LAND DEGRADATION IN COQUIMBO REGION – CHILE:

ITS EXTENT AND IMPACT

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Preface

This paper is part of a series of case studies, which attempt on a pilot country basis to examine the costs of land degradation. This stage of the work involves a desk analysis of:

- Impacts of land degradation
- Costs of land degradation
- Costs of land improvement measures
- Costs of policy reform and institutional development.

In one region of Chile in general there is reasonable, though not comprehensive, information on the impacts of land degradation and a good assessment base of the proximate and root causes. Linkages with poverty are well established.

There is much less information on the impact on the ground of these actions. It is clear that the impact of land degradation is a drain on economic growth in rural areas and has an affect on national economic growth patterns. Investment in remedial action is hard to quantify, but appears an order of magnitude smaller than the scope of the problem. Actual in country joint assessment with national stakeholders will be necessary to provide specific analysis of the countries concerned.

CASE STUDY OF COQUIMBO REGION – CHILE

LAND DEGRADATION IN COQUIMBO REGION, CHILE: ITS EXTENT AND IMPACT

Executive Summary

This regional case study of a heavily degraded semi-arid region illustrates the high cost of land degradation in such regions. Losses of nearly 50 percent on wheat yields and 23 percent on goat rearing are attributed to land degradation. Land degradation also impacts tourism, a major income producer of the region and also most other environmental services.

Edited by Leonard Berry

LAND DEGRADATION IN COQUIMBO REGION, CHILE: ITS EXTENT AND IMPACT

The Coquimbo Region of Chile is an arid-semi-arid part of the country. It was the pilot area for a multi-country study of indicators of land degradation (GEF Indicator Project MONITOR, Santibáñez, 2002). That work including field analysis produced a detailed systematic set of indicators. As a follow up to this work Dr. Fernando Santibáñez was asked to produce an assessment of the cost of land degradation for that region as a part of the GM case studies. Obviously the core work was carried out in a different context than the other case studies, and the results are presented here in a somewhat different format.

Environmental Background

Region IV of Chile is an area of 40.707 sq. km with a population of 504,387. Agricultural land is held in three types of tenure; modern irrigated lands (3 % of land area), large traditional estates and communal holdings. The irrigated sector has problems with unsustainable water use and salinization, but the most serious land degradation is found both in the traditional estates and in the communal areas. The greatest pressure is on the communal lands where poverty and land degradation combine. Goat herding is the main animal raising activity. Wheat is the major grain crop.

Economic Assessment of Land Degradation

The economic assessment concentrated on three areas:

- The impact of land degradation on the production of goods and services
- The impact of land degradation on environmental services
- The impacts of land degradation on the natural heritage of the region

Wheat and goat herding, the two basic agricultural products were studied

Wheat

Alcores community was chosen as a test site; it comprises about 8 % of the total area under wheat. Using actual data for wheat yields and field observations for erosion levels it was calculated that yields were 5.6 qq/ha compared with a minimum expected yield of 10 qq/ha. This equates to a loss of $80,000 for the region almost half of the expected crop value in the absence of land degradation. (For calculations see Annex 1).

Goat Herding

The region is a major goat raising area in Chile, with over 300,000 goats, 41.5 percent of the national herd. Census data on the goat population and its specific distribution was related to potential stocking rates with the range in good condition. The economic consequences of the lower than potential stocking rates were calculated for milk/cheese production, meat, leather and manure for the whole region. Table 1 summarizes the losses for the region. Current regional income from goat rearing is $656,677. Without land degradation another $196,970 would have been added to the local economy. This represents a 23 percent loss to this sector of the economy from land degradation. (Annex 2).

Table 1 – Losses in goat production because of land degradation

Product	Present income	Variation in gross income due to degradation
Cheese	3,393,023,248	-1017,899,026
Meat	839,239,020	-251,774,950
Leather	27,337,050	-8,201,700
Manure	270,782,240	-81,220,000
Total ($)	**4,530,381,558**	**-1,359,095,676**

Total loss is 1,359 million Chilean pesos ($US 196,970)

Environmental Services

According to the study the following environmental services are provided by the ecosystems of Coquimbo Region (Table 2).

Table 2. Environmental Services provided by Ecosystems of Coquimbo Region

Environmental services	Functions
Carbon sequestration	About 50,000 hectares reforested with woody shrubs.
Climatic regulation	High Solar radiation level requires soil protection to prevent desiccation. Plant cover regulates surface temperature of soil and, consequently, air temperature.
Hydrological regulation	This arid region gets the most of its water from high Andean rangelands. Vegetation of the upper part of basins plays an important role in water retention and seasonality of water flows.
Freshwater	An important part of the population live in rural areas having small water points as unique source of water. This water is highly dependent from infiltration of precipitation in the upper slopes.
Erosion control and sediment retention.	When the first precipitation of the rainy season comes, soil surface is dry and vulnerable to erosion. At this moment, plant cover is very important to prevent removal of fertile layers of soil.

Table 2. continued	
Environmental services	**Functions**
Biological control	Considering the aridity of this region, ecological equilibrium is precarious. Populations of insect move to irrigated areas during drought periods.
Species protection	There are several ecosystems that are strategic for animal and plant species.
Biodiversity reservoir	Several plant and animal species are endemic. Important vegetation relicts remain in coastal areas.
Tourist services	This region has several tourist attractions: National Parks, Natural Monuments, Valley and mountain ecosystems, etc.
Cultural Services	Several historic sites from older cultures are spread within this region.

It is quite difficult to evaluate the cost of these services in the region, but several are negatively impacted by the severe land degradation in the region. For example:

- The removal of plant cover leads to increased dessication of the soil.
- Degradation of upper valley areas increases variability of river flows
- 150,000 rural dwellers depend on well water from stressed aquifers
- Irrigated farms are supplied from large dams (La Paloma dam stores 650 million m^3). Dam life is being shorted by sedimentation
- Tourists and cultural services are an important local source of revenue. This component was subjected to more detailed analysis

Impact of Land Degradation on Tourism

Over 208,000 tourists visited the region in 2001 and of these over 31,000 visited areas of ecological interest. Tourist expenditure is estimated at $300 per visit for a total of $62,400,000. Estimates were made of the possible reductions in tourist income, as a consequence of continued land degradation and the loss of ecosystem and natural heritage visitors. The range of losses to the tourist industry are from less than 2 percent as a result of low continued levels of degradation to over 10 percent if degradation continues at a high level. This latter implies an $8 million loss of potential revenue (Annex 3).

Summary and Conclusions

This detailed regional study is included in the cases because more than most such efforts it attempts to address impacts in detail in the field and at the level of individual crops and services. While there may be questions about individual assumptions, the finding for this region at least, is that loses from land degradation are higher the most national figures would suggest. Losses of over 40 percent on wheat yields even with current technology, 23 percent on goat rearing and up to 10 percent on tourism revenues are major economic loses to the region. The data as elsewhere indicates that these loses are borne differentially by the poor.

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ANNEX 1 – Loss of Wheat Production due to Land Degradation in Alcones Community

	Cultivated surface (ha)	Yield	Production qq	Price (2002) ($)	Total income ($)
Wheat	69.5	5.6 qq/ha	390.6	11.700 qq	4,570,020

Source: Oficina de Estudios y Políticas Agrarias – ODEPA and Publisher information of agricultural market. One qq = 100 Kg.

Evaluation of Soil erosion.

Soil erosion was evaluated in the field by mean of expert protocols, referred to 5 degrees (states of erosion):

CONCEPT	DESCRIPTION	VALUE
Very light	Very light erosion signs, the process is incipient and not very evident, some sedimentation is observed in small places where rainwater accumulates.	1
Light	Light erosion, signs begin to be visible. Removal of fine material is visible leaving the thicker material exposed (gravel, small stones), runoff waters are not totally clear.	2
Mean	Moderate erosion, clear signs of particle removal from the surface of the ground. Erosion is evident, with the hardpan material clearly exposed on the surface. Some rill erosion is noticeable.	3
Strong	Erosion strong, strong mantle erosion leaves gravel spread on the surface, rill erosion is abundant and increasing, some gullies appear in their initial state of formation. There are very few materials left from the original superficial soil, the soil has begun to change its color.	4
Very strong	Very strong erosion, all original surface materials have been removed generating a change of color of the soil, there is a widespread change of soil texture due to the dominance of the horizon C on the surface. Active gullies are observed.	5

Establishment of erosion/productivity functions

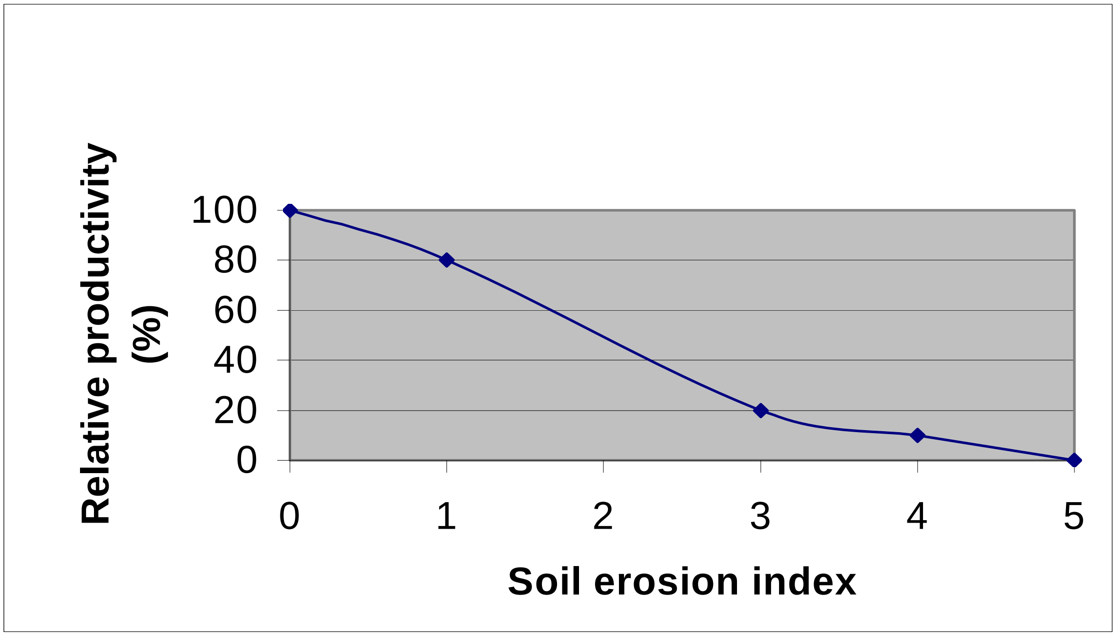
By mean of field observations, inquiries to farmers, available experimental data and numerical assumptions, we established production functions to relate soil erosion and soil productivity in arid and semiarid regions of Chile. We associated a production coefficient to each class of the scale of erosion degree:

Erosion Degree	Concept	Relative Productivity index
0	Non eroded soils	1
1	Very light	0.80
2	Light	0.56
3	Mean	0.20
4	Strong	0.10
5	Very strong	0.01

Technological coefficients were derived from field observations and inquiries. The following indices were derived:

Technological coefficients Actual yield/Potential yield	**Technological level**
Potential 1	Crop potential. Small plots in experimental conditions.
High 0.7	Farmers with good level of technology use. Yields above the national average.
Mean 0.4	Average yield. Mean level of technology use.
Low 0.2	Agriculture of low inputs, small farmers with restricted access to technology.

- Average wheat yield in the Region is 5.6 qq/ha, corresponding to 11 % of the potential productivity in rainfed cultivation.
- Most farmers use low levels of technology, so their yield should be near 20 % of the potential productivity (50 qq/ha).



Soil productivity index related with soil erosion index.

- On the basis of statistical information and empirical observations Cosio *et al* (1986), we estimated the following relation between yield and technology:

Technological level	Technological factor (Relative yield)	Absolute yield (qq/ha)
Potential	1	50
High	0.70	35
Mean	0.40	20
Low	0.20	10

- The agricultural systems in the Region are characterized by low levels of technology, so we can estimate that wheat yield has to be close to 20% of the potential (potential: 50 qq/ha, possible using low inputs: 10 qq/ha). In fact, actual yield in agricultural communities is 5.6 qq/ha, so about a half the corresponding level, considering a system of low inputs. This difference may be attributed to soil degradation, especially, soil erosion, which is the main factor of degradation in the area. About 2/3 of wheat is sown in more or less degraded soils and 1/3 in soils only recently used for agriculture.

Considering that this situation is representative of the whole region, we can extrapolate the impact of soil erosion, using the regional global figures. Combining the effect of soil erosion and technological level, we established the following table of relative productivity *(Ry)*, based on empirical data and observations. (Shaded case corresponds to present situation):

Soil erosion index	Technological level				
		Potential	**High**	**Mean**	**Low**
	0	**100**	**70**	**40**	**20**
	1	**80**	**56**	**32**	**16**
	2	**56**	**39**	**22**	**11**
	3	**20**	**14**	**8**	**4**
	4	**10**	**2.8**	**4**	**2**
	5	**1**	**0.7**	**0.4**	**0.2**

To test this matrix the following consistency has to be verified:

$$Ry_{(e,t)} * P_y \cong A_y$$

$Ry_{(e,t)}$ is the relative yield factor considering soil erosion and technological level
P_y correspond to estimated potential yield (depending on climate, specie and variety).
A_y is actual yield of this specie in the problem area.

In this case the figures are the following= 50 * 0.11 = 5.5, which corresponds with the actual yield 5.6.

About 97,5% of the wheat production is made under the rainfed system, consequently, it is very sensitive to drought. Annual rainfall varies between 150 and 250 millimeters. Despite this low amount, rainfall efficiency is very high, considering that ninety percent of this figure occurs in the milder winter when temperatures are lower, but enough for growing winter wheat. Also, the relative humidity tends to be high along the year, because the proximity of the coast. In good years, when precipitation is well distributed, potential yields, in the dry farming system, may reach 50 qq/ha. In this pilot region, total cultivated area of wheat is 873 hectares. On this basis we can make the following scenarios:

Technological level	Yield (qq/ha)	Production (qq)
Potential	50	43,650
High	35	30,555
Mean	20	17,460
Low	10	8,730

Total economic loss, T_{loss}, can be estimated as follow:

$$T_{loss} = (P_y*T_f - A_y)*C_a*P_w$$

P_y = Potential yield considering climatic situation.
T_f = Technological factor considering the level of inputs.
A_y = Actual yield
C_a = Cultivated area
P_w = Market Price of wheat.
Applying this relation to our pilot region we have:
T_{loss} = (50 * 0.11 – 5.6) * 873 * 11,700 = 55,156,140 (Chilean pesos, about US$ 80,000).

ANNEX 2 – The case of grasslands carrying capacity and goat production

We estimated the impact of land degradation on carrying capacity of the grasslands. We established the several degrees of degradation we can observe empirically, and we associated an estimation of forage productivity to each degree of degradation. This estimation was made integrating several indices describing the state of soil and plant cover:

GrasslandStateIndex = Po * I*erosion* * **I***cover* * **I***forragevalue*

Po : potential forage production, estimated by mean of a climatic model that consider precipitation regime, temperature and solar radiation (SIMPRAD Model)
I*erosion:* Relative erosion index
I*cover* **:** Soil cover (woody perennial species)
I*forragevalue:* Index of forage value of species (considering nutritional facts and fraction of consumable biomass).

To evaluate the impact of land degradation on goat production we defined minimum spatial units (polygons). The selected spatial unity was the census unit, what allow us to match environmental, agriculture and social information. We compiled information on numbers of animals, estimated carrying capacity of grasslands, composition of herds, production of meat, milk and cheese.

Basic Data – Cheese production

- Cheese represents about 73% of total income of farmers.
- Milk production per head is low as a consequence of inbreeding and the lack of genetic selection. Mean production is 150 liters per year/head.
- As consequence of low fertility, herds include 37% of females producing milk.
- They need 7 liters of milk to produce 1 kilogram of cheese.
- Mean price of cheese is 1,282 Chilean pesos per Kg. (about 2 dollars).

Basic Data – Meat, Leather, Manure

- One animal is sold for 8110 Chilean pesos (US$ 12).
- 31% of animals are sold as meat every year.
- One unit of leather (one animal) is sold for 1,170 Chilean pesos (US$ 2)
- Annual production of leather is about 7% of the number of heads.
- Price of one Ton of manure is 20,960 Chilean pesos (US$ 30).
- Annual production of manure per head is 38.7 Kg.

Assessment of stocking rate (number of heads per unit area)

The number of animal in each polygon was obtained from census data. We divided this number by total area of the polygon, to calculate present animal density. Using satellite data, we calibrated a system based on *NDVI* (normalized vegetation index) to assess biomass. This map was combined with a detailed map of vegetation, providing information on the dominant species. Each species was qualified by experts in terms of its forage value (considering nutritional facts, palatability, and consumable material). Combining both maps we distributed biomass into the dominant species, which were weighted by its forage value index. This gave us an indication of quantity and quality of forage. On this basis we calculated carrying capacity (potential heads/hectare).

It was assumed that this carrying capacity degraded proportionally to soil erosion. The "state of soil-vegetation complex" was described by a five categories system. The best condition qualified as 1, associated to the highest carrying capacity found in the region. The worst situation was 5, associated with the lowest carrying capacity (near zero for practical purposes). The following scale was then established:

Index of the sate soil-vegetation complex	Relative carrying capacity
1	1
2	0.75
3	0.50
4	0.25
5	0.05

The mean slope of relative carrying capacity is 0.25. Considering that degrading vegetation may affect more to more sensitive species, which recuperate slowly, we preferred to be pessimistic and consider a slope of 0.30 (30% of reduction on carrying capacity when the system degrades one degree.)

Assuming proportionality between degradation and production (number of animals recommended to make the system sustainable), we can express this proportionality as:

$$\frac{CC_{(t)}}{P_{(t)}} = \frac{CC_{(t+1)}}{P_{(t+1)}}$$

Where:

CC(t): Present Carrying capacity (ha/head).

P(t): Present animal stocking rate (heads/ha), as indicator of extraction pressure .

CC(t+1): Carrying capacity when the system degrade one degree (ha/head).

P(t+1): Adjusted stocking rate considering the next lower category (animal/ha).

So the new stocking rate, after degrading the system one degree is:

$$P_{(t+1)} = \frac{CC_{(t+1)} * P_{(t)}}{CC_{(t)}}$$

To assess potential impact of land degradation on this activity, we assumed a homogeneous degradation of one degree in the whole region. $P_{(t+1)}$ was calculated for the new carrying capacity and, on this basis, the carrying capacity of each polygon and the region, RCC:

$$RCC = \sum_{i=1}^{i=n} P_{i(t+1)} * Ap_{(i)}$$

RCC=regional carrying capacity
$Ap_{(i)}$= total area of the "i" polygon

To evaluate the regional impact of this situation we globalize the figures at the regional level. Summarizing the results for the whole region we have:

CC ha/head	**A Total area (ha)**	**Nh Number of heads (t)**	**P(t) heads/ha**	**P(t+1) heads/ha**	**Nh1 Number of heads (t+1)**	**Variation in number of heads**
1	2,264	219	0.0967	0.0677	153	-66
2	183,605	25,246	0.1375	0.0963	17,672	-7,574
3	312,808	36,974	0.1182	0.0827	25,882	-11,092
4	576,804	69,216	0.1200	0.0840	48,452	-20,765
5	771,632	85,805	0.1112	0.0778	60,064	-25,742
6	671,816	63,688	0.0948	0.0664	44,582	-19,106
>7	603,253	52,664	0.0873	0.0611	36,865	-15,799

CC = Carrying capacity category. Found, 1 (high) to more than 7 ha/animal head (low)
A= total area in the region having each carrying capacity category
Nh= present number of animals in each category
P(t) = present stocking rate (the highest pressure correspond to category 2 with 0.1375 heads/ha)
P(t+1)= calculated stocking rate considering one degree of degradation
Nh1= Adjusted number of heads for the new stocking rate

On the basis of variations in the stocking rate and the corresponding adjustment of the number of animal heads, we calculate economic consequences of this. We calculated the reduction in milk/cheese production, meat, leather and manure for the whole region.

Impact on Milk/cheese production

CC ha/head	Variation in number of heads	Females producing milk (37%)	Total milk production (150 lt/year)	Cheese production Kg/year	Income variation ($1282 Kg.)
1	-66	24	-3,600	-514	-658,948
2	-7,574	2,802	-420,300	-60,043	-76,975,126
3	-11,092	4,104	-615,600	-87,943	-112,742,926
4	-20,765	7,683	-1,152,450	-164,636	-211,063,352
5	-25,742	9,525	-1,428,750	-204,107	-261,665,174
6	-19,106	7,069	-1,060,350	-151,479	-194,196,078
7	-15,799	5,846	-876,900	-125,271	-160,597,422
Total ($)					**-1,017,899,026**

Impact on meat production

CC Ha/head	Variation in number of heads	Animals sent to the market (31%)	Income
1	-66	-20	-162,200
2	-7,574	-2,348	-19,042,280
3	-11,092	-3,439	-27,890,290
4	-20,765	-6,437	-52,204,070
5	-25,742	-7,980	-64,717,800
6	-19,106	-5,923	-48,035,530
7	-15,799	-4,898	-39,722,780
Total ($)			**-251,774,950**

Impact on leather and manure production

CC ha/head	Variation in number of heads	Number of leather units (7%)	Income provided by leather (1170 ChP/ unid.)	Manure production (0.0387 Ton/head)	Income provided by manure (20960 ChP/ ton)
1	-66	-5	-5,850	-3	-62,880
2	-7,574	-530	-620,100	-293	-6,141,280
3	-11,092	-776	-907,920	-429	-8,991,840
4	-20,765	-1,454	-1,701,180	-804	-16,851,840
5	-25,742	-1,802	-2,108,340	-996	-20,876,160
6	-19,106	-1,337	-1,564,290	-739	-15,489,440
7	-15,799	-1,106	-1,294,020	-611	-12,806,560
Total ($)			**-8,201,700**		**-81,220,000**

ANNEX 3 – Impact of land degradation on tourism

To evaluate the possible impact of land degradation on tourist activity, we supposed that a fraction of the tourist population is less interested in visiting the region, or the stay is shorter if landscape degrades. For that, we divided visitors in two: those who are sensitive to environmental factors and those who are indifferent. Only the first will react to land degradation. To establish the proportion of "sensitive" tourists we assumed that who visit National parks, while staying in the Region, are more sensitive.

1) Tourists visiting the Region in 2001

		IV Region 2001
Visitors	HOTEL	99,118
	HOSPICE	671
	MOTEL	64,920
	APART-HOTEL	20,733
	CAMPING	23,056
	TOTAL TOURISTS	**208,498**

Source: Instituto Nacional de Estadísticas - INE

2) Tourists visiting areas of ecological interest (National Parks, Ecological reserves, Natural monuments)

SNASPE	**Number of visitors in 2001**
Fray Jorge	14,241
Pingüino de Humboldt	10,069
Las Chinchillas	1,627
Pichasca	5,486
Total	**31,423**

Source: Instituto Nacional de Estadísticas - INE

- We used the following algorithm to estimate the decay in number of tourists as a consequence of land degradation

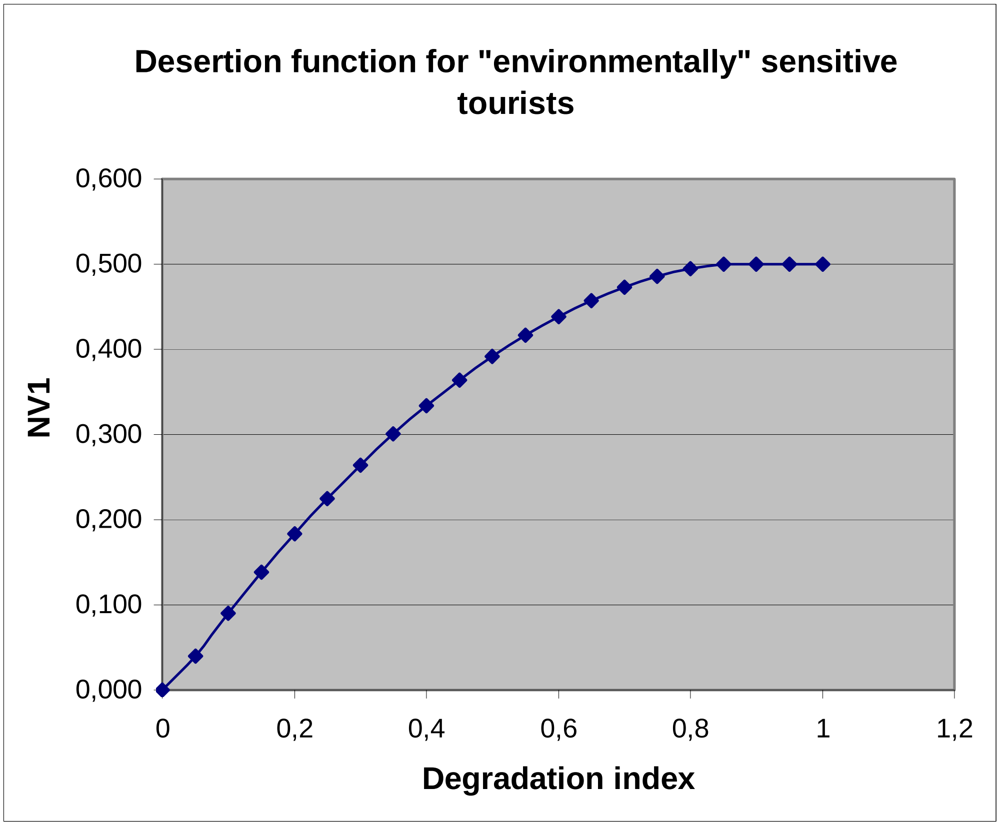
$$\Delta T = TVR\,[(VS * SD1 * NV1) + (1 - VS) * SD2 * NV2)]$$

Where:
ΔT: Decay in number of tourist
TVR: Total visitors
VS: Fraction of "environmentally sensitive" visitors (estimated from visits to ecological sites, SNASPE)
SD1: Factor of potential desertion of this type of visitors when environment degrade.
NV1: Actual desertion function of environmentally sensitive visitors when environment degrade.
SD2: Factor of potential desertion of less sensitive visitors.
NV2: Actual desertion function of less sensitive visitors when environment degrade.

- In 2001 ecological sites registered 22,832 visitors. To avoid double computation we estimated the number of visitors that visited more than one site. This figure represents 11% of total tourists visiting the region (TVR).

- The desertion function for environmentally sensitive visitors was estimated as follow. We consider that in a scenario of total degradation (supposing that all ecological interesting sites disappears), fifty per cent of these visitors do not come.

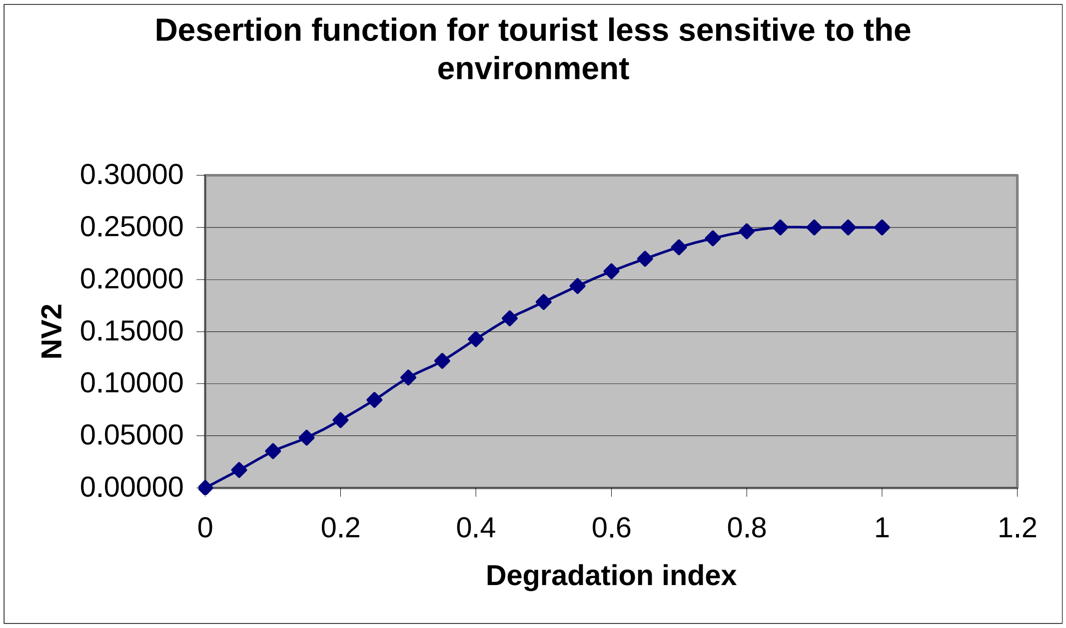
Relative degradation	**Desertion factor, NV1**
0.05	0.040
0.1	0.091
0.2	0.183
0.3	0.264
0.4	0.334
0.5	0.392
0.6	0.438
0.7	0.473
0.8	0.490
0.9	0.500
1	0.500



- In the case of less sensitive visitors we have supposed a maximum decay of 25% as reaction to an absolute desertification. That means that, despite degradation, 75% of these visitors continue choosing the Region as tourist destination.

- The desertion function for less sensitive visitors was estimated as follows:

Relative degradation	Desertion factor, NV2
0	0.00000
0.1	0.03529
0.2	0.06500
0.3	0.10593
0.4	0.14278
0.5	0.17847
0.6	0.20800
0.7	0.23100
0.8	0.24622
0.9	0.25000
1	0.25000



We created three scenarios:

1. Decay of tourist activity facing an extreme degradation (100% of the territory desertified)
2. Decay of tourist activity facing a moderate degradation (40% of the territory desertified)
3. Decay of tourist activity facing a light degradation (10% of the territory desertified)

<u>Scenario 1.</u> Decay of tourist activity facing an extreme degradation (100% of the territory desertified):

ΔT = TVR [(VS * SD1 * NV1) + ((1 - VS) * SD2 * NV2)]
TVR: 208,498
VS: 0.11
SD1: 1
NV1: 0.5
SD2: 0.25
NV2: 0.25
Then:
ΔT = 208,498 * [(0.11 * 1 * 0.5) + ((1 – 0.11) * 0.25 * 0.25)]

<u>Scenario2.</u> Decay of tourist activity facing a moderate degradation (40% of the territory desertified)

ΔT = TVR [(VS * SD1 * NV1) + ((1 - VS) * SD2 * NV2)]
TVR: 208,498
VS: 0.11
SD1: 1

NV1: 0.334
SD2: 0.25
NV2: 0.14278
Then:
$\Delta T = 208{,}498 * [(0.11 * 1 * 0.334) + ((1 – 0.11) * 0.25 * 0.14278)]$ **= 14,284 tourists**

Scenario 3. Decay of tourist activity facing a light degradation (10% of the territory desertified)

$\Delta T = TVR\ [(VS * SD1 * NV1) + ((1 - VS) * SD2 * NV2)]$
TVR: 208,498
VS: 0.11
SD1: 1
NV1: 0.091
SD2: 0.25
NV2: 0.035
Then:
$\Delta T = 208{,}498 * [(0.11 * 1 * 0.091) + ((1 – 0.11) * 0.25 * 0.035)]$

Total losses due to decay in tourist attraction

Existing information suggest that each visitor spends US$ 50 per day. The mean permanence in the region is 6 days, so total expenses are 300 US dollars. Considering these figures we can estimate total economic losses o the region, due to tourist decay. The following table summarizes the resulting figures.

Degradation Index	Reduction in number of visitors (desertions)	Total losses in US$	% of reduction in tourist income
0.1	3,724	1,303,469	1.8
0.2	7,212	2,524,363	3.5
0.3	10,969	3,839,136	5.3
0.4	14,284	4,999,363	6.9
0.5	17,270	6,044,430	8.3
0.6	19,695	6,893,152	9.4
0.7	21,564	7,547,549	10.3
0.8	22,660	7,931,135	10.9
0.9	23,065	8,072,782	11.1
1	23,065	8,072,782	11.1

This calculation does not include positive externalities of tourist activity like the existence of services (public and private associated to tourist activity), providing jobs all year long, public investment, increased cultural activities, etc.
There is a global impact up to 11.1 %. However, it is likely this impact may fall mostly on the poorest sector of human communities. Jobs associated to tourism probably represent a higher part of their family incomes, and they do not have many options to mitigate this negative change. So this estimate may underestimate reduction of the quality of life and the increase in social vulnerability of some poorest groups.