is then used to assign a value to the environmental loss. This evaluation must be realistic in other words the replacement solution must be the least costly of the alternative solutions. This method is useful when it is difficult to estimate the economic and physical data or to obtain them, as the replacement scenario is independent of the preferences of individuals in these markets. For instance in the case of desertification, when the quantities and variations of nutrients in the soil are known, it is possible to assign a value to the degradation of land by using the price of commercial fertilizers.

Sources: Bailly *et al.*, 2000; Brismar *et al.*, 2004; Lescuyer, 2005; Wilinger, 1996.

Since the 1980s, a lot of experiments conducted in Africa have tried to understand and better characterise the relationships between soil loss in nutrients and in productivity<sup>10</sup>. In Ethiopia for instance, the valuation of the impact of nutrient loss on soil productivity is based on the results of practical experiments on farms: the yield of the two main cereals is studied in

<sup>10</sup> On the other hand, statistical tests performed in Lesotho and Zimbabwe to try and establish a direct link between soil loss and crop yield did not give any conclusive results (Bojö J., 1996. op. cit.).

relationship to the amount of nitrogen in the soils (tables 1 and 2)<sup>11</sup>. The loss of yield observed varies between 46 and 544 USD per hectare for wheat and between 31 and 379 USD per hectare for maize, assuming the low estimate of the impact of nitrogen loss on the harvest amount per hectare.

*Table 1: Loss of yield of two cereals due to loss of nitrogen (N) caused by erosion of soils in Ethiopia (a kilogram is equal to 2.2 pounds)*

Crop	Loss of yield (kg) by kg of N lost	Loss of nutrient N (kg/ha)		Harvest lost (kg/ha)	
		Low	High	Low	High
	Crop response rate				
Maize	9.6	36	429	345	4120
Wheat	6.9	36	429	248	2960

Source: Sertsu, 1999, quoted by Berry and Olson, 2003.

*Table 2: Monetary values of loss of cereal yields due to degradation of soils in Ethiopia*

Crop	Harvest lost (kg/ha) Low range	Price of grain (Birr/kg) (Birr: is the basic unit of Ethiopian currency <sup>12</sup> )		Total loss (Birr)	
		Low	High	Low	High
Maize	345	0.80	9.5	276.0	3,294
Wheat	248	1.60	19	396.8	4,736

Source: Sertsu, 1999 quoted by Berry and Olson, 2003.

Finally, other types of models are used to understand the relationships between water, soils and agricultural production as well as for estimating degradation costs. In Ethiopia for instance, the Food and Agriculture Organization of the United Nations (FAO) developed a model to determine crop water needs which relates the monthly rainfall values, the soil water storage capacity and the evapotranspiration to determine variation in crop yields<sup>13</sup>. In Zimbabwe, models of plant growth were applied to on the scale of districts to measure the effect of erosion on the yield of six distinct crops<sup>14</sup>.

*On the whole, soil erosion models are becoming more and more sophisticated as they simultaneously take into account the effects of rainfall and wind on soil erosion. They also relate the depth of soils, the losses of organic matter and the loss of water in soils as well as the organisms in soils or biota to obtain the rate of decline of crop or fodder crop yields<sup>15</sup>. Several partial models are often coupled together to encourage more refined and complete modelling of erosion and its impact. There are also combinations of generic and applied models<sup>16</sup>. Mapping of erosion and land-use on a national scale is enriched with results obtained at plot level or district level.*

<sup>11</sup> Sertsu, 1999, quoted by Berry and Olson, 2003.

<sup>12</sup> The Birr is the unit of currency in Ethiopia. It was first called the Ethiopian dollar and was introduced in 1945, and then renamed into Birr in 1976. 1 birr equals 100 cents. As of April 1, 2005, the United States dollar was worth 8.658600 birr. [http://en.wikipedia.org/wiki/Birr\\_\(currency\)](http://en.wikipedia.org/wiki/Birr_(currency))

<sup>13</sup> FAO, 1986. Quoted by Bojő J., 1996, op.cit.

<sup>14</sup> Grohs F., 1994. Quoted by Bojő J., 1996, op. cit..

<sup>15</sup> See for instance Pimentel *et al.*, 1995.

<sup>16</sup> For instance for Malawi: World Bank, 1992 quoted by Bojő J., 1996, op. cit.

Finally, from a methodological point of view, modelling is used to estimate production losses for a predefined series of years and to thus determine a mean annual value for land degradation. *However, most of the work referred to is restricted to the impact of desertification on crop yields thus neglecting livestock breeding and forestry activities which are also affected by the loss of soil productivity.*

The *Millennium Ecosystem Assessment* (MEA, 2003) is now recommending an approach in terms of services provided by ecosystems: for arid areas, this concerns the supply of food and wood, the regulation of biodiversity, the nutrient cycle, the quality of air and the climate, human health, detoxification, cultural and tourism services. Many institutions, among which the World Bank and the UNEP are currently trying to implement this approach for operational purposes by using classic or innovative methods of economic valuation (Pagiola *et al.*, 2004; Shepherd, 2006)<sup>17</sup>. *How will the knowledge acquired through models of erosion processes which focus mainly on services provided, such as food and more marginally regulation of the nutrient cycle, be used or improved to increase our new understanding of the role of the environment and to provide more complete valuations of the costs of its degradation?*

## 2 – Spatial approaches based on land-use data

*The second type of approach to evaluating the costs of desertification is based on dividing the rural space according to its main economic uses. Generally these are: crop fields (irrigated and rain-irrigated crops), grazing areas for livestock and forests used mainly for producing wood and non ligneous products. By applying a rate of decline in the natural productivity of these spaces, one obtains the overall losses of rural production.* The evaluations of these rates of decline in productivity depend on the state of desertification observed; the data come from local observatories of desertification or experts' judgements.

For instance the only world estimate of the cost of desertification divides up dry areas according to three main rural activities: irrigated agriculture, rain-irrigated agriculture and grazing lands (Dregne and Chou, 1992). In this study dating from the 1990s, forests appear to have been treated as grazing land. The surface areas affected are counted by country using data from the United Nations Educational, Scientific and Cultural Organization (UNESCO).

The other part of the work consists in evaluating the cost of desertification by hectare for each type of land or activity. This valuation was based on several micro-surveys conducted in Australia and the United States: the loss of productivity related to the desertification process globally estimated at 40%; each year the degradation costs 7 USD per hectare of grazing land, 38 USD per hectare of rain-irrigated crops and 250 dollars per hectare of irrigated crop. These figures are then applied to all of the world surface areas which have been degraded (table 3).

*Table 3: Surface areas degraded by type of land in the world and in Africa (1 000 ha)*

Type of land	Total surface area	Affected surface area	% of surface area affected
<b>World</b>			
<b>Irrigated land</b>	145,495	43,147	30
<b>Rainfall-irrigated crops</b>	457,737	215,567	47
<b>Grazing land</b>	4,556,420	3,333,465	73

<sup>17</sup> See Pagiola *et al.* for the application of classic economic methods for environmental evaluation; the UNEP is working on an energy approach.

<b>All kinds of land</b>	5,159,652	3,592,179	70
<b>Africa</b>			
<b>Irrigated land</b>	10,424	1,902	18
<b>Rainfall-irrigated crops</b>	79,822	48,863	61
<b>Grazing land</b>	1,342,345	995,080	74
<b>All kinds of land</b>	1,432,591	1,045,845	73

Source: Dregne and Chou, 1992.

Thus, each year, 11 billion USD are lost following the desertification of irrigated land, 8 billion following the desertification of rain-irrigated crops and 23 billion following the degradation of grazing lands. The annual economic cost due to desertification is thus 42 billion USD (1990). This study still has to be brought up to date.

Among the reports of the World Bank written in 2003 on valuation of the costs of environmental degradation in MENA countries (Middle East and North Africa), the survey conducted in Morocco used a similar approach to the previous one: the area was broken down into crops, grazing land and forests and the corresponding areas subjected to desertification were then evaluated. Two states of desertification were thus distinguished for crops and grazing lands respectively and each was given a specific rate of decline of productivity based on the opinion of experts (table 4).

*Table 4: Estimate of the degradation of rain-irrigated crop lands in Morocco*

	<b>Lower limit</b>	<b>Upper limit</b>
<b>Moderate erosion</b>	25%	50%
<b>Degraded cultivated land (1000 ha)</b>	2,175	4,350
<b>Decline in productivity</b>	20%	20%
<b>Decline in yield (qx/ha)</b>	2	2
<b>Lost production (1000 qx)</b>	4,350	8,700
<b>Lost value (millions Dirham<sup>18</sup> [Dh])</b>	130	260
<b>Lost value (millions USD)</b>	13,7	27,3
<b>Slight erosion</b>	50%	100%
<b>Degraded cultivated areas (1000ha)</b>	4,350	8,700
<b>Decline in productivity</b>	5%	5%
<b>Decline in yield (qx/ha)</b>	0,5	0,5
<b>Lost production (1 000qx)</b>	2,175	4,350
<b>Lost value (million Dh)</b>	65	130
<b>Lost value (million USD)</b>	??	??
<b>Mean (millions Dh)</b>	97,5	195
<b>Mean (millions USD)</b>	10,2	21,5

Source: World Bank, 2003.

The loss due to burnt forest land was obtained by summing the average loss of wood with that of non ligneous forestry products derived from a mean estimate per hectare for the entire world (World Bank, 2003).

<sup>18</sup> The basic unit of money in Morocco; equal to 100 centimes.

The producer price for wood, wheat and barley was used to determine in monetary terms the annual quantities of production lost.

In many countries, the lack of data, whether it be scattered in various institutions (and thus difficult to obtain) or simply not available often means that it is impossible to evaluate such costs for desertification and land degradation. Various combinations of environmental and agro-economic data may then be used: in Tunisia, the national valuations of land areas lost each year make a distinction between irrigated surfaces and rain-irrigated crops. It is thus possible to calculate the economic loss for cereals on the basis of mean yields from this land and of the international wheat price (World Bank, 2003). In Rwanda, land degradation is evaluated by using the calculated loss of productivity per person between 1982 and 1994 for cereals and root crops, obtained by combining micro-research and national data on the types and volumes of agricultural production between 1966 and 1986. On the hypothesis that this loss in productivity is related to degradation of the land, it is possible to obtain the mean cereal production lost annually and consequently its monetary value (Berry and Olson, 2003)<sup>19</sup>.

*These valuations are done by means of a spatial approach, taking mainly into account the costs of desertification in terms of lost rural production (agriculture, livestock breeding and forests). When used for the approach developed by the Millennium Ecosystem Assessment in terms of services provided by ecosystems, they are limited only to evaluating services for provision of food and wood.*

### **3 – Limitations and non-inclusion of indirect effects**

#### **\* Internal limitations**

Most of the valuations are based on a reference period and use data series for long periods of time. This makes it possible to limit the particular effect of a given event, which is a fundamental criterion for dry regions in which rainfall varies greatly. However the final annual value always depends on the period of time chosen as a reference. For the Sahel region for instance, the estimates based on the period 1970-1985 will give annual costs for desertification which are probably higher than those calculated for 1990-2003 due to the periodicity of the variation in rainfall.

All of the methods we have seen hypothesize that the data obtained at a micro scale and from local experiments can be extrapolated. They are used as a basis for representative modelling of the main types of land and farming methods, whose results are then aggregated at a national level. At this level, they can be used to define mean annual rates of decline in productivity depending on the economic activities in question. The costs resulting from these two types of method are generally gross costs since the way in which rural populations effectively adapt to the degradation of land for, instance using techniques for conserving water and soil, is not taken into account.

#### **\* External limitations**

*We find numerous different activities in the same dry areas according to the seasons. The main limitation of spatial approaches is that they are not able to take into account this multi-functionality of space when evaluating desertification costs: with these approaches, the rural surface areas are in fact broken down according to the predominant activity. As*

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<sup>19</sup> This report on Rwanda suggests an interesting relationship between civil war and land degradation.

*for erosion models, these mainly evaluate the degradation of crop soils and sometimes that of integrated agropastoral systems. However, they do not apply to natural grazing lands which make up the most of arid regions.*

The costs of desertification expressed in monetary value also depend greatly on the price of reference cereals. These prices may vary by a factor of two from one year to the next and very strong variations have been observed for any given year. Moreover, they differ between the city and the countryside and according to whether they are considered at the producer scale or that of international exchange rates. This is why some valuations use cost intervals taking into account both the lowest price and the highest price observed for the same cereals.

These valuations use remote sensing services or national databases monitoring the evolution of the degradation, land use and rural production. The heterogeneity of the data available, depending on each country, leads in many cases and in a pragmatic way to the use of distinctly different evaluation methods. It would appear, *a priori*, that it is hard to compare these results.

#### **\* The issue of indirect effects**

*Most evaluations only deal with the direct effects of desertification and the degradation of land. More rarely evaluated are: the silting-up of dams and subsequent losses of water and electricity, variation in fishing production and disturbances to shipping on water courses, the impacts of dust clouds on air transport and human health or on a more global level, the losses of carbon and biodiversity due to diversification and land degradation.*

Morocco and Tunisia however estimate the costs of silting-up of dams: the amount of water lost each year is translated into the amount of electricity lost (KWh) or the loss of industrial and domestic water, which is evaluated on the basis of current prices<sup>20</sup>.

Thus, given most of the limitations referred to, the following results are largely underestimated.

## **4 – The results**

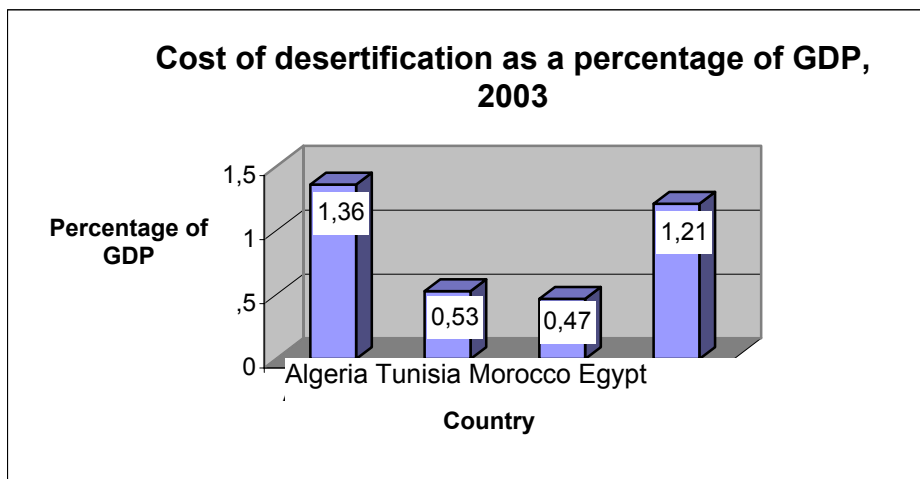
The national results are given as a percentage of GDP (Gross Domestic Product) for North African countries (figure 2). For Sub-Saharan Africa, the costs of land degradation are given as a percentage of the agricultural GDP (AGDP) given the importance of the primary sector for these countries (table 5)<sup>21</sup>.

*Figure 2: The cost of desertification for four North African countries (as a percentage of GDP)*

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<sup>20</sup> These indirect costs of desertification thus account for 0.06% of the GDP for Tunisia and 0.03% for Morocco.

<sup>21</sup> The agricultural GDP may account for up to 40% of GDP (as for Niger for instance).



Source: Sarraf, 2004.

*Table 5: Annual costs of land degradation on a world scale and for nine countries in Sub-Saharan Africa (percentage of agricultural GDP and in absolute value)*

Country, source year	Type of loss	Cost (AGDP)	Annual cost (absolute value)	Main methodological elements
<b>World</b> Dregne, 1992	Agriculture Livestock	-	42 billion USD (USD 90 <sup>22</sup> )	Spatial extent of desertification, cost of decline in productivity by ha
<b>Rwanda</b> Berry, 2003	Agriculture	3.5%	23 M USD (USD2003)	Series on agricultural production, loss of productivity per person
<b>Ethiopia</b> Berry, 2003	Agriculture Livestock Forestry	4%	139 M USD (USD2003)	Updating of previous evaluation
Bojö & Cassels (1994)	ditto	4%	130 M USD (USD94)	Improvement of Sutcliffe's study: soil transfer matrix
Sutcliffe (1993)	ditto	5%	155 M USD (USD 94)	Depth of soils and loss in productivity
FAO (1986)	Agriculture	<1%	14.8 M USD (USD 94)	Modelling of crop water requirements satisfaction
<b>Zimbabwe</b> Grohs (1994)	Agriculture	<1%	0.6 M USD (USD94)	Modelling of plant growth, erosion mapping
Norse & Saigal (1992)	Agriculture Livestock	8%	99.5 M USD (USD94)	Improvement of Stocking's study: soil budget in nutrients
Stocking (1986)	ditto	9%	117 M USD (USD94)	Cost of replacement; main types of soil and farms
<b>Lesotho</b> Bojö (1991)	Agriculture	<1%	0.3 M USD (USD94)	Statistics relating losses of soil, nutrients and productivity
<b>Malawi</b> World Bank (1992)	Agriculture	3%	6.6-19 M USD (USD94)	Modelling of soil losses and drop in productivity
<b>Mali</b> Bishop & Allen (1989)	Agriculture	<1%	2.9-11.6 M USD (USD94)	1 - Cost of replacement; 2 – Modelling of losses of soil, nutrients and productivity
<b>Ghana</b> Convery & Tutu (1990)	Agriculture	5%	166.4 M USD (USD94)	Cost of replacement

M: million Ag GDP: agricultural GDP

Source: Bojö J., 1996; Berry *et al.*, 2003.

Concerning the North-African countries, the costs of desertification speak volumes: given the proportion of oil and natural gas resources in Algeria's GDP, the relatively high amount of desertification costs emphasises the seriousness of the phenomenon. The Egyptian percentage must be related to the considerable surface areas irrigated in Egypt, for instance in the Nile valley and also to land salinisation problems.

In Sub-Saharan countries, economic losses due to degradation of land account for between 1 and 10% of agricultural GDP. It appears difficult to conclude anything *a priori* from these results to the extent that they do not appear to depend on the type of methods used.

<sup>22</sup>

this means 'at the 1990 USD value'

Nevertheless, the lowest percentages correspond to studies which only evaluate the agricultural loss, which means they are somewhat coherent. Then, one may also emphasise that in spite of the diversity of methods, the results obtained often fall within a significant range of from 3% to 5% of the agricultural GDP. Finally these results may be related to the annual agricultural growth of the countries in question: *in short, one might argue that the annual cost of land degradation in Sub-Saharan African countries is more or less equivalent to their mean agricultural growth. Which brings into question the reality of rural development in these countries both in the present and in a more sustainable perspective*<sup>23</sup>.

## 5 - Conclusions

An analytical inventory of the different studies conducted since the 1980s on the economic costs of desertification and land degradation has made it possible to distinguish two main categories of methods: (i) those which may be called more geographical, which are based on a spatial division of economic activities in dry regions, on an estimate of degraded areas and on the corresponding rates of decline in productivity and (ii) those which are based on the agro-ecological modelling of erosion processes, which have been proven and improved for a long time but which are limited more to crop, farming of fodder systems while not taking into account the exploitation of natural grazing lands, which is the predominant type of farming in arid regions.

We thus have a first category of methods which use the global scale and a second one using a local scale. The first is based on micro-studies to determine the global rates of decline of productivity or economic loss per hectare and the second extends these micro-results by aggregation as a function of spatial and human data. These methods may thus be complementary and enrich each other.

***The results obtained show that the rural development of African countries is trammelled by desertification and land degradation.*** This is not apparent of course in the national accounting systems of the countries in question. It is thus necessary to consider more intermediary scales of analysis: there are profitable agricultural and livestock breeding systems whose positive results in terms of annual production are accounted for; some are sustainable, others less. Production based on subsistence systems (generally neglected by sectorial investment of States but which concerns again the major part of rural African populations) is also increasing in absolute value; but at what ecological price? Beyond the less than perfect statistics and difficult comparisons, the global potential of human and economic development is compromised by desertification.

***These results may be considered to be the economic costs of lack of action in dry regions and be used as arguments in favour of investment in the fight against the degradation of land and desertification. To the extent that most of the studies do not take into account the direct costs of desertification and often only agricultural losses, the final values obtained are greatly under-estimated.***

***Finally, it should be remembered that current valuation methods are turning more and more towards the issue of services provided by ecosystems. There are many such services in arid areas: are they limited to those listed by the MEA? How can the valuations so described then be included in this new paradigm? Finally, is it necessary to achieve***

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<sup>23</sup> In essence, this comment also applies to the agricultural growth of the Northern countries. Should we therefore work towards a general renewal of public accounting systems including the ecological downsides of economic achievements or growth in production?

*complete valuations in order to use the argument of the costs of desertification in an attempt to encourage more investment in these regions? May we not define the conditions for a valuation of the minimum investments that the countries concerned could implement in an easier way and more immediately?*

## SECTION II – THE SOCIAL COSTS OF DESERTIFICATION: CONTRIBUTIONS AND LIMITATIONS OF A MIGRATION APPROACH

No general studies have identified the different social costs of desertification, in a way that explains the potential or observed consequences and which also suggests a method of measuring these costs. However, in public interventions of governments, for instance at international meetings, migration appears to be the main social cost of desertification.

Migration is defined as a movement of people crossing a certain boundary in order to set up a new residence elsewhere (Population reference bureau, quoted by Domenach and Picouët, 1995). It is acknowledged to be a response to insecurity, in particular economic and more generally to poverty. For instance, in Africa, the securing of income which previously was based on the temporal and sectorial diversification of agriculture, is now based rather on the spatial diversification of income sources between members of the family unit (Guilmoto, 1997). Migration in rural areas definitely appears to be related to climatic hazards and the variability of available natural resources, but this is also due to economic hazards and in particular to the variability of agricultural prices<sup>24</sup>.

On the international level, it should be noted that the relations between the migratory phenomenon and the Millennium Development Goals (MDGs) have not been investigated. However, a specific document was produced in 2005 by the International Organization for Migration (IOM) which briefly examined the ways in which migration and the MDGs (Usher, 2005) depend on each other. Concerning the subject under discussion, in other words goal 1 of the ‘fight against poverty’ and goal 7 of the ‘fight for a sustainable environment’, we note the following elements:

- Sixty per cent of the world migrant population, estimated at 175 million people in 2000, currently live in the most developed countries.
- However, migratory fluxes occur to a large extent within the developing countries and between them. The developing world thus receives most of the internal migrants (whose number is much higher than that for international migrants).
- Both internal and international migration has continued to increase and a mutation of migratory fluxes has occurred: shifting from a permanent and unidirectional phenomenon, migration now appears to be more and more temporary, seasonal and circular.
- The link between internal migration and international migration is controversial: some believe that it involves different stages of the same process.
- Generally speaking it has been observed that there is an increase in migratory movements between cities and the country (a two-way movement).
- One real obstacle to the understanding of migratory phenomenon is due to problems with the data recording systems and lack of reliable data.

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<sup>24</sup> No studies have yet investigated the possible statistical relationships between these two types of hazard by comparing for instance the situation of regions subject to desertification to that of other African regions.

## ***1 – Migrations and desertification in the African region***

### **\* Vitality of migration in Africa**

***Generally speaking the frequency of migrations in Africa has continued to increase since the period of independence with the multiplication of migrations within countries and between countries as well as of movements of refugees.*** At the same time, the immigration policies of African countries have become more and more restrictive (Bonnassieux, 2005).

There is little quantitative data available on international migration within Africa. However, the few statistical studies found on Western Africa show that migration is particularly significant there.

- At the end of the 1990s, 13% of the total population of Western Africa (excluding Nigeria) lived in a country other than their country of origin and 40% of the population no longer lived in their original district or region (Cour, 2001).
- A survey of seven countries in REMUAO<sup>25</sup> (Ivory Coast, Burkina Faso, Guinea, Mali, Niger, Mauritania, Senegal) for the period 1988-1992 showed that migrations were 2.6 times more prominent in Western Africa than in Europe. It should be noted that African immigration of REMUAO towards Europe only accounts for 9% of intra-African migration noted for this period (Traoré and Bocquier, 1996).

Migration is particularly developed in Africa and operates as a socially organised protective mechanism, in the sense that migration helps to relieve areas under strong demographic pressure. However, its recent evolutions are due more to socio-economic difficulties such as the increase of poverty and in the number of conflicts (Pliez, 2002). ***Thus, migration as a social protective mechanism would disappear in favour of emergency or poverty migrations which are neither prepared for in the area to be left nor in the regions receiving migrants. Now, this type of migration is a recognised vector of environmental degradation.***

### **\* Migratory movements: environmental and economic factors**

The principal migratory movements which developed in Africa between the independence period and the period 1990-2000 is related both to the availability of natural resources and to economic opportunities in the receiving regions (plantation agriculture, mining industries, manufacturing and household goods industries). Worth noting are:

- migrations towards the coastal areas of Abidjan and Dakar from landlocked countries of the Sahel as well as return migrations affecting the Ivory Coast;
- migrations from countries in the Southern zone towards the gold or diamond mines of South Africa, given that the country has closed its frontiers to immigration since the 1990s (Guilmoto and Sandron, 2003);
- migrations towards Nigeria until the 1980s following the development, particularly industrial, of this country and later expulsion of many migrants;
- migrations towards Libya until the tightening up of the migratory policy from the years 2000 (Bredeloup and Zongo, 2006);

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<sup>25</sup> Réseau migrations et urbanisation en Afrique de l'Ouest (Network of migrations and urbanisation in Western Africa)

- migrations from Sub-Saharan African countries towards North-African countries in particular Morocco (Bredeloup and Pliez, 2006)<sup>26</sup>.

These migratory trends are changing and immigration countries are becoming emigration countries (Ivory Coast, Democratic Republic of the Congo, Senegal). There may be many causes of this: conflicts, legislation which is unfavourable to migration, economic and social difficulties. New destinations, new concentrations of employment, such as Ghana for the Burkinabe, are emerging.

***However, the evolution of the population distribution in Western Africa indicates on the whole that migration is continuing from areas exposed to desertification*** (Cour, 2001)<sup>27</sup>. These population movements towards the South are of course a response to regional inequalities in the availability of natural resources but they are also more and more determined by the size and location of urban markets as well as by available infrastructures:

- thus, the rural population density decreases inversely to the distance from a market.
- Likewise, agricultural yield and productivity are related to the presence of markets.

#### \* **Geographic typology of migrations: case of the rural exodus**

The ***so-called geographic typology*** makes a distinction between *country-city* or *rural exodus* migrations, *city-city* migrations, *city-country* migrations called *disurbanisation* and *country-country* migrations (Domenach and Picouët, 1995)<sup>28</sup>.

***Desertification*** may be related both to migrations between country areas (towards areas with better land or pioneer frontiers) and to the rural exodus.

- In Burkina Faso, a statistical study undertaken on inter-provincial migrations from countryside to countryside show that the main reason for permanent migration from the North of the country, in other words from the arid regions, is desertification (Henry *et al.*, 2003).
- In Morocco, a study undertaken on the rural exodus emphasises the high proportion of rural migrants in slums, thus suggesting a strong relationship between migration due to desertification and poverty in the city (Lahlou and Zouiten, 2001). Thus, the informal sector absorbs the majority of migrants coming from the rural exodus: in 2000, it employed two-thirds of the urban population as against one third in 1960. On average, the consumer needs of these migrants are multiplied by three once they are living in a city as are their needs for income (Cour, 2001).

Urbanisation in Africa was very significant in the Sahel region since the urban population was multiplied by 8 between 1960 and 2001 whereas the total population grew only by 2.8 (Bossard, 2004). After independence of the various countries, priority was generally put on the growth of capital cities. But this growth had a negative effect: it increased unemployment and under-employment in the city, put pressure on urban services (such as education, housing and sewage), it destructured the social fabric, developed criminality and engendered environmental degradation. It has slackened since the end of the 1990s with the emergence of secondary cities whose growth rates are currently higher than those of the capital cities.

<sup>26</sup> As we are limiting our discussion to migration within Africa, we shall not consider here migrations from North African countries towards the Arab Emirates, nor from Africa towards Europe.

<sup>27</sup> It should be remembered that the whole of the Sahel region (Mali, Mauritania, Chad, Niger, Burkina Faso) is characterised by naturally high growth rates of the order of 2 to 3%.

<sup>28</sup> There are several migration typologies: for instance, Guilmo and Sandron (2003) suggest a typology by migratory profile.

At the present time, urban exodus phenomena are increasing due to living conditions in the cities becoming more and more difficult (demographic data from the United Nations<sup>29</sup>). The future thus appears to be one of more flexible and temporary urbanisation marked by a back and forth migration between the city and the country depending on socio-economic and political events.

In Africa, rural exodus and urban growth are accompanied by:

- A degradation of urban life due to the *lack of infrastructures* and characterised by the increasing number of slums which house a vulnerable population as well as by the development of the informal sector.
- *ruralisation of cities*, in other words development of agricultural activities in the periurban environment among which market gardening and livestock breeding for commercial purposes. *These activities cause desertification due to too much anthropic pressure.*
- *a competition for space on the outlying areas of cities which is another vector of desertification*<sup>30</sup>.

*Desertification and land degradation are thus factors which increase the growth of slums. In return, the rural exodus coupled with no hope of employment in the city, leads to desertification of periurban spaces.*

#### **\* Migration and rural development policies in arid areas**

Since the independence of various states, rural development policies and then later urban dispersal policies were implemented, to develop agriculture, in order to reduce or even reverse the rural exodus phenomenon and to put a priority on the emergence of secondary cities. The territorial development policy conducted in the region of *St Louis du Senegal* thus created favourable conditions for the urbanisation of this region. The populations of villages as well as some from the city of St Louis moved to secondary cities known as ‘intermediary or semi-urban zones’ (Regnard, 2001).

*A few studies undertaken on the impact of rural development and urban dispersal policies have shown that they affect migratory behaviour*<sup>31</sup>:

- One study focused on the role of different socio-economic variables affecting migration on the basis of data collected in 12 Senegalese villages (Guilmoto, 1997). The level of education, measured by literacy rates, even though it was positively related to migration had a lesser significance than expected probably due to the poor perspectives offered by the cities. Furthermore, short migrations are undertaken by the

<sup>29</sup> Internet site: <http://esa.un.org/unup/>

<sup>30</sup> For instance, 140,000 ha have been lost around metropolitan Alger and the growth of the city of Sfax in Tunisia apparently led to the elimination of 9,000 ha of agricultural gardens (Benoît and Gomeau, 2005).

<sup>31</sup> The rural development strategies emphasise the development of agricultural and non-agricultural employment, of infrastructures (electrical, water and road networks), the access to loans for small producers, the development of health services, the improvement of education and agrarian reforms in order to improve the quality of life and increase the income of rural dwellers and ultimately to reduce the trend towards rural exodus.

The urban dispersal strategy aimed at increasing the economic conditions and improving the living conditions in secondary urban centres so that rural migrants would choose other destinations. The aim was thus to develop employment in selected places by means of public investment in infrastructures and state industries, by providing support for local authorities and by offering incentives to private investors as part of a strategy of employment decentralisation. These strategies also aimed to reduce inter-regional inequalities (Beauchemain *et al.*, 2005).

least educated individuals. The existence of infrastructures (education, business and health) is related in a negative way to migration as it helps stabilise populations (a brake on mobility)<sup>32</sup>. The proximity of a road network does not affect migration and the most locked-in areas are in fact the ones most affected by emigration. Finally on the family scale, irrigation (modernised agriculture) acts as a brake on mobility.

- The other study conducted in Burkina Faso (Beauchemain *et al.*, 2005) dealt with the effects of local development policies implemented both in rural areas and in secondary cities to reduce migration towards the principal cities. Local development is defined as the availability of public services and infrastructures, of income-related activities and commercial services. The components of local development relative to the economic context, markets in the villages, large companies and agricultural opportunities in secondary cities, to some extent prevent migration. Road and health infrastructures are an incentive to migration which contradicts the results of the study previously referred to.

*These studies indicate that the local economic dynamics in particular when they are extended to non-agricultural activities, to production of local products (agro-foods, handicrafts, etc.) help to stabilise populations.*

## ***2 –Transfers of migrants and the fight against desertification***

### **\* The amounts transferred in Africa**

By 'transfers' we mean the sending of private funds. In 2005, recorded international transfers of migrants towards their original countries accounted for 232 billion USD, including 167 which were sent to developing countries. These transfers are in fact at least twice as great if we also include informal transfers which account for a large proportion of those towards African countries (Cotula and Toulmin, 2005), and they increase quicker than the number of migrants (World Bank, 2006).

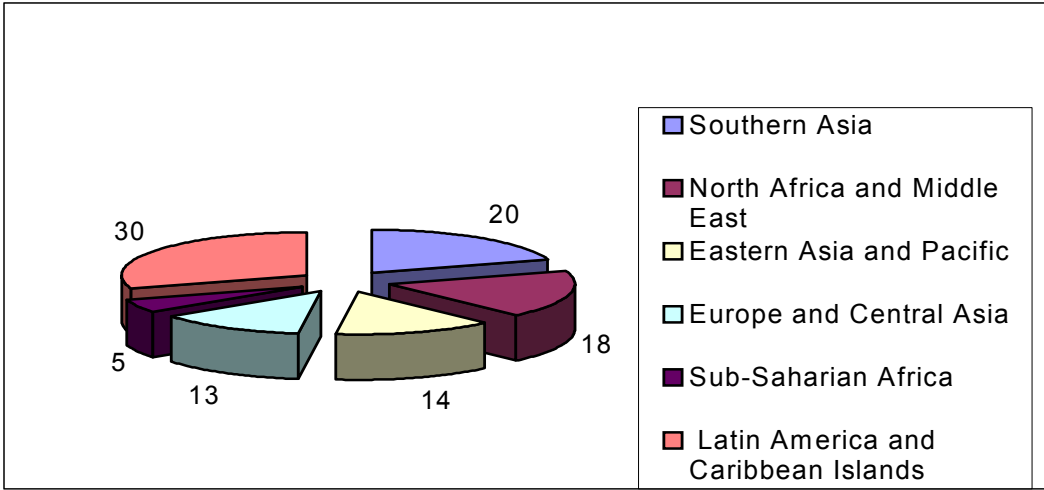
These transfers are on the whole twice as great as official development assistance (ODA). ***However, in Sub-Saharan, Central and Southern Africa, the ODA remains greater than transfers, contributing to 50% of external financial fluxes as against 14% only for transfers (Sander, 2003).***

Africa, especially Sub-Saharan Africa, accounts for the lowest volume of transfers, but it receives more transfers in proportion to its wealth (percentage of GDP); this confirms how important it is for its economy (figures 3 and 4).

*Figure 3: Distribution of migrant transfers received, by world region in 2002 (percentage)*

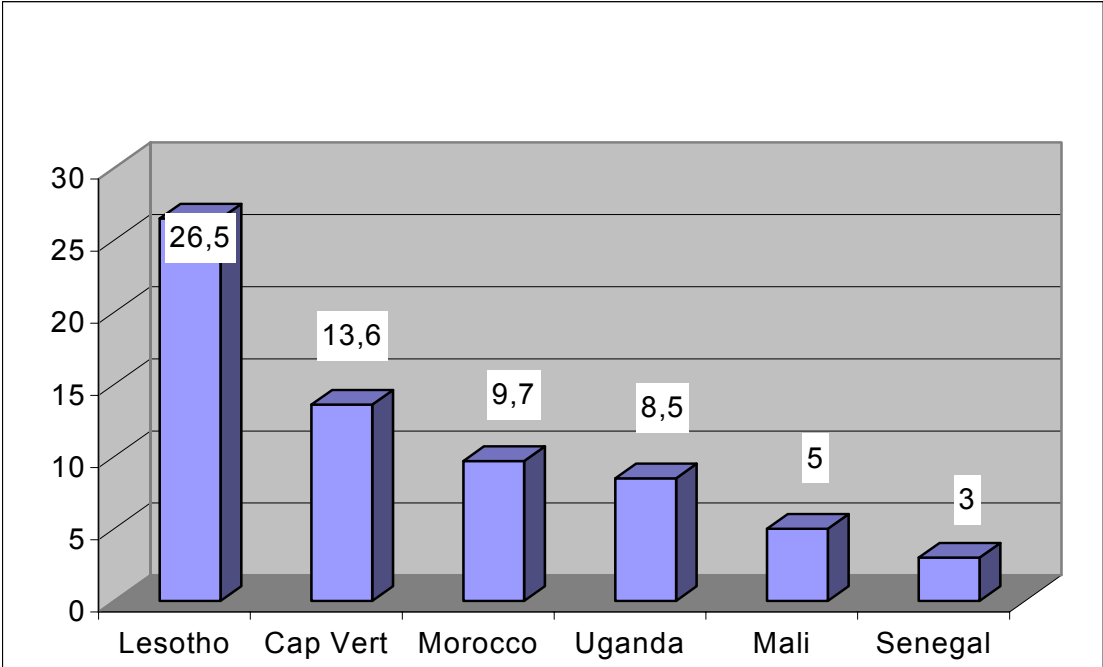
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<sup>32</sup> According to the author, infrastructures are also an indicator of the state of development of non-agricultural activities, of the diversity of resources and of the size of villages.



Source: Sander, 2003.

Figure 4: Transfers as a percentage of GDP for a few African countries



Source: Sander, 2003.

### \* The use of transfers

Migrant transfers are mostly used to improve daily living conditions, current consumer or primary needs (health, food, education, housing and construction in particular) (Cotula and Toulmin, 2005).

The purchase of durable goods or for leisure activities (hi-fi systems, games, etc.) is also an objective of current transfers (Kapur, 2004). The transfers also contribute to improving social status: investment in socio-cultural life (weddings, births, etc.) enables the family of the migrant to improve its status. Finally they are used to invest in land (through purchases), livestock, to reimburse migration debts and for savings as well as investment in economic activities (businesses). The increase in local demand enabled by transfers helps stimulate economic activity unless this demand is for imported products.

### \* Little investment of transfers in the fight against desertification

*The transfers contribute little to anti-desertification investments.* Local studies give conflicting results:

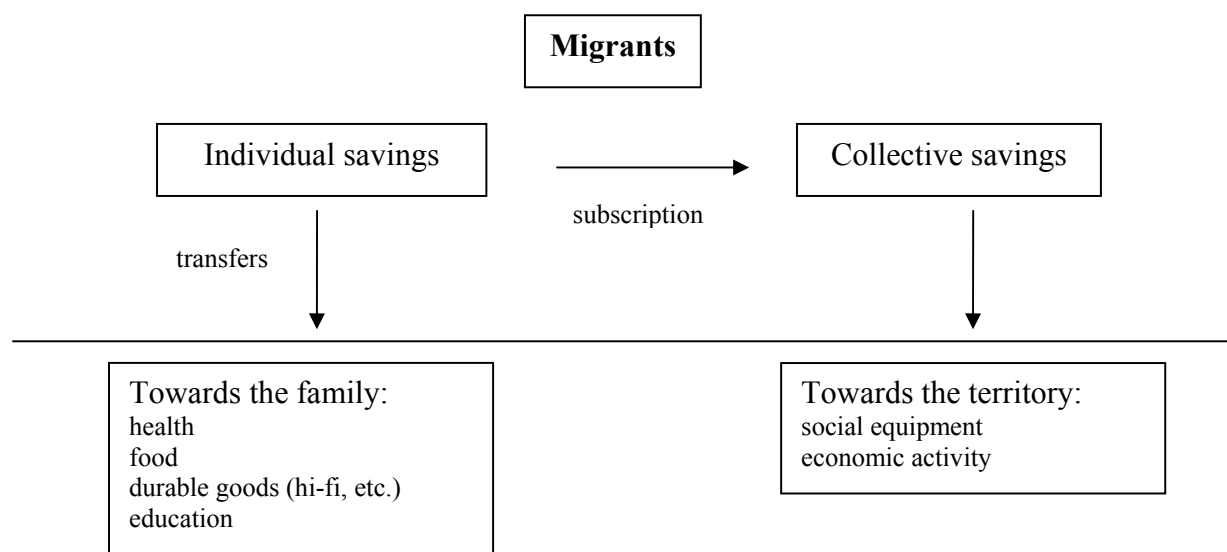
- transfers may discourage agricultural investment or even economic activity as the households wait to receive funds to enable them to offset their daily expenses (observations made in Morocco);
- transfers could also lead to improved technical efficiency on farms of the families concerned (Mochebelele, 2000, case study in Lesotho);
- we should also emphasise here the contribution in human capital potentially provided by migration.
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The collective use of transfers accounts for the least proportion of the amounts transferred. It may be directed towards socio-economic type investments (figure 5). Migrant associations thus finance schools or even universities (investment in human capital), sanitation infrastructures (wells or water distribution points, dispensaries, sewage systems) as well as economic activities such as the development of tourism, so-called fair trade sectors and marginally, land rehabilitation operations. These investments may be developed by public-private partnerships<sup>33</sup>.

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<sup>33</sup> This is the case of the French Development Agency (AFD - *Agence Française de Développement*) and French migrant associations from Morocco for the implementation of green tourism in their regions of origin.

Figure 5: Complementary uses of collective and individual transfers



Source: AFD, 2003.

#### 4 – The costs of migrations

##### \* What do we mean by ‘cost of migrations’?

If we want to distinguish between direct costs and indirect costs as a function of the places of origin and arrival, this cost includes:

- **Direct costs borne by migrants:** when a person or a whole family leaves, they pay for direct and immediate costs: transport, installation, people smugglers. This amount may range from a few hundred to a few thousand euros.
- **Direct costs borne by receiving communities and authorities:** supplementary infrastructures such as for water, sewage, connections to networks, urbanism, infrastructures, housing. If the level of integration in the receiving society is high, we then have to add an extra-cost for schooling and health.
- **Possible indirect costs borne by the environment of the original country:** lack of maintenance for the natural environment, increasing erosion, destructuring of the society, loss of labour and sometimes qualified labour.
- **Indirect costs borne by the receiving environment:** impact on the environment of an increased number of people (this is particularly true for refugee camps), impact on crop and livestock systems in receiving areas and risks of degradation; depending on the policies of the receiving countries, there may be a social cost as well for integrating migrants.

**While migrations generate partially quantifiable costs, it is obvious that they also provide numerous benefits for the receiving country.** The first economic benefits come from work migration. The contribution of cheap labour to more dynamic receiving countries stimulates economic development. This is the dominant (and liberal) theoretical model which describes migration as a factor of economic development as it enables the reduction of production costs and stimulates competition (Domenech and Picouët, 2004)<sup>34</sup>. Other authors prefer to emphasise consumer aspects and human capital: migration stimulates consumption in the

<sup>34</sup> Relocation of firms is another possibility.

receiving countries, hence production and investment and incites the native population to improve its skills (Oudinet, 2005).

**\* A qualitative inventory of costs and benefits of migration coming from arid areas**

We suggest a qualitative inventory of costs and benefits of migrations in the form of the three following tables and according to three types of migration:

- migration within Africa from agricultural region to agricultural region,
- internal migration towards African cities
- migration outside of the African continent and in particular towards the countries of the Organisation for economic co-operation and development (OECD)

*Table 6: Costs of migration, regional migrations and pioneer frontiers*

Type of migration (destination)	Costs of migration		Benefits of migration	
	Place of arrival	Place of departure	Place of arrival	Place of departure
<b>Regional migrations towards other rural parts of Africa: pioneer agricultural frontiers</b>	1 – Pressure on the environment possibly related to the migrant’s lack of knowledge  2 – Costs for installing migrants (housing, etc.)  3 – Costs of integration (social tensions, access to resources, participation, striving for legitimacy)	1 – Loss of labour  2 – Environmental cost due to lack of maintenance of land	1 – Extra and cheap labour (agricultural farm workers)  2 – Contribution of specific knowledge (innovations, in particular for maintenance of the natural environment but also social and economic)	1 – Reduction in pressure on resources  2 – Reduced tensions for social conflicts and land conflicts  3 – Extension of social fabric (new connections)

*Table 7: Costs of migration, regional migrations and rural exodus*

Type of migration (destination)	Costs of migration		Benefits of migration	
	Place of arrival	Place of departure	Place of arrival	Place of departure
<b>Regional migrations towards Southern cities (capital cities and secondary cities) = internal and external</b>	1 – Loss of fertile land related to extension of cities  2 – Sanitation costs related to pollution of water tables and the lack of sewage systems (infrastructures)  3 – Increase in water	1 – Loss of human capital (of migrant)  2 - Loss of labour  2 - Environmental cost due to lack of maintenance of land	1 – Extra and cheap labour  2 – Exchanges with the rural environment: privileged access to food resources (cereals, exchanges between countryside and cities)	1 - Reduced pressure on resources  2 – Reduced tensions for social conflicts and land conflicts  3 – Transfer of funds from the city (food safety, schooling, development improvements including the fight against desertification)

	consumption for drinking water leading to environmental depletion (case of oases)			4 – City networks (extended social capital)
	4 – Increase in poverty and insecurity			
	5 – Costs for installing migrants (housing, etc.) and living costs			

Table 8: Costs of migration, international migrations towards OECD countries

Type of migration (destination)	Costs of migration		Benefits of migration	
	Place of arrival	Place of departure	Place of arrival	Place of departure
<b>Migrations towards Northern countries</b>	1 - Individual cost of travel to the North  2- Human costs: mortality of migrants ‘en route’  3 – Tensions and conflicts with authorities of transit countries (control costs, etc.)  4 – Extra-cost for integrating migrants (protection etc.)	1 – Loss of qualification (human capital)  2 - Loss of labour  3 - Environmental cost due to lack of maintenance of land	1 –Cheap poorly-qualified labour hence increased economic growth  2 – Increase in birth rates  3 – Taking of jobs that locals do not want	1 – Transfer of funds (food safety, schooling, improvements for development)  2 – Northern contacts for new migrants (extended social capital)

Having made these three tables, it appears to be difficult to make a complete analysis of cost/benefits for migrations. We note that there are similarities between the three situations: the economic benefits related to cost of labour in the receiving regions and the social costs of integration are common elements for the three types of migration. As for the environmental aspects, in other words desertification, they are more difficult to evaluate as they are subject to the socio-economic, environmental and institutional contexts of the regions of origin and of arrival. Migration both for the place of departure and for the place of arrival may be the vector of increased desertification or on the contrary lead to less pressure on resources or again to the development of suitable techniques for the fight against desertification. ***It is thus clear that the series of causes which relate migration to desertification in the field are complex and that they may be contradictory depending on the context.***

### **5 - Conclusions and recommendations**

A study undertaken by the environment department of the FAO (2000) shows that rural societies subject to severe crises react according to a scale of increasing seriousness. It distinguishes the following adjustments in response to situational crises such as poor rainfall (or flooding, social disorder, predators, etc.):

- 1 – adjustments in crops and livestock
- 2 – changes in types of food eaten
- 3 – ‘famine’ foods (such as wild fonio<sup>35</sup>)
- 4 – borrowing of food from family/neighbours/allies
- 5 – looking for non-agricultural work
- 6 – temporary work emigration
- 7 – off-season farming with emigration
- 8 – sale of small animals
- 9 – sale of large livestock
- 10 – borrowing of food and/or money from outside of the family/neighbours/allies
- 11 – temporary emigration
- 12 – selling of goods (land,...)
- 13 – final emigration

***As we can see from this list, migration is not the first reaction to increasing consequences of desertification.*** First of all, there is a local search for a solution both for food and for solidarity through social networks. Many studies have been made of solidarity and described the most varied forms have been observed such as reciprocity, self-financing saving groups, transfers. In Africa, solidarity generally applies to a group with successive redistribution; it is a protective mechanism, a safety net, but also a strong social obligation. Recent studies on the budgets of households in the Ivory Coast show that about 15% of the money is devoted to various forms of solidarity.

In the cities, these solidarity phenomena are less evident, in the middle classes (depending on the distance from the original village) but also in some poverty-stricken areas: the link between the city and the country remains but with a contribution from the countryside. The link between city dwellers in slums appears to disappear no doubt due to a lack of means (Frayne, 2004, case of Namibia).

***The elements put forward make it possible to determine two types of relationship between desertification and migrations, both related to the lack of locally suitable rural policies.***

- Some authors believe that the lack of development policies for internal agricultural markets is behind the increasing migrations in the African region and leads to agricultural decline. This agrarian decline contributes to a major risk of desertification (Domenach and Picouët, 2000).
- On the contrary, other authors see migration rather as a response to land saturation in agricultural areas combined with a decline in yields (case of Niger in particular); they also point to the lack of policies for securing land and development of internal agricultural markets as factors which discourage all agricultural investment and in particular investment in preserving soil fertility.

These results confirm that desertification is a development problem for dry regions (Cornet, 2002). The recent evolution of African migration from a social protection mechanism well-regulated in time and space towards a series of short-term displacements in emergency situations reveals both the aggravation of living conditions and desertification.

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<sup>35</sup> Minor cereal of importance only in West Africa where it is eaten in place of rice during famines. The seeds are cooked by steaming the whole grain

We have not delved into the issue of possible links between desertification and clandestine migration towards countries of the OECD: in fact, no studies up to now have linked this type of migration to desertification, even though specialists agree that it is due to an increase in inequalities in living conditions: inequalities caused by globalisation (Mouhoud, 2005); these inequalities are very notable it is true between African regions affected by desertification and European regions. This very widely covered migration still only concerns small numbers of the population even if they continue to grow, in comparison to internal movements in Africa (Bocquier, 1998).

***The most noteworthy point remains the increasing immigration from highly threatened areas. It should be noted that it is practically impossible to talk of thresholds for at least two reasons:***

- The conditions are not the same depending on the areas (diversified activities between agriculture and livestock breeding, different techniques, etc.) and some areas may support higher population densities than others which have the same climatic conditions and soil. The notion of carrying capacity should be handled with extreme care.
- Even though ecology specialists refer to thresholds beyond which the environments would be definitively degraded, they do not suggest any particular threshold. In fact, economic conditions intervene: restoration may be costly but profitable if a particular type of production can turn it to economic benefit.

***We may however identify at least three early warning indicators when conditions of maximum degradation have been reached:***

1. When the whole surface area of a particular local region is being cultivated and there is no crop rotation: it is clear that if no land is left fallow, conditions will rapidly degrade.
2. When a regular decrease in yields is observed.
3. As soon as it is observed that soil is bare for the whole year: this means that the germination potential of seeds is reduced, that rooting is no longer possible, that there is no more water available for plants and generally that crusting is beginning which would make it more and more difficult to restore the soil.

We have noted that the transfer of migrant funds is significantly high; more than double the world ODA. However these funds are not used for agricultural investment and restoring environments.

***If we want to invest in agriculture and livestock systems, it is recommended that we use ODA resources for investments taking care that they reach the intended beneficiaries and that we set up public-private partnerships. This would involve:***

- Following the example of migrants, their funds might serve as guarantees for obtaining micro-bank loans.
- Stimulating the creation of local companies for rehabilitating land with support from institutions (including standards, technical assistance, legislative backing, etc.) and purely private resources (capital, management resources, etc. ); which assumes that a lot of training will be available.
- Involving private service companies (maintenance, business, etc.).

- Improving road infrastructures
- Creating conditions for a dialogue between the civil society and the government administration.

*Following this synthesis, it may thus be observed that migration is not the first social consequence of desertification since the latter first affects the organisation of daily life, in particular between men and women. Other social costs of desertification should be studied and taken into account to improve our understanding of the impacts of desertification on rural societies. Moreover, since final migration is the ultimate solution to desertification, it appears to be necessary to work upstream in order to prevent it or organise it. Finally, migration as a social cost of desertification again raises the crucial issue of the economic development of dry rural areas as well as an overall approach to inequalities between developed regions and developing regions.*

### SECTION III – PROFITABILITY AND REALITIES OF INVESTMENTS IN THE FIGHT AGAINST DESERTIFICATION

This section is a synthesis of a few studies made on the return on investment in the fight against desertification<sup>36</sup>. Most of the development projects focus on the *ex ante* return of action plans that they put forward. The calculation of this return serves both for planning the project and for justifying its implementation by announcing significant returns and benefits for local populations. However the results effectively obtained by these projects generally differ from those announced. This is because their implementation in fact depends on local, national or international contexts which are difficult to predict accurately.

What we are interested in here is thus *the economic rate of return ex post (ERR)* of anti-desertification projects, a rate which indicates the effective success of the project or profitability of the investment made.

Starting with the reference study in this field, that of Reij and Steeds in 2003, this section discusses the ERR of several projects in the fight against desertification in Africa. It stresses those aspects which are not taken into account by the ERR and suggests *widening the definition of benefits to include more social or institutional aspects*. When these other aspects are taken into account and measurable, they cause the ERR level to vary.

A second statistical indicator complements the ERR by better describing producer constraints: *this is the delay in economic return on investment*, calculated for several techniques for soil and water conservation (SWC) based on data from projects in Burkina Faso.

#### *1 – The conditions for a positive ERR, an analysis of the study made by Reij and Steeds, 2003*

##### **\* Method for calculating the ERR of anti-desertification projects and difficulties encountered**

The reference for this work is that of Reij and Steeds who in 2003 evaluated several anti-desertification projects in dry African regions<sup>37</sup>. These projects were financed and implemented by joint international programmes, African governments and the populations who benefited from them. They are mainly Conservation of soil and water (CSW) projects (using traditional planting pits known as *zaï*, dikes, stone bunds), irrigation and reforestation operations. Their rate of return exceeded 10% (see table 9).

*Table 9: Ex post rate of return of four anti-desertification projects*

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<sup>36</sup> The investment in these projects concerned land rehabilitation operations, in other words for restoring the operation of ecosystems and services which depend on them (resilience and productivity). They are different from ecological restoration which aims to re-establish an ecological integrity or authenticity as well as from reassignment. Reassignment refers to the transformation of a landscape by choosing a new land use. These two latter types of investment may be more costly than rehabilitation which has different impacts and benefits (Aronson *et al.*, 1995).

<sup>37</sup> The studies of C. Reij were of 12 agricultural development projects and the anti-erosion fight in dry African regions whose rainfall was between 200 and 800 mm per year.

Project	Country	Duration	Rate of return
CSW (water, zaï)	Niger	1988-1995	20%
Small-scale irrigation (individual pumps)	Nigeria, Kano	1975 -?	38%
Community forest management	Tanzania	1992-1999	12%
Niger Office, large-scale rice growing	Mali	>25 years	30%

Sources: Reij and Steeds, 2003

The evaluation of economic rate of return consists in comparing an initial situation (or a situation with no project) with the situation with the project. A study of the profitability is generally limited to local benefits generated and more precisely the measurable aspects of the benefits, in other words mainly to variations in crop yields or to that of wood production in the case of reforestation operations. These volumes are then multiplied by the corresponding prices. Finally the economic valorisation of gains obtained is related to the cost of the projects.

Economic rate of return:  $\text{benefits} / \text{costs} * 100$

It is important to emphasise that the *duration of projects is an essential criterion for the validity of valuation operations*. Moreover, it is difficult to calculate the benefits of a short term project since the productivity variations of land in dry regions depend first of all on variations in rainfall; a short-term survey is thus not sufficient for simply distinguishing the effects of a project in the fight against desertification from the climatic context in which it is carried out. Furthermore, the response of the natural environment to rehabilitation techniques is only optimal after several years, perhaps even as much as a decade. Even if rural producers observe positive effects immediately from the first years, all of the benefits resulting from ecological improvements on the scale of an ecosystem can only be measured in the medium and long term. Evaluations of projects over three to five years will thus only take into account the smallest proportion of potential return.

#### \* Four examples promoting adaptative and consensus-building projects

By analysing the four projects in the previous table, the evaluation of the benefits of the fight against desertification by means of a calculation of the ERR is based on the increase in yields, on gains due to diversifying agriculture towards crops with higher added value and of gains from planned production of wood.

However, success depends above all on the context: it is because the empowered local populations of Niger and Nigeria took responsibility for the projects that they were a success (see box 2). *Or again success may depend upon the capacity of such projects to enable the emergence of a social demand compatible with their objectives then adapting to it.*

#### *Box 2: Two projects which succeeded due to them being adopted by local populations*

##### *1. - Conservation of soil and water in Niger, in the Illela district*

1 – This project's objective was to promote water 'trapping' techniques by building bench terraces along contours and in half-moon shapes. At first, the people were fairly hostile to this as no use was made of heavy machinery nor were food rations paid in return for work, which had been the case previously in the region.

2 - In 1989, the project organised exchanges with the region of Yatenga in Burkina Faso, a region in which land is rehabilitated using the zaï technique. The project then supported the Niger farmers who copied and adopted this promising technique after their visit to Burkina Faso.

3 - In 1998, 9,000 ha of degraded land were treated, i.e. 15% of the cultivated areas of the zone covered by the project.

A cost-benefit analysis compared the yields on treated land and untreated land:

- The total cost of rehabilitation was 250\$/ha: this required 40 to 60 days of work per ha, plus production and transport of manure and compost.

- The profits were 65\$/ha and per year.
- The economic rate of return for the project was 20%.

#### 2 – Small scale irrigation in Nigeria, through pumping of superficial water tables

From the middle of the 1970s, agricultural development projects were initiated in the North of Nigeria to increase production by means of irrigation, by using fertilizers and by building infrastructures (in particular roads). The distribution of individual fuel pumps enabled farmers to trap well water for irrigation.

On the whole, these projects were failures, except for those located at the bottom of valleys, where dry season crops and market gardening were developed (onions, tomatoes, garlic) thanks to irrigation. The rate of return for the project of the State of Kano for instance was estimated at 38%<sup>38</sup>.

Source: Reij and Steeds, 2003

In one case, the change in orientation of the project and its success was based on an exchange of experience between African producers from different countries; in both cases, the success of the project depended on local stakeholders and enabled them to take advantage of the opportunities offered by the local markets: the local markets were integrated into the regional market garden economy and the anti-desertification techniques led to the creation of a local market for the rehabilitated land.

The successful decentralisation of the management of natural resources and the subsequent empowerment of the producers explains the positive ERR of the two following projects (see box 3).

Indeed:

- the achievement was due to the participation of local populations in the Tanzanian project (which limited irresponsible free-riding behaviour);
- the success of the Niger office's project was due to the decentralisation of the management of irrigated perimeters and hence of irrigation rotation.

#### *Box 3: Two successful projects thanks to participatory decentralisation of the management of natural resources*

##### 3 – Community management of forests in Tanzania

Between 1992 and 1999, a joint management project for 13,000 ha of forest was set up by the government authorities and the local communities of a region in Tanzania. It led to a significant reduction in illegal exploitation of wood, to the planting of trees and the construction of more efficient ovens.

The benefits were calculated on the following basis:

- 9 million plants on 3,500 ha of land with a yield of 400 m<sup>3</sup> of firewood per ha in three crop rotations of 7 years,
- a 50% reduction in the use of wood, i.e. savings of 9,600 tonnes of wood per year for a use of 5 kg per day.

The economic return rate for this project was estimated at 12%.

##### 4 - The Office du Niger irrigation scheme in Mali

The *Office du Niger* scheme is one of the most significant irrigation projects in Sub-Saharan Africa. In 1980, the 50,000 ha of irrigated land yielded 1.5 tonnes of rice per ha. It was a centralised state organisation with little maintenance and inefficient management of water.

From 1986 on, the management of irrigated land was decentralised through a reform: management committees consisting of farmers were created to manage irrigation rotation, the farmers were bound to these committees by performance contracts:

- yields grew from 1.5 tonnes to 5.5 tonnes per ha. Production then reached 300,000 tonnes.
- Revenues were diversified by introducing dry season crops such as the onion (70,000 tonnes were produced in 1999).

<sup>38</sup> Only the cost of extracting water was taken into account. To our knowledge no evaluations have been made of the price of underground water in rural African environments.

- Water taxes collected increased from 60% to 97%.
- 30,000 ha of irrigated land were rehabilitated and 30,000 other hectares were irrigated.
- The net income from rice increased from 450\$ per ha to 1,000\$ per ha in the rehabilitated areas.

The rate of return due to this reform was 30%.

Source: Reij and Steeds, 2003.

It is not known for the Tanzanian example how the profits from the plantations were redistributed. The rehabilitation of common areas generally fails due to a lack of definition of and respect of the rights to use their resources. But in a context of desertification and rarefaction of wood, assuring a regular source of supply or supplementary income can foster coordination and encourage respect for maintaining and valorising the resource (deferred grazing, surveillance, cleaning, sharing of dead wood, etc.).

**These positive economic rates of return appear in fact to depend on the social and institutional conditions governing the implementation of these projects.**

#### \* Limitations on the evaluation of ERR

The ERR is an interesting indicator in that it can be used to convince people about the profitability of investments in the fight against desertification on the grounds of statistics. Can it, however, be used in the case of short duration projects which are the most common beneficiaries of current investment in cooperation in the fight against desertification<sup>39</sup>?

The potential ecological benefits of several anti-desertification techniques have long been known. The ERR can be used to evaluate these techniques in different socio-economic contexts: when combined with a contextual analysis, it can be used to understand the profitability factors of projects. Three of the key criteria appear to be the suitability of projects to meet social demand, the access of the beneficiaries to market opportunities and participative decentralisation of the management of national resources on the local level<sup>40</sup>. Reij and Steeds, 2003 recommend that projects should not be made to depend on public services alone and that it is a good idea to get to know the private and public local institutions in order to identify the providers of suitable services.

In the examples given, the projects evaluated concern SWC activities or irrigation in crop and reforestation fields. They implemented traditional anti-desertification techniques<sup>41</sup>. On one hand, pastoral projects are lacking from these statistical estimates<sup>42</sup>. It is indeed difficult to calculate their ERR: ecological surveys on grazing lands in different transhumance zones and those of veterinary surgeons on the productivity of migrants herds are cumbersome and costly to implement (Bonnet *et al.*, 2004).

<sup>39</sup> It would be useful to try and calculate the ERR of short term projects by weighting results from rainfall data for longer periods, compared with reference projects undertaken over a long duration, etc.

<sup>40</sup> Not much operational work has been done to date on the social demand in development actions.

<sup>41</sup> These SWC techniques are:

- Mechanical: *zai*, half-moons, stone bunds, Earth dikes, filtering dikes.
- Biological: straw mulching and deferred grazing.
- Agroforestry techniques: reforestation, ligneous vegetation, grass strips, herbaceous cover, windbreaks and live hedges.

<sup>42</sup> Most of the livestock breeding projects forced the herds and breeders into a sedentary life style which was not suited to the climatic variability of dry regions. They thus failed. But the arguments have changed over fifteen years and new projects are now trying to organise pastoral mobility.

Furthermore, the benefits of the most innovative anti-desertification techniques, such as seeding under plant mulch in agro ecological projects, have not yet been estimated: the actual data are still too recent to enable calculating a representative ERR. The positive externalities of agro-ecology such as the capacity to store carbon and to improve biodiversity are nevertheless significant and acknowledged (Raunet and Naudin, 2006). There are some figures for them. A realistic calculation of the ERR should take them into account.

Finally the ERR gives no information on what occurs after the project. In several cases, the end of a project signals the stopping of the proposed developments. However, on the scale of one generation, projects have significant effects on local society (see box 4).

*Box 4: Summary of benefits of SWC techniques for rural development, Central Plateau of Burkina Faso*

Between 1975 and 1985, 25% of the population of the central region, which was the most degraded and the most densely populated (100 inhabitant/km<sup>2</sup>) migrated towards the more humid areas, agricultural yields dropped to 400-500 kg per ha and the level of water tables dropped. From 1986 on, three projects for environmental rehabilitation and agricultural intensification over a period of 10 to 15 years enabled the improvement of 101,000 ha, i.e. 35 to 40% of the cultivated areas of 7 provinces. The projects were based on village groups which represented 30% of the target population (i.e. 120,000 people).

*Strong points:*

in villages which have a lot of experience of these techniques,

- 1 – There was a noteworthy reduction in poverty and improvement of food security
- 2 – The reduction in the rural exodus was due to an increase in yields of 50% and a reduction of areas cultivated per person
- 3 – Production surpluses gave supplementary income which was sometimes invested in livestock
- 4 – Better integration of agricultural and livestock activities and diversification of production systems occurred: reappearance of some commercial crops and cash crops (cowpea and sesame).
- 5 – The development of collateral sources of income : labour market for digging planting pits (*zai*), the organic manure market, rental of transport equipment. These new activities helped increase agricultural income by 25 to 30%.
- 6 – The increase in the income of women who benefit from the conservation of soil and water; a reduction in the time they spend on daily chores (fetching water and gathering wood) following the replenishment of water tables and reforestation.
- 7 – The constitution of an elite peasantry class

Among the criteria for success, we should also note the remaking of the main roads which enabled an extension of trading activities.; in villages in which methods for conserving water and soils were not applied, the trends to improvement did either not occur at all or only occurred slightly.

*Weak points:*

The CSW developments required collective choices and organisation, in particular because they had to be implemented on the scale of the catch basin.

- 1 – Degradation of collective areas continued, the techniques were not adopted widely, and sometimes the installations were not maintained.

The projects were based on a participatory approach by means of groups of producers, which had often existed for more than a generation.

- 2 - The representativeness of these groups is an issue as this participatory approach does not prevent the marginalisation of some groups.

- 3 – Socio-economic disparities increased leading to the exclusion and increasing poverty of those who were not able to maintain the developments (costs of intrans and lack of adequate labour) on the one hand and enriching of the beneficiaries on the other hand.

Source: Hien *et al.*, 2004.

## ***2 – More qualitative analyses of return on investment taking the role of institutional and social factors into account***

The favoured indicators in Reij and Steeds' study mainly concerned the increase in agricultural yields and improvement of food security. These are the classic priority objectives of the fight against desertification adapted to dry regions: the aim is indeed to relieve poverty

and increase living conditions in a sustainable way. Nevertheless, given two recent anti-desertification projects, more social criteria could be included when calculating the ERR such as estimating the benefits of the reduction in local conflicts over resources in order to defend the profitability of these projects.

Other more regional or global criteria (such as migrations, water, biodiversity, climate change) could also be put forward and integrated into these calculations. They would set the issue of desertification into a global perspective.

### \* **Two anti-desertification projects offering social and institutional benefits**

Analysis of the evolving environmental situation in most African countries reveals three characteristics:

- The extension of cultivated areas (to the detriment of grazing land),
- The general degradation of soil fertility and modification of ecosystems,
- The reappearance of conflicts over the management of natural resources.

Two long duration projects, one of which is on the management of natural resources in the North of Burkina Faso and the other on pastoral mobility in Chad are banking on ***the decentralised management of natural resources and local development to promote the fight against desertification*** (box 5). The methods used have the following points in common:

- They identify the basic resources for different rural activities;
- They list the methods and time needed for different social groups to appropriate and use these resources;
- On the basis of this information they design consensus-building frameworks to define sustainable use of rehabilitated resources by placing an emphasis on traditional modes of decision-making about resources.

#### *Box 5: Two anti-desertification projects with a key institutional component*

*The PSB-Sahel (1989-2004), Burkina Faso*

This is a project for fighting desertification in the North of the country, which is based on empowering populations to manage natural resources. It organised:

- institutional support: defining and implementing local environment conventions
- SWC improvements: 20,787 ha (zaïes, half-moons, grass strips, composting, straw mulching, reforestation, bunds and dikes).
- training / literacy training,
- support for the socio-economic initiatives taken by populations (socio-economic and hydraulic community infrastructures, loans for lucrative activities)
- sanitation and educational infrastructures.

Results:

- Doubling of crop and fodder yields in zones treated,
- Variation of the subsequent pastoral load,
- Increasing rate of recovery,
- Return of biodiversity,
- Increasing adoption of these techniques by the local populations,
- A 75% reduction of conflicts over the management of natural resources.

However no quantitative data on the improvement of living conditions, on economic valorisation of increased yields gains is yet available.

#### *The Almy Bahaim pastoral project in Chad (1995-200?)*

This is a project for gridding a pastoral zone with hydraulic infrastructures in order to increase the fluidity of the summer transhumance and avoid over-grazing. Surface area: 300,000 km<sup>2</sup>; Hydraulic installations: 400 wells and ponds (being created and repaired); livestock concerned: 3.7 million tropical livestock units (TLU), population concerned: 150,000 breeders.

Principal strategic objective: ensure a better distribution of migrating livestock in the territory by means of a hydraulic grid in which each installation has a low capacity (less than 7,000 m<sup>3</sup>) in order to limit grazing pressure and avoid agricultural installations in each area.

These hydraulic installations have different functions and are ranked differently: they allow for opening new pastures, securing transport routes and caravan routes, delaying and diverting herds of livestock moving downwards towards dry season areas (during harvesting) and moving upwards (during sowing), protecting cultivated river banks.

The project's scope includes two parts:

- A pastoral part (livestock) which goes along with local negotiations for the installation of watering points and user management of structures and resources; it includes the reconnaissance work for marking routes;
- A hydraulic part for technical studies, signing contracts and supervising work performed by companies (hydraulic structures and beacons). The traditional organisation of irrigation rotation is handled by the 'water points manager', who is often the head of the village or of that part of the population which has been using the area the longest.

Source: Dabiré *et al.*, 2004; Bonnet *et al.*, 2004; Jouve *et al.*, 2002

In the case of PSB-Sahel, the implementation of collectively-negotiated local environment conventions has made it possible to ***reduce conflicts over resources by 75%***; the administration manages less than 20% of the residual conflicts which has led to a ***decrease in up to 90% of expenses related to settlements of conflicts***.

The Almy Bahaïm project was based primarily on traditional managers of water resources: no conflicts occurred during the setting up of the committees for managing the installations<sup>43</sup> and the migration circuits have actually been made safe.

The successful implementation of anti-desertification techniques thus requires a more integrated vision of local development. ***The calculation of the rate of return of such projects could take into account the benefits related to the reduction or absence of conflicts over resources***. These investments in the implementation of consensus-building approaches for the management of resources have helped contribute to the successful implementation of anti-desertification techniques<sup>44</sup>.

#### **\* Conclusion: an under-estimation of benefits**

By taking into account all of the aspects referred to previously, the benefits which are used as a basis for calculating the ERR of anti-desertification projects can be significantly increased (see table 10).

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<sup>43</sup> The creation of joint management committees for water points and prefectural commissions for determining transhumance routes.

<sup>44</sup> The reservations expressed take into account that the legal context of the country does not recognise the local institutions managing natural resources and the local development implemented by the projects.

Table 10 : A more exhaustive basis for calculating the ERR of anti-desertification projects

Types of benefits	Indicators	Possible measurements
<b>LOCAL</b>		
<i>Increase of available agricultural products</i>	Variation in agricultural production	Variations in yields* local/global prices
<i>Increase of available fodder and livestock capacity</i>	Variation in livestock production	- Variations in livestock carrying capacity * local/ global prices - Variations in fodder yields * local/ global prices of reference fodder
<i>Reforestation</i>	Variation in forest cover	Variations in volumes of wood and non-ligneous products * local/ global prices
<i>Increase in available water</i>	Replenishment of water tables	- Variation in water carrying time * average cost of labour - Volume * value of water recovered -?
# <i>Management of natural resources</i>	Decrease of conflicts	Reduction in number of conflicts observed * mean cost for settlement of conflicts
# <i>Stabilising of the population</i>	Drop in rural exodus	Opportunity cost: cost of connecting drinking water in the city (in relation to the number of beneficiaries) ?
# <i>Recovery of biodiversity</i>	Species recovered in private gardens	Surface areas or amounts concerned * local/ global prices of species recovered ?
<b>GLOBAL</b>		
# <i>Adaptation to climate change</i>	Storage of carbon	Quantities of carbon stored * market price of carbon
# <i>Recovery of biodiversity</i>	Modification of ecosystems and landscapes	?
# <i>Recovery of soil fertility</i>	Variation of vegetable cover: better water infiltration, increase in fertility (organic matter, nutrients, etc.) Drop in albedo	?

#: indicates benefits which have rarely been quantified to date by anti-desertification projects

? : which (other) methods of evaluation?

Generally speaking, the social and environmental benefits are never or hardly ever taken into account when calculating the figures for projects. However it appears it is fairly easy to determine three types of benefit. These are:

- the benefits of reducing the number of conflicts over natural resources
- the benefits of storing carbon once the average rates of storage are known.
- the benefits of stabilising populations even though the opportunity costs method may be criticised<sup>45</sup>.

<sup>45</sup> If the civil society of Northern countries were to classify the importance of impacts of the fight against desertification, in first place they would put themes related to climate change and migration (according to the content of the French media on the world 'deserts and desertification' year).

*Ultimately, the result is that the ERR of successful anti-desertification projects is underestimated. Better integration of their benefits is hampered by the lack of available methods and the cost of implementing them.*

### ***3 – The delay in return on investment or producer constraints***

While investments in the fight against desertification produce effects which are objectively advantageous for societies and for the environment, it remains hard to understand why rural populations of the regions affected do not invest more spontaneously and systematically. Analyses of determining factors for investment in land at the household level would be welcome.

We shall now develop an approach based on the delay in return on investment. Using a few examples with figures, we hypothesize that the delay in return on anti-desertification investments is too long given the low financial margins of most of the local producers.

#### **\* Delays in return on dikes, small dikes and stone bunds**

The delay in return on dikes, small dikes and stone bunds was calculated in Burkina Faso by the PATECORE project (box 6) , then using data from the PSB-Sahel (box 7).

#### *Box 6: Delay in return according to PATECORE (1988-2000)*

PATECORE = 800 groups of villagers, 8 decentralised project offices, 60,000 ha of restored land (CSW)

##### Costs per hectare:

Total = 155.233 CFA ~ 237 €

External (paid by project) = 80.244 CFA ~ 122 €

Local farmers (contributing through work) = 75.000 CFA ~ 115 €

##### Benefit taken into account:

Yield per area increased by 250 kg/year/ha (25.000 CFA/year)

##### Delay in return:

The 80.000 CFA/ha investment in the project was amortised after 4 years

The 75.000 CFA/ha local farmer investment was amortised after 3 years.

Total period: 7 years

Source: Wauters E., 2005.

***Delay in return on investment calculated by the PATECORE project was 3 years for producers with project backing and would have been 7 years otherwise.***

The following costs are listed for each type of mechanical installation for CSW (table 11).

*Table 11: Costs per ha of stone bunds, dikes and filtering dikes in Burkina Faso*

Structure	Costs per ha in FCFA
<b>PATECORE Project</b>	
Stone bunds	32,000
Small filtering dikes	49,000
Filtering dikes	100,000
<b>Sahel Burkina Programme</b>	
Stone bunds	94,540
Filtering dikes	114,206

Source: Hien V. et al, 2004.

The costs of stone bunds differ according to the two projects. This may be explained by two principal factors:

- the distance over which the necessary rubble stones have to be brought and the corresponding transport. If rubble stones have to be brought, then trucking costs have been evaluated between 87,500 and 105,000 FCFA;
- labour cost: the labour cost of individual stone bunds is 97 h per ha (if built by the family) and 673 h per ha for collective bunds (NGOs, development projects).

The cost/benefit ratio obtained on the basis of results for the PSB-Sahel (box 7) indicates that ***a return on total investments (bunds, dikes and small dikes) takes from three to eight years*** (Hien et al., 2004).

***Box 7: Economic benefits of CSW techniques in the framework of the PSB Sahel project***

Production gains observed:

- + 47% in the case of pearl millet with stone bunds
- + 11% for sorghum with stone bunds
- from 75% to 133% for crops grown with stone bunds, filtering small dikes and dikes.

Economic benefits for 1999:

- under stone bunds, the annual profit for millet plantations was 11,600 FCFA, and that for sorghum was 24,682 FCFA,
- with filtering dikes, the annual profit for the growing of sorghum was 45,570 FCFA

Source: Hien et al, 2004.

**\* The *zai*: a generic calculation in Burkina Faso**

The *zai* is one of the most widely documented CSW techniques in the literature. The optimum conditions for successful implementation of the *zai* are 300 to 800 mm of annual rainfall and very poor soils<sup>46</sup>. The main constraint is that of labour for which periods of 900 to 4,000 hours of work per hectare have been observed<sup>47</sup>. The adoption of the *zai* leads to a reduction in the areas cultivated. The benefits of the *zai* for the soil and vegetation may be felt for thirty years (Le Houérou, 1998).

<sup>46</sup> The *zai* is not very suitable for sandy soils.

<sup>47</sup> i.e. 150 to 571 work days of 6 hours each

*Thus, in Burkina Faso, a hectare of zaï costs a minimum of 120,000 FCFA in labour<sup>48</sup>. For the variation in yields, again in Burkina Faso, the zaï with organic matter has made it possible to increase cereal yields from 0.7 t/ha to a yield varying from 1 tonne to 1.7 tonnes per hectare depending on the quality of the soils and the amount of rainfall (Somé et al., 2000).*

On the basis of FAO data on cereal prices between 2000 and 2003 (table 12), we tried to determine how many years would be necessary to return a profit on investment in one hectare.

*Table 12: Price of three cereals: millet, maize and sorghum from 2000 to 2003 (Burkina Faso, FCFA per tonne)*

Years	Millet	Maize	Sorghum
2000	75,407	66,331	69,291
2001	120,161	99,455	107,624
2002	133,952	112,337	122,411
2003	96,737	71,653	84,382

Source: statistics from the FAO

The same trends were observed for the prices from one cereal to another and significant variation from one year to another. For information, these variations appear not to be related to the level of production of these cereals for the four years<sup>49</sup>.

We have considered three scenarios: optimistic, intermediary or pessimistic based on variations in zaï yields. We have assumed that the crop yields obtained in the first year following the investment in is one tonne per hectare. The net gains were calculated successively for the three main cereals in the country: millet, maize and sorghum. The measurements for millet crops are shown in the table below for each scenario. The titles in bold refer to the year in which the initial investment is recovered by the producer.

*Table 13: The delay in return on investment, millet using zaï, Burkina Faso*

	Scenario 1: optimistic	Scenario 2: intermediary	Scenario 3: pessimistic
<b>Year 0 (2000)</b>	Yield = 0.7	Yield = 0.7	Yield = 0.7
<b>Year 1 (2001)</b>	Yield = 1 NET GAIN = 0.3 * 120,161 = 36,048 FCFA	Yield = 1 NET GAIN = 0.3 * 120,161 = 36,048 FCFA	Yield = 0.7 NET GAIN = 0.3 * 120,161 = 36,048 FCFA
<b>Year 2 (2002)</b>	<b>Yield = 1.7</b> NET GAIN = 1 * 133,952 = 133,952 FCFA	Yield = 1 NET GAIN = 0.3 * 133,952 = 40,185 FCFA	Yield = 1 NET GAIN = 0.3 * 133,952 = 40,185 FCFA
<b>Year 3 (2003)</b>		<b>Yield = 1.7</b> NET GAIN = 1 * 96,737 = 96,737 FCFA	Yield = 1 NET GAIN = 0.3 * 96,737 = 29,021 FCFA
<b>Year 4</b>			<b>Yield = 1</b>

<sup>48</sup> i.e. 183 euros and 235 dollars (November 2006)

<sup>49</sup> Production of millet, maize and sorghum from 2000 to 2003 in Burkina Faso, thousands of tonnes, source FAO

Years	Millet	Maize	Sorghum
2000	423,494	1,016,275	725,613
2001	606,291	1,371,569	1,009,044
2002	653,081	1,373,331	994,661
2003	665,508	1,610,255	1,184,283

The delay in return on investment for a hectare of millet varies between 2 and 4 years. This delay depends greatly on the inter-annual variations in the price of millet. For maize and sorghum crops, the calculations show that the delay in return for the initial cost and a minimum of 120,000 FCFA may be as long as 5 years in the case of a pessimistic scenario<sup>50</sup>. The delay in return on investment with *zai* planting on a hectare in Burkina Faso thus varies between two and five years taking into account the minimum cost for this investment.

***These scenarios enable us to evaluate the joint impact of climatic hazards and economic variables on the possibilities for producer investment.*** The significance of these calculations is of course relative: as we have used the lowest value for the cost of a *zai*, the delay in return on investment might have to be multiplied by two<sup>51</sup>. ***This then gives comparable delays in return on investment for the *zai* to those for dikes, small dikes and stone bunds, of between three to eight years.***

#### ***4 - Conclusion: support investment for the recovery of land***

***It takes several years for producers to get a return on investments in SWC for the recovery or maintenance of their land: from four to five years on average and this may range from two to eight years. These delays are a brake on the use of these techniques.***

This variability of the return time is greatly dependent on that of rainfall and cereal prices. It remains difficult to evaluate the economic aspects of different SWC techniques, their cost and their benefits due to the diversity of the costs observed. The evaluations do not take into account the costs for maintaining those improvements.

Our indicator of the likelihood of people investing in maintenance of land is thus the delay in return on investment: given the low budget margins and the lack of land tenure security of rural producers in the regions, the longer this delay, the more unlikely they will be to invest<sup>52</sup>.

***The land question must of course have to be considered and integrated*** in the case of the district of Machakos in Kenya, analyses made of the reasons for a high investment of households in the recovery of land underlined the pivotal role of fluid systems through which people try to claim more secure rights to work land and of the fact that there were infrastructures (in particular roads) (Reij and Steeds, 2003).

On the basis of these observations, several proposals may be developed:

- the fairly traditional one would be to extend micro-loans to the rural sector to reinforce investment in fight against desertification. However micro-loans do not work very well or do not work at all in rural environments. Moreover, such an approach is one of repairing problems created by desertification; finally, as long as producers are not able to increase their income substantially, they will remain dependent on these loan possibilities. Micro-loans, while they should be developed for anti-desertification issues, are not enough to stimulate local development.

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<sup>50</sup> Based on 2003 prices for years 4 and 5.

<sup>51</sup> The cost of 100,000 FCFA per ha may vary by a factor of at least one to four due to variations in necessary labour time while including the cost of organic matter, its transport and the necessary water. Maintenance costs would also have to be taken into account. In these regions of Burkina Faso, the price of manure varies from 1,000 to 2,500 FCFA per cartload (Hien *et al.*, 2004), but no one knows how many cartloads are necessary to treat a hectare of land planted with the *zai* technique.

<sup>52</sup> Poverty is generally considered to be the reason for the lack of investment. But we should note that no research dealing with the relationships between types of poverty (or the lack of capacity in the meaning given to it by Sen) or with rural investment was found during this work.

- Indeed, the Keita project in Niger shows that land rehabilitation alone is not sufficient for African rural development (box 8). This project's leaders acknowledged that it had reached a limit to agricultural development in its area after achieving several anti-desertification improvements over a period of more than 20 years. Naturally one might wonder what the local blocking factors were or the inadequacies in the organisation for implementing the project. One might also defend the idea that investment in more lucrative activities, putting a value on natural products and the specific know-how of dry areas (i), locally producing added value (ii) and involving the national and international private sectors (iii) would enable producers themselves to implement the anti-desertification techniques using the profits due to these new activities. This proposal raises several issues as to the actual feasibility (legal, institutional, etc.) of such projects undertaken (i), the local distribution of profits made (ii), the sustainability of production based on economic profit (iii).

*Box 8: Achievement and levelling out of anti-desertification operations, the example of the Keita project (Niger)*

In 1962, the Keita region in Niger was covered with dry forests. This vegetation had completely disappeared in 1984. That year, there were no agricultural yields due to a new drought. The Keita project covering 3,500 km<sup>2</sup> (out of the 4,860 km<sup>2</sup> in the district) was implemented between 1984 and 1999. The main achievements of the project were soil and water conservation (bench terraces, trenches, windbreak vegetation strips, dike dams). The objective was to reduce erosion, to facilitate infiltration of water and provision of water to livestock. Twenty thousand ha of land were treated including 9,300 of agricultural land, the rest being grazing land and forests; 17 million trees were planted between 1984 and 1991. Dunes were fixed. Several infrastructures were built including roads, wells and schools.

Cereal yields went from 1.5 tonnes in 1972 to 0 in 1984, then to 0.364 between 1984 and 1994; production of fodder was 50% more for the zones treated by the project.

The population in the region grew from 65,000 people in 1962 to 170,000 in 1995 and to 231,680 people in 2002. The cultivated areas increased from 33,750 to 44,850 ha in 1979, to between 107,000 and 167,828 ha in 1994.

The zones which were actually cultivated exceeded those normally allotted for agriculture, **indeed in 1994, it was thought that the maximum area which could be cultivated had been reached, evaluated at about 120,000 ha. This area barely covered the food needs of the population at the time:** it was considered that 237 kg of cereals per person and per year were needed, which corresponded in the region to 0.7 ha of crop land per person giving a yield of 350 kg/ha (Di Vecchia *et al.*, 2002).

**Development perspectives thus suggested that activities should be diversified.**

Source: Reij and Steeds, 2003; Vecchia *et al.*, 2002; PEICRE, 1998.

## GENERAL CONCLUSION

Since the United Nations Convention to Combat Desertification was adopted, there has not been much commitment on the part of the countries concerned or of developed countries. The fight against desertification is the daily lot of populations in the affected regions, often the poorest and most marginal areas in the world; apart from that, the fight against desertification remains limited to the narrow circle of those people who are convinced that it is necessary to act: activists in NGOs, scientists, national organisations for development and research in the countries affected and in developed countries and finally international organisations.

Knowledge of costs still has to be improved and is not widely disseminated. There is not enough knowledge of economic achievements in the fight against desertification nor of the corresponding rates of return. Furthermore none of this knowledge has been sufficiently publicised to convince those who might be in a position to invest.

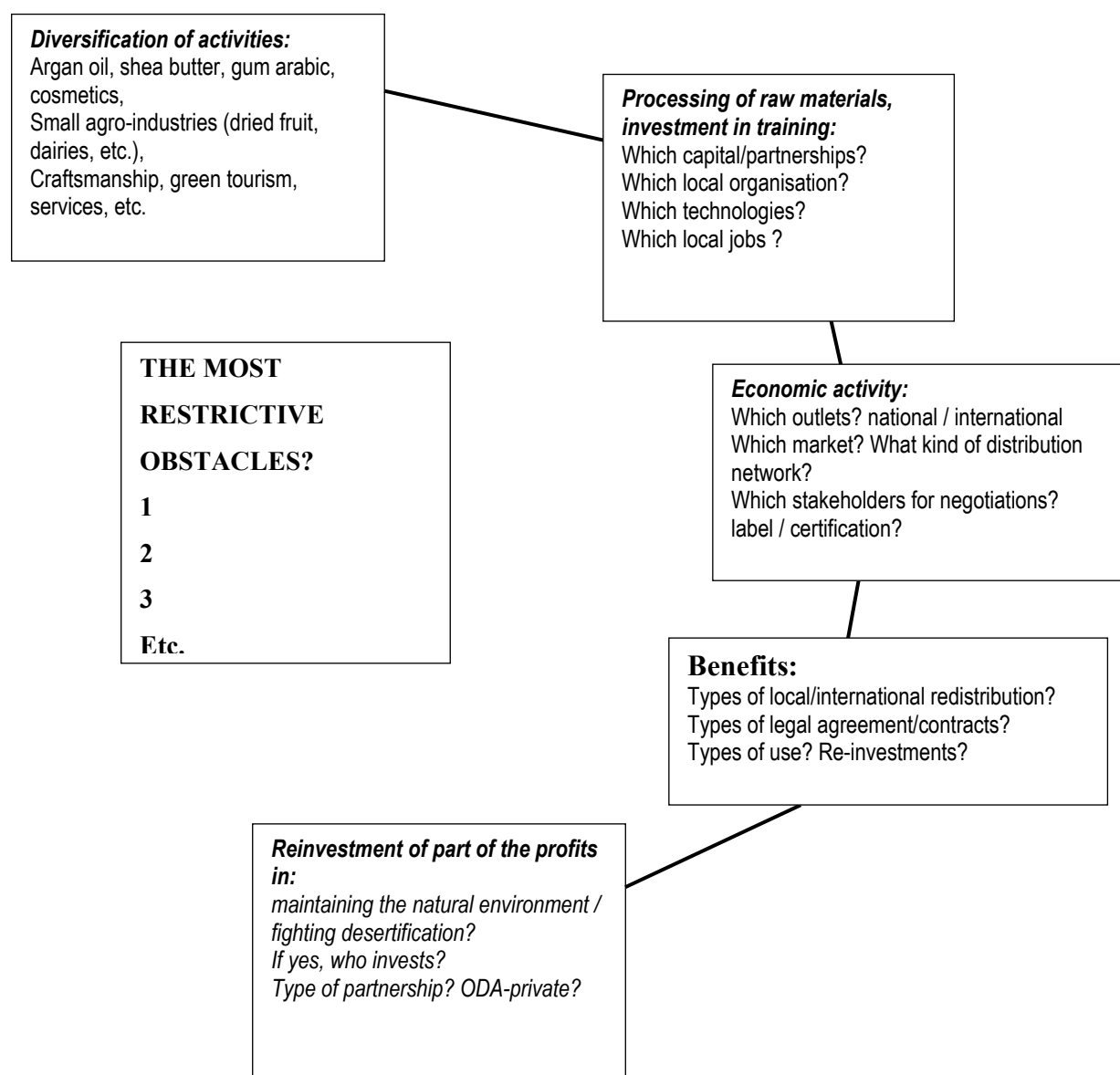
There are still many obstacles to be overcome to persuade public, national, international and private investors, such as for instance, the lack of secure land title for many producers, the lack of guarantees of investment, weaknesses in the organisation of civil society, the lack of government regulations and the excessive fluctuation of markets.

Furthermore, not much has been said about the type of investments to be made:

- Should interventions aim at the recapitalisation of the degraded natural capital of arid areas and/or the protection of areas which have not yet been greatly affected? Is this really the role of overseas development assistance and national budgets?
- Should investments be made in food production and/or in more commercially oriented production? With which loans and which stakeholders? What role could micro-loans and money sent back by migrants play?
- Should investments aim to set up high added-value production schemes, with all of the inherent problems of distributing this added value between the basic producers, businessmen, processors and distributors of final products to guaranteed markets? What role might private investors play? Under what conditions?
- Should investments be made in activities other than agriculture, forestry and grazing to relieve pressure on resources (such as green tourism, craftsmanship, services, etc.)? Who can invest in these sectors? With which stakeholders?
- Should investments be made in training, development of human and social capital and scientific research? Once again, is this the role of overseas development assistance and national budgets?

Along with these questions on guidelines for investment (figure 6) are those questions as to who is ready to invest, how much and how and with which stakeholders. Are local farmer or village organisations legally acceptable partners with whom one may contract, and to whom one may give or lend? If not, how can they become acceptable partners? From these partnerships, is it possible to distinguish between overseas development assistance, government loans, private loans and money sent back by migrants?

Figure 6: Will investment in dry regions further the fight against desertification?



*To conclude, this workshop on the costs of inaction and opportunities for investment in dry arid, semi-arid and sub-humid areas will be an extremely important opportunity for various stakeholders, experts, economists, public and private decision-makers:*

- *to make an inventory of the economic and social costs of desertification;*
- *to compare the rates of return of successful projects as well as obstacles to be overcome;*
- *to make proposals to increase our knowledge;*
- *to increase our understanding of decision-making mechanism for investment;*
- *to consider various ways of investing in ethical production projects, their advantages and obstacles;*
- *to demonstrate that investing in the areas concerned is the only way of reducing poverty and ensuring sustainable development;*
- *to identify the extra-work needed to do this.*

- *and finally to transform our knowledge of costs and investments into a rationale to help convince public decision-makers and national and international companies to invest in partnerships to fight desertification.*

Among the final recommendations, we might suggest:

- updating Dregne's study on the global cost of desertification;
- an inventory of creating and marketing products from arid areas;
- reflecting on the impact of different kinds of commercial investments in the anti-desertification actions referred to and of increasing local income,
- etc.

*This conference should enable us to set up a flexible system for facilitating dialogue between stakeholders, for undertaking studies based on the proposals made, following them up and distributing results, for honing the necessary arguments and arranging for them to be publicised. The work could be done through a network whose structure and plan of action also have to be defined.*

## LIST OF ACRONYMS AND ABBREVIATIONS

AFD	French Development Agency <i>Agence Française de Développement</i>
AGDP	Agricultural Gross Domestic Product
C3ED	Centre of Economics and Ethics for Environment and Development <i>Centre d'Economie et d'Ethique pour l'Environnement et le Développement</i>
CSFD	French Scientific Committee on Desertification <i>Comité Scientifique Français de la Désertification</i>
Dh	Moroccan Dirham
ERR	Economic rates of return
FAO	Food and Agriculture Organization of the United Nations
FCFA	Franc CFA
GDP	Gross Domestic Product
GEF	Global Environment Facility
GM	Global Mechanism
IOM	International Organization for Migration
IRD	<i>Institut de Recherche pour le Développement, France</i>
MDG	Millennium Development Goal
MEA	Millennium Ecosystem Assessment
MENA	Middle East and North Africa
NGO	Non-Governmental Organisation
ODA	Official Development Assistance
OECD	Organisation for Economic Co-operation and Development
REMUAO	Network on Migrations and Urbanisation in Western Africa <i>Réseau migrations et urbanisation en Afrique de l'Ouest</i>
SWC	Soil and Water Conservation
TLU	Tropical Livestock Unit
UMR	Joint Research Unit
UNCCD	United Nations Convention to Combat Desertification
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
USD	American Dollars
USLE	Universal Soil Loss Equation

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## Summary

The issue of economic costs and in particular macroeconomic costs of the degradation of land is slowly becoming a priority one in international meetings on the development of dry regions. It is also being combined with the cost of inaction revealed by the OECD in 2005. However, there are not many practical studies of the cost of degradation of land on a national level and furthermore the few there are not referenced very well in scientific publications. This article will describe different studies undertaken mainly by the World Bank, their methods and limitations as well as their results. Two types of approach can be distinguished on the whole: on the one hand, modelling principally based on understanding processes of rainfall erosion, based on plot surveys; furthermore more spatial approaches dividing the areas affected according to the main economic activities which take place there. The results show on the whole that the cost of desertification is often equal to or greater than the agricultural growth of the countries concerned which brings into question the reality or sustainability of their rural development.

The issue of the social cost of desertification has hardly been dealt with at all in the scientific literature. The question of relationships between migration and desertification in Africa which is now becoming a current issue was recently the subject of a symposium in Almeria (Spain). The contribution made here is based on the results of the 'migrations and development' theme, on several demographic analyses in the field as well as on articles and data available on the rural exodus and the use of transfers of money by migrants in Africa. Based on these works it includes a qualitative inventory of the cost of migration. This inventory emphasises both the lack of locally adapted agricultural policies and development policies for internal markets and also the lack of a global approach to inequalities between developed countries and developing countries. To conclude the concept of the social cost of desertification cannot be limited to studying the migratory phenomenon alone even if the relationships between migration and desertification require more thorough and precise knowledge.

Finally, analyses of the rate of return on investments in the fight against desertification are still inadequate. Referring to several key studies on this issue and a review of several anti-desertification projects, the document shows that the rates of return of successful projects are often under-evaluated because they are generally limited to agricultural production gains. However the delays in return on investment observed for the rehabilitation of degraded land can also explain why anti-desertification projects are so poorly deployed among local populations who are not able to bear the cost. Finally we consider investment in the recovery and maintenance of land as a motor of rural development. Should one not as well in order to fight against desertification, promote small industries producing products from dry regions as well as ecotourism or service activities?

Keywords: desertification, land degradation, costs, modelling, land use, erosion, migration, rural exodus, transfers, development policies, investment, economic return rate, delay in return, fight against land degradation