

Desertification in Piura (Peru)



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Summary

Desertification is a process in which natural and social factors play an important role. In Peru's case, the latter are of paramount importance and are basically related to the fact that the development models that have been launched up to now have not blended into the specific ecosystems that make up this country. This imbalance goes back 500 years. The natural factors can be mainly found in the mountainous nature of our country and, above all, in the arid zones, which make up one third of the country's total surface, including the arid coastal area, the semi-arid and the dry sub-humid mountainous areas (36% of the total surface: 479,174 km²). 90% of Peru's population has settled in these arid, mountainous zones and most of the country's farming, industrial and mining activities are also concentrated in these areas.

Problems such as the high salinity of coastal soils nowadays affect 40% of the arable lands in this region. The mountainous zone (Sierra), on the other hand, is affected by serious deterioration problems, especially on the eastern slopes (Selva Alta/High Forests) where, due to both the processes of desertification and the natural geological erosion, an estimated 50 to 60% of this region's surface can be considered as deteriorated. Both on the Coast and in the Sierra, desertification has basically been caused by the human factor through farming, stockbreeding, forest and mining activities that have led to salinity, water, soil and genetic erosion as well as water and air pollution, etc..

Some of the points mentioned above also apply to Piura, the main topic of this paper, yet in this case, one must underline man's utilization of the coastal plains' arid ecosystems, where the dry forests can be found, and the use of the Sierra where the cloud forests evolve. This goes back to 10,000 B.C., a period during which the forests both improved and declined. The El Niño phenomenon is also involved in these processes since it contributes to the natural reforestation of these natural formations wherever they have been "hit" too hard by the activities of mankind.

Activities such as deforestation, poor water management, inappropriate use of the soil, overgrazing and forest fires, together with demographic pressure and low living standards, are the determining factors for the different desertification processes in Piura such as soil erosion, genetic erosion, salinity, fragmentation of the vegetation covering the ground, destruction of habitats, reduction of fauna and extinction of species. All this brings about food shortages and insecurity, lower living standards (poverty), alterations in the water balance and the food cycle as well as microclimatic changes that lead to further arid conditions.

It is important to emphasize that there are no quantitative facts concerning the above-mentioned processes. There are only a few well-adjusted, long-lasting, interconnected and well-known monitoring mechanisms. At any rate, they are not generally well-known, which has created an information vacuum. Nevertheless, it must be stressed that these facts are not the whole picture because the historical and cultural quantitative processes behind the dynamics of desertification in a given region are just as important.

In the end, there are some proposals on how to combat desertification as well as on the role that the local governments can play. Among them: the integral management of river basins; better use and conservation of water, soil and biological diversification (e.g. forests, fauna); the development of clean technologies (e.g. agro-ecology) and appropriate systems (i.e. agro-pasturing systems for the forest areas); waste and sewage water recycling, better monitoring and prevention systems as well as a good coordination between the main initiatives. Furthermore, there are a number of suggestions with respect to those who will be in charge of carrying out the overall task.

1. Introduction

Geographic Framework

Peru is located in the western region of South America immediately south of the Equator. It has a total surface of 1,285,215 km² and it has a geographic diversity that presents extreme physical contrasts: extremely arid areas (Coast), a mountainous zone – the Andes – (Sierra), and an extensive area of tropical rain forests (60% of its total surface).

Due to its geographic location, between 0° and 18° South Latitude, Peru should have a tropical climate all over its national territory. However, the Andean mountain chain that crosses the country from the southeastern to the northeastern end creates a rather mild and even cold climate in its mountainous zones. At the same time, on its eastern flank, the Andes form a perfect wall that retains the atmospheric precipitation coming from the Atlantic, creating conditions of high precipitation (over 3000 mm/year) and at the same time semi-arid rain conditions (400-700 mm/year) and aridity (100-150 mm/year) in the region between the western flank of the Andes and the coast.

On the other hand, the anticyclone motion of the South Pacific and the Humboldt Oceanic Current or Peruvian Current, consisting of cold waters, temper the climate of the Coast, turning it mild and emphasizing its arid conditions to a maximum level.

All these phenomena make up the special characteristics of Peru's national territory and turn it into a highly diversified geographical complex, not only in terms of its climate, but also in morphologic, geologic, edaphic and ecological terms. In addition, all these factors modify and determine the living conditions and standards of this country's inhabitants.

From a purely geographical point of view, the country is divided into three natural zones: the Coast, the Sierra and the Rainforest.

Piura is one of the Departments of the Northern Coast. It has a surface of 36,403.5 km² (2.8% of the country's total surface) and a population of 1.45 million inhabitants (Cuanto, 1996). This makes it the second most densely populated Department in the country, surpassed only by the capital Lima.

Desertification in Peru

Desertification resulting from natural and human factors is one of Peru's most paramount problems today.

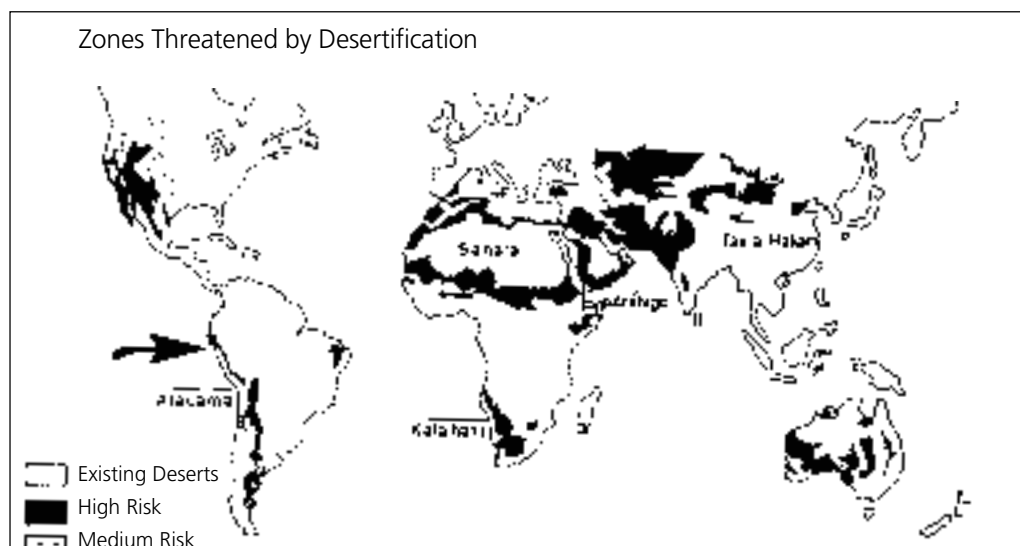
In our case, the natural factors can be identified by conditions such as aridity, semi-aridity and sub-humidity on the Coast and the Sierra, as well as by the mountainous geography and by the large expanses of tropical rain forests (64% of the national territory).

Human factors play the main role, largely due to the inappropriate utilization of natural resources which does not take into consideration the particular make-up of the different ecosystems in our arid, mountainous and tropical rain forest zones. This lack of understanding of our particular environment has led to an imbalance that goes back 500 years.

Going further into detail, it must be stressed that in view of Peru's arid and mountainous characteristics which create highly dynamic and fragile systems (See Fig. 1), this country can be listed among the areas most prone to desertification in the world. Peru's arid zones make up one third of the country, including the arid coastal area, the semi-arid mountainous area, the sub-humid zones (36% of the total surface: 479,174 km²) and the Andean mountain chain that traverses Peru from the south to the north, thus creating two extremely opposite flanks, especially in hydrologic terms. This phenomenon has been called THE HYDROLOGIC ASYMMETRY. 90% of the country's population has settled in these areas and most of its farming, agricultural, industrial and mining activities are concentrated here. The problem of soil salinity currently affects 40% of the surface used for growing crops. The Sierra, on the other hand, is plagued with serious problems due to the depletion of its fragile

ecosystems as a result of the inappropriate utilization of its slopes, the extreme overgrazing of pasture lands and the inadequate technologies used in mining activities. The eastern flank (the high rainforest/Selva Alta) is also being affected by the illegal growing of coca trees which bring about an extreme deterioration of the soil and a clear alteration of water resources, factors which also lead to desertification processes. Finally, if you add the natural ecological erosion to all the factors mentioned above, the estimated deterioration encompasses 50 to 60% of the total surface: (See Figs. 2 and 3)

Fig. 1 **Peru's Location in the Processes of Desertification**



Source: PNEUMA "The Sands of Change"

Fig. 2 **The Processes of Desertification in Peru**

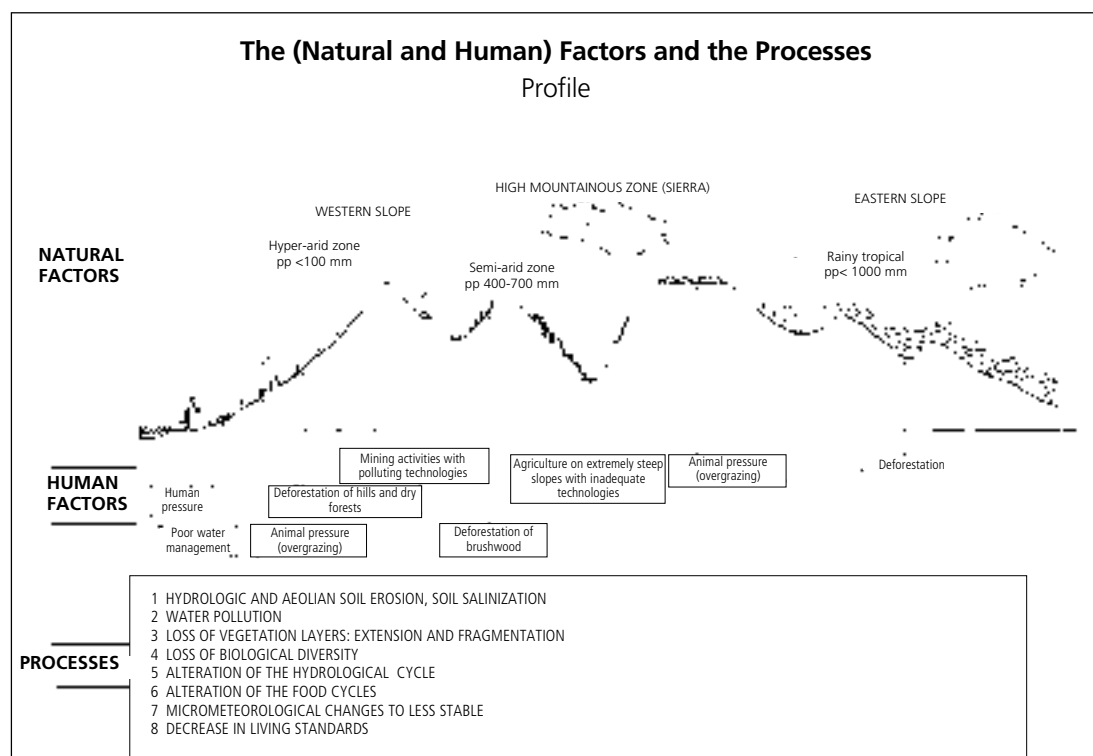
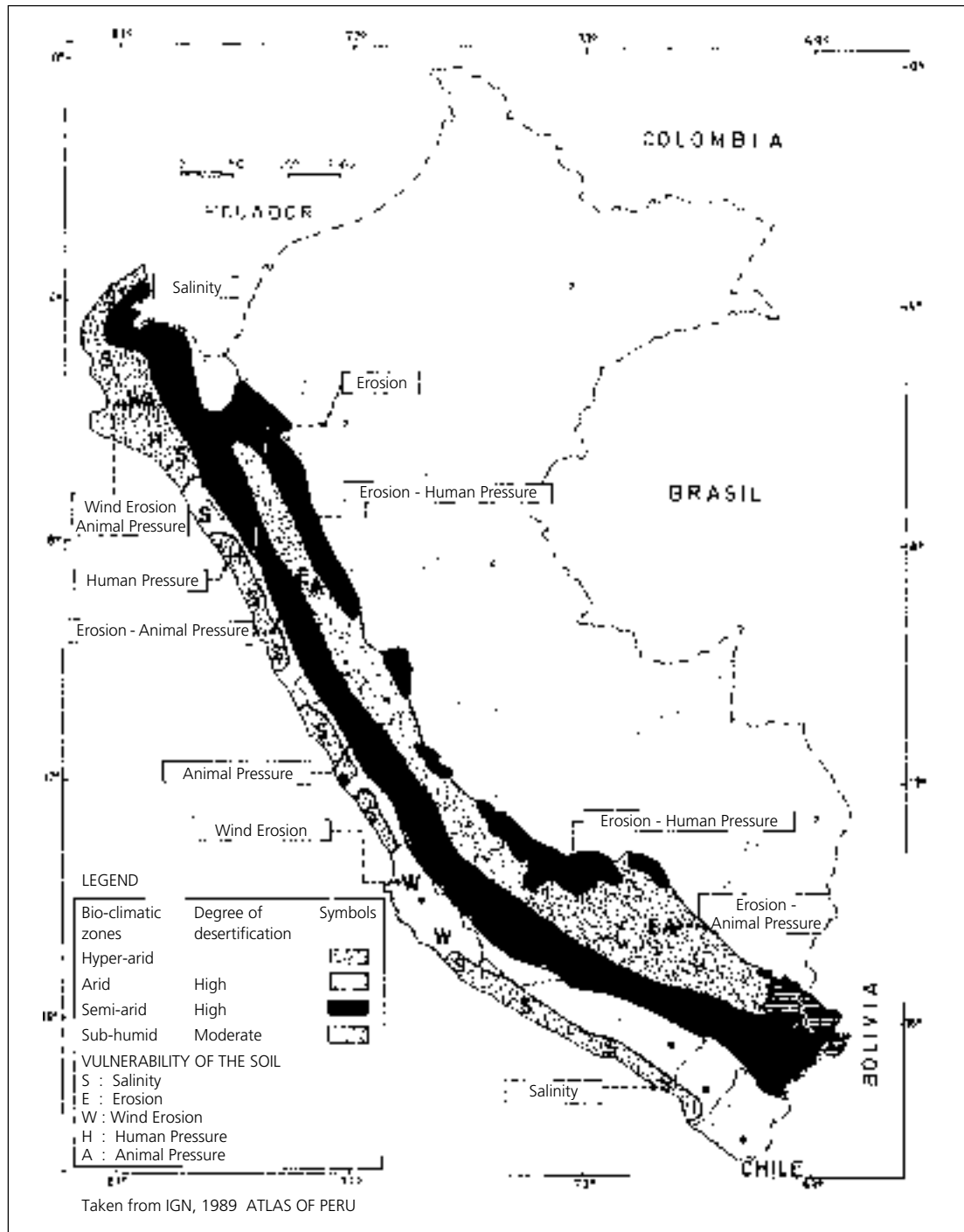


Fig. 3 **Desertification in Peru**



2. Historical Background

From 10,000 B.C.

The region we are focusing on in the present paper has witnessed human settlements for approximately 12,000 years. The presence of groups of human beings in the hills of La Brea and el Tablazo de Talara has been traced as far back as 10,000 B.C. during what is known as the Preceramic Period. This period was made up of three cultural complexes: the Amotape, the Vicús and the Tallán, of which the Amotape is the oldest, having existed between 10 and 7 thousand B.C.. From 3000 to 400 B.C., groups of families became sedentary on

a permanent basis, inhabiting coves along the coast close to the rivers' mouths, but also settling in the valleys. (Hocquenghem, A.M. 1998).

According to Hocquenghem (1998), up to 6 extensions of the agricultural borders of Piura were recorded during the period prior to the Spanish Conquest (between 100 B.C. and 1470 A.D.). He also points out that with the beginning of the Conquest (1532) and during the Colonial Period – that is, up to the middle of the 19th century – great extensions of dry forests in this area went through a natural reforestation due to the fact that the native peoples had been introduced to other activities (e.g. trade, stockbreeding, mining) or had simply been decimated as a result of the epidemic diseases that afflicted the indigenous population, thus generating a huge demographic decline.

During the Republican Period, between the 19th and the 20th centuries, another phase of decline took place in the dry forests due to the ever-growing needs of the cities, industry, stock and cattle farms, steam engines, ships, railroad trains, etc., but also as a result of the thermodynamic revolution and new crops such as cotton. Nowadays, the irrigation methods and the progress made in the monoculture of commercial crops (e.g. cotton, rice) tend to destroy the dry forests, especially those close to the valleys.

The paradigm of commercial agriculture versus the sustainable utilization of the forests weighs heavily on the rural population in spite of all the efforts made in order to make them more compatible.

What Has Happened in the Last 40 Years

The issue of arid zones and desertification dates back to 1963 when the Peruvian Committee for Arid Zones was established. Later, the National Commission on Arid Zones (CONAZA) was created, but the initiative to elaborate a monitoring plan for desertification goes back to 1977 when Peru took part in the World Conference of the United Nations on Desertification held in Nairobi from August 29 to September 9 of 1977. During that conference, a document was presented entitled: "Synopsis of Arid Zones in Peru" and "Desertification in Peru".

At the beginning of 1990, Peru's government informed the United Nations Environment Program (PNUMA) that it was interested in preparing a National Action Plan to Combat Desertification (PNACD). This program was finally created at the end of 1990 and the organization ONERN (known today as INRENA) was its pivotal point.

In March of 1991, the National Plan to Combat Desertification (1990) was launched and a technical meeting was held in Lima between May 13 and 17 of 1991, attended by members of the private and public sectors representing 10 of the 12 regions of the country. This allowed two things: on the one hand, we were able to obtain a better understanding of the causes and the magnitude of the problem of desertification in Peru and, on the other hand, projects were presented in order to stop and/or reverse this process.

Two and a half years later, after having signed the International Convention to Combat Desertification in the countries suffering from serious drought or desertification, especially in Africa, (Oct. 1995), the government in Peru decided through INRENA (National Institute of Natural Resources) to adjust the PNACD (1993) to the Convention's framework, thus creating the current National Action Program to Combat Desertification (PAN-Peru) of 1996.

This document (PAN-Peru 1996) was supported by various regional workshops where consensus was reached in agreements dealing with the issues and alternative measures vis-à-vis the problem of desertification (See Appendix 1). This Appendix describes the current situation of this issue. It is, however, incomplete because it does not include the extraordinary El Niño years 97-98 that radically changed the outlook in the region.

In Piura

In Piura, people became concerned with environmental issues in the late 80s. Various meetings have taken place since in which the issue of desertification has not been explicitly dealt with, but has been implicit in the general concerns about the deterioration of natural resources and the environment. There is, for instance, a “Declaration of Piura” (1988) and a proposal for development (Development and Preservation of Natural Resources, the Environment and the Grau Region Regional Government-CEPESER: 1990). The media are constantly dealing with this issue: The radio station Radio *Cutivalù*’s slogan is “The Voice of the Desert” and the daily *El Tiempo* newspaper was awarded a national prize for its role in environmental protection.

Since the middle of this decade, there have been various kinds of coordination meetings in order to prevent and contain the processes of desertification in this region. Many institutions such as local universities (National University of Piura, the University of Piura), regional offices (municipal government), non-governmental organizations (CEPESER, CIPCA, ITDG, IDEAS ...) as well as national institutions such as the National Institute for Natural Resources (INRENA, Algarrobo Project), the National Environment Council (CONAM), the National Agrarian University La Molina (CIZA-UNAM) have participated in creating a platform to deal with this problem, even on a world level, with projects such as the International Seminar (Nov. 97) on Dry Forests and Desertification, which was organized by the Algarrobo-INRENA Project with the participation of some African countries. They have also launched prevention projects to fight against desertification in the communities of the Northern Coast. Nevertheless, there is still a great deal to be done. Among other things, there should be a better coordination and a higher concentration of the various activities.

3. Piura and the Ecosystems of the World

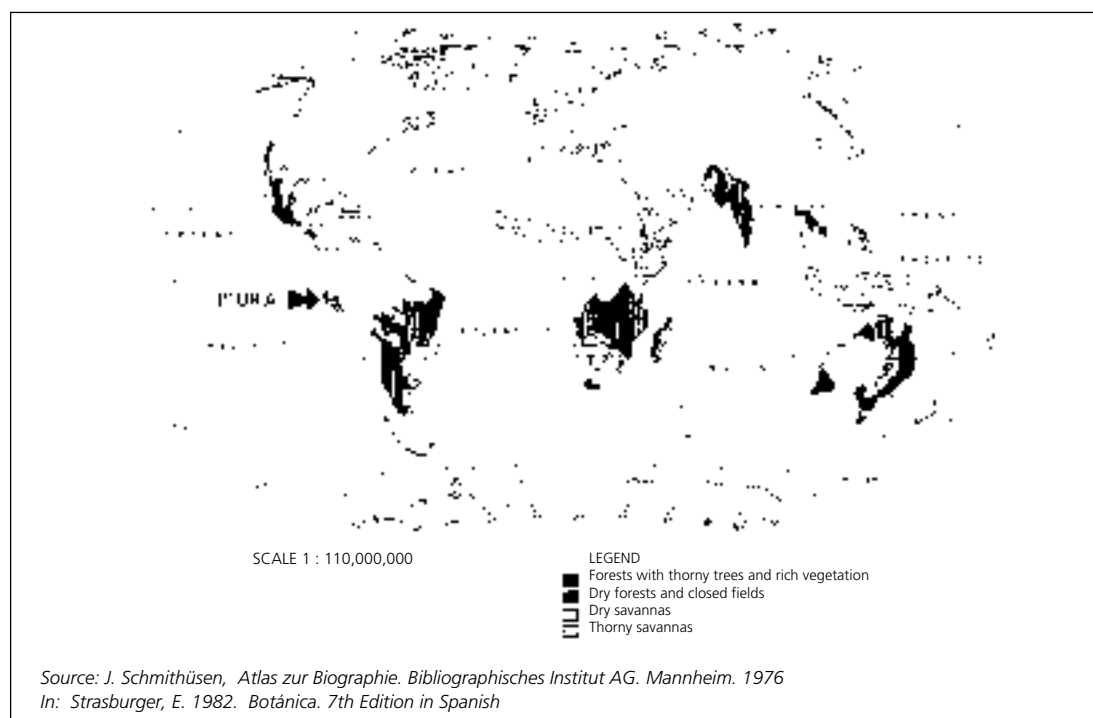
Piura’s northern coastal plains and their western and eastern slopes (Sierra) are characterized by extremely vulnerable landscapes (fragility). This can be compared to the many land expanses between Mexico and the US (towards the Atlantic), the Sahel in Africa and large areas in India and Australia (See Fig. 4)

On the Coast, the dry algarrobo (locust tree) forests stand out while the Sierra is characterized by low-humidity mountainous forests. Both play an important role in maintaining the microclimatic conditions (less dry), for the conservation of the soil, the water (regulated and clean), the biological diversity (wild crops related to various cultivated plants such as papayas, *lúcuma* (a pear-shaped fruit), *chirimoyas* (custard apples), potatoes, etc. Furthermore, they serve as habitats for a large number of species of wild animals, some of which are in danger of extinction such the *pava aliblanca* (a white-winged turkey: *Penelope albipennis*).

The Sierra falls under the category of the tropical mountain systems of the world. It is very similar to those in Ecuador and Colombia and to some mountainous regions in Ethiopia and the Himalayas. The Peruvian Andes are low, uneven and green for the most part of the year (8 months). In some parts, there are even humid forests (See Fig. 13).

Due both to its desert-like coastal plains and its mountainous area (Sierra), Piura figures, at world level, among the so-called FRAGILE-VULNERABLE ECOSYSTEMS which places it on the priority list of the International Convention to Combat Desertification.

Fig 4 The Dry Forests and Similar Formations in the World



4. Piura's Ecological Characteristics

As was mentioned before, Piura is Peru's second most densely populated *Departamento* (administrative district) (estimated at 1.45 million inhabitants in 1995 according to "Cúanto" 1996). Its territory covers 36.4 thousand km² which corresponds to 2.8% of the national territory.

In geographical terms, it is located between the 4°04'50" - 6°22'12" southern latitude and the 79°12'30" - 81°19'36" western longitude.

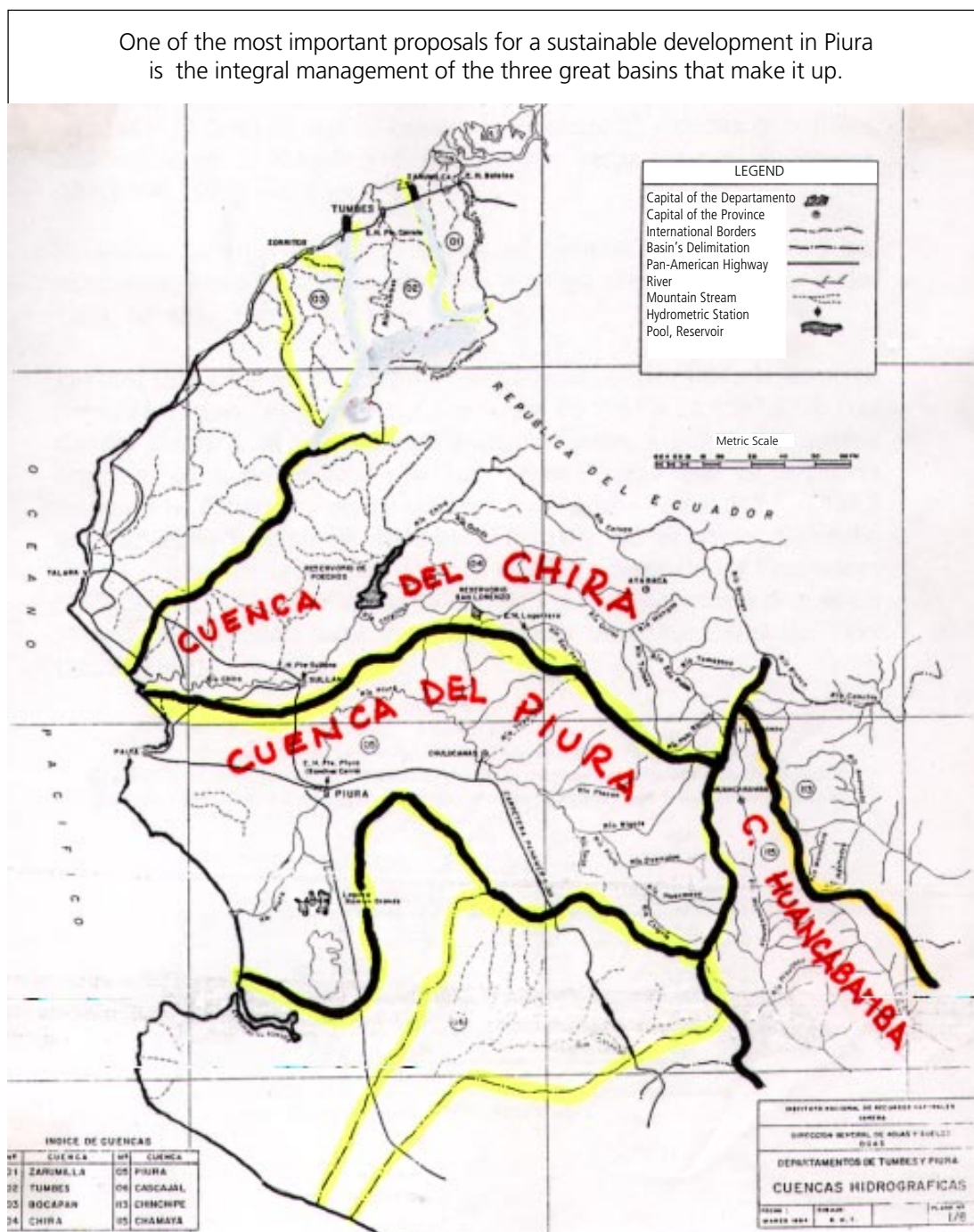
Piura is essentially made up of two relatively well-defined geographical spaces: the coastal plains that make up 71% of the Departamento's total surface and are home to 82% of Piura's inhabitants, and the mountainous system of the Western Chain of Mountains of the Andes (29% of the total surface) where 18% of the Piuran population has settled. Both expanses of land are closely linked and at the same time form part of the three large basins: Chira, Piura and Huancamba (See Fig. 5).

One of the most characteristic features of the region where Piura is located is its large *diversity of ecosystems*, species, varieties and its cultural diversity. According to ONERN's (now INRENA) Ecological Map (1:1 000.000), Piura covers 17 of the 84 areas recognized as living zones in Peru. As to its *diversity of vegetation*, approximately 583 different species of plants belonging to 424 genres and 135 families - 174 of which are considered as being endemic- have been recorded in its two Natural Conservation Areas (Parque Nacional Cerros (Hills) de Amotape and Coto de Caza (Game Preserve) el Angolo). Furthermore, this region, which was the origin of many important farming crops and also serves as habitat to their related wild species, is also well known for the *genetic diversity* it offers within these species, as can be seen by the varieties of tomatoes, beans, and squash (cucurbitaceae) that can be found in the Bosque Seco (Dry Forest) (See Graph 1).

Graph 1: **Diversity of the Various Species of Plants in the Conservation Areas of Piura**

Sector	Families	Classes	Species
The Amotape Hills National Park	75	273	404
Game Preserve el Angolo	60	151	179
Total	135	424	583
<i>Source: INRENA 1997</i>			

Fig. 5 **The Main Basins in Piura**



As to the *diversity of the fauna*, there is such a great variety of species that the information available is still incomplete since there are only a few isolated research papers on this topic. With respect to vertebrates, it is estimated that there are more than 200 of the 1703 bird species recorded in Peru in this region, gathered in 22 suborders and 57 families, of which 31 species are endemic. There are 50 species of mammals belonging to ten suborders and 27 families, whereby many species are endemic. There are 34 species of reptiles including nine species of lizards, five *saltojos*, 15 ophidians – four of which are poisonous – four species of turtles and one species of crocodile. These are divided into three suborders and 12 families with 12 endemic species. There are also 32 species of amphibians belonging to two suborders and six families, of which various species are endemic. (INRENA, 1997). See Figs. 6 and 7.

Finally, the rich *cultural diversity* found in Piura deserves special mention, a cultural patrimony that goes back to 10,000 B.C. (i.e. the cultures of the Vieùs, Tallanes, Chimùs, Mochicas, Incas, etc.).

Graph 2: **An Example of the Climatic Instability in the Grau Region**
The Case of Precipitation: Comparison of the Norm with the Values Recorded during 1983 and 1998 due to the “El Niño” Phenomenon (in Cubic Millimeters)

MONTH	PIURA		
	1983	1998	Normal
January	353.9	768.7	5.6
February	557.1	500.0	8.2
March	426.0	485.8	17.0
April	453.0	95.1	4.3
May	316.0	5.6	0.1
TOTAL	2,106.0	1,855.2	35.2

Source SENAHM (1983); CEPESER (1998); Source: INRENA 1997

On the other hand, it is important to underline the great climatic instability caused, among other things, by the “El Niño” phenomenon, as was the case in 1983, 1997 and 1998 (See Graph 2), and the thin surface of the soil which is poor in organic matter and has a very weak vegetation layer, especially on the Coastal plains. According to reports made by INRENA (1995) and the Algarrobo Project (1998), the coastal deserts lacking vegetation make up between 515.9 and 438.5 thousand hectares and this in spite of the recovery that led to the creation of grass surface layers for more than 50% of the total surface, a measure which was unfortunately only temporary

Fig. 6: **THE Dry Forests and Biological Diversity**

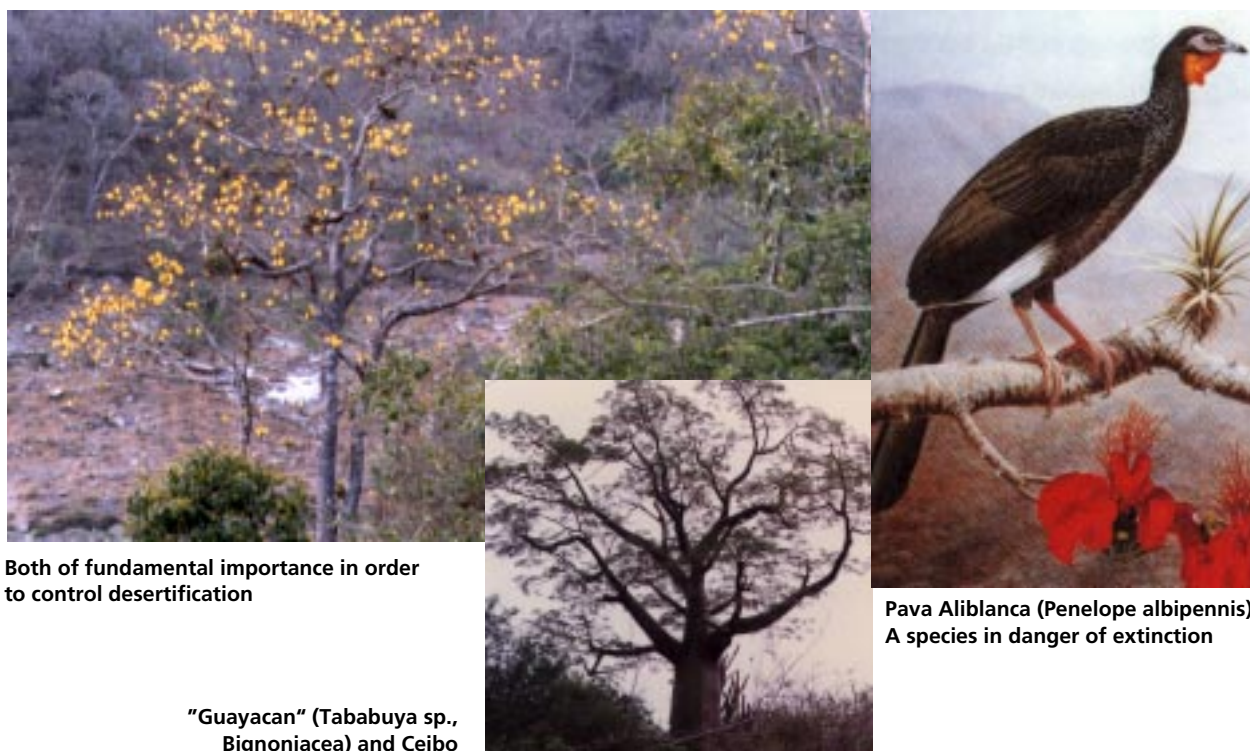
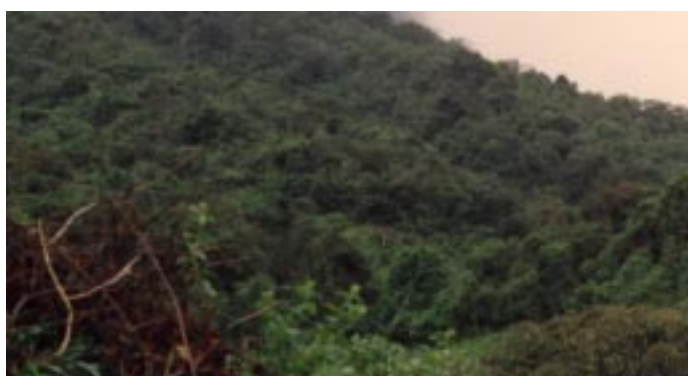
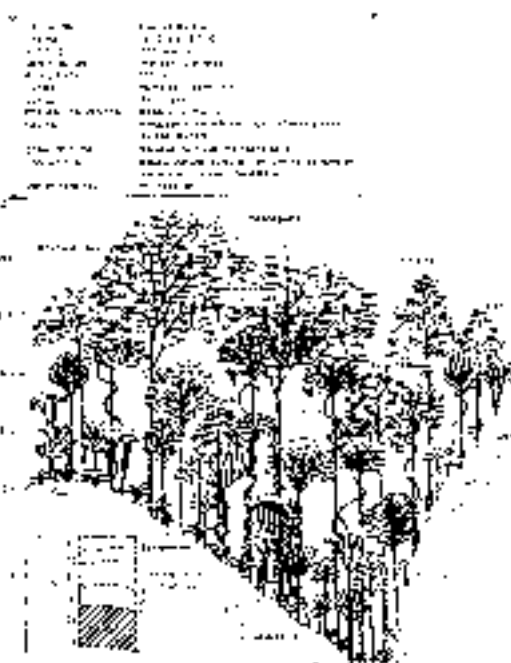


Fig. 7: **Mountainous Humid Forests of the Sierra of Piura**

Key natural formations in the struggle to fight desertification in the mountains.
Concentration of a great biological diversity and fundamental for the water and food
cycles typical of this region's climate



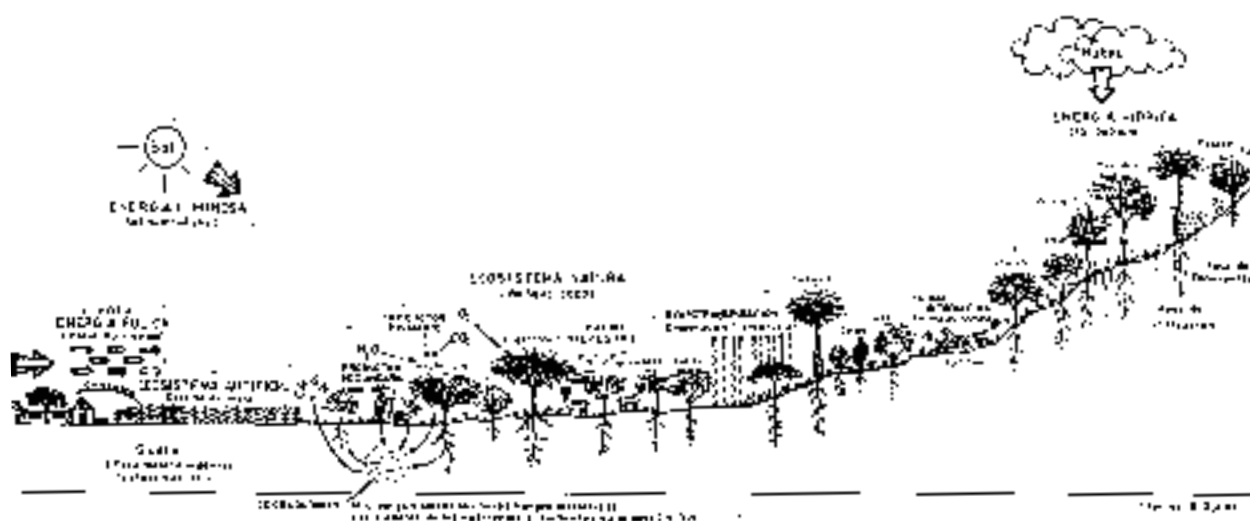
Vegetation Structure of the Microbasin
Tabias- Avacaca Grau Region
MIDDLE BASIN 1991



In spite of their capacity for natural recovery (homeostasis) and coexistence with strong phenomena such as droughts and the “Niños”, these ecosystems are still considered as FRAGILE because their structures can easily be thrown out of balance by the activities of mankind. Unlike phenomena such as “El Niño” or droughts, which they have been able to tackle for approximately 5 thousand years, these ecosystems are not “traditionally” used to dealing with humans.

All these considerations are very important and should be taken into account when making use of the natural resources of this region. It is important to recognize the potential advantages that diversity offers but also the limitations of its fragility. This would be a good prerequisite for achieving the sustainable development so strived for. (See Fig. 8).

Fig 8: **The Ecosystem of the Dry Forest of Peru’s Northern Coast: Piura**
(CASE: Dense Dry Forest. Malingas Cooperative in Alto Tambo Grande, Piura), 1990



5. Desertification in Piura

The Processes of Desertification

Desertification constitutes the final depletion process of a given ecosystem. The Convention of the United Nations to Combat Desertification (June 17th, 1994) has defined desertification as “the deterioration of arid, semi-arid and sub-humid dry lands as the result of diverse factors such as climatic variations and human activities”.

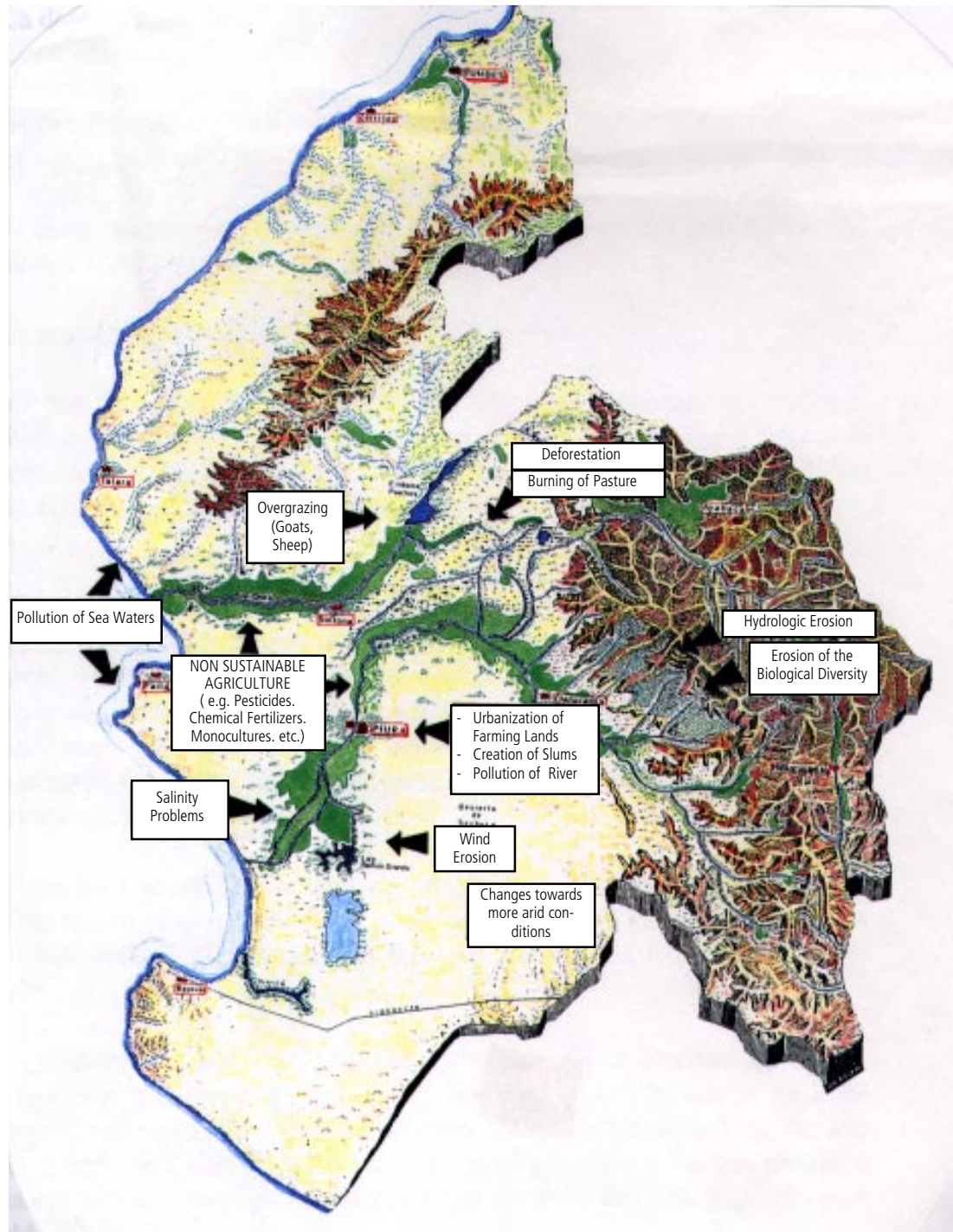
Desertification has always been a risk hanging over the coastal arid plains and the semi-arid, sub-humid dry areas (mountains: Sierra) that the Departamento of Piura encompasses. These areas are considered to be FRAGILE because they feature the characteristics mentioned above. This means that they are highly susceptible to falling into the processes of desertification when it is caused by human activity since, contrary to what might be expected, nature has bestowed them with the means to adapt well to the climatic characteristics of the region.

During the last “El Niño 97-98” phenomenon, for example, everything seemed to indicate that the Coastal Dry Forest would once again be able to recover from the negative impacts of human activity in this zone, provided that whatever had been regenerated was managed properly. When these ecosystems are constantly weakened due to the inappropriate use of the land, “El Niño” and the droughts will inexorably lead them to desertification.

In Piura, a variety of factors come together that generate the processes of environmental deterioration. These factors are mainly of economic, social, political and cultural nature.

Fig. 9 graphically depicts the main desertification processes. Graph 8 is a schematic summary of Piura's desertification process which shows the environmental aspects involved, their characteristics, the processes themselves, their causes and even possible solutions.

Fig. 9: **The Main Processes of Desertification in Piura**



The Most Important Causes of Desertification

The main human activities that have the greatest impact on the coastal arid, semi-arid and dry sub-humid tropical ecosystems of Piura, “weakening” them in the face of natural climatic phenomena (e.g. EL Niño. droughts, etc.) are:

- a) Deforestation
- b) Fires
- c) Poor water management
- d) Inappropriate use of the land and
- e) Overgrazing

Other factors that should be taken into special consideration because of their relation to the processes of desertification are:

- f) Demographic pressure and low living standards

These questions have all been recurring issues during the different meetings on the environment, ecology, proposals for development and the struggle against desertification that have taken place in Piura since the late 80s (1988) until now, all in relation to the El Niño phenomenon.

a) Deforestation

The denudation of the forest, the indiscriminate felling of trees and the fragmentation of the forests have been going on for many decades in this region. The growth of the cities has made this process more acute by constantly demanding higher supplies for its various industries (e.g., timber industry, parquet factories, wooden box factories, brick works, chicken farms, firewood for domestic use, etc.)

On the other hand, we have to live with what has been called the “extension of the agricultural frontiers” which has found an easy prey in the dry forests since this extension has come about by the clearing of trees in the forests both on the Coast and on the Sierra.

Experts maintain that in spite of legal regulations that prohibit the felling and replanting of trees, such as the Supreme Decree (DS 0144-AG-74), the speed of deforestation especially of the dry forests ranges between 9 and 12 thousand hectares per year or 2 m³/hectare/year. Their growth capacity, however, is only 1 m³/hectare/year (Algarrobo Project 1996) (See Fig. 10).

The total area covered by the dry forests between Lambayeque and Tumbes measures 2.8 million hectares (Algarrobo Project. Lambayeque 1996). This area is home to approximately 35 thousand families which, standards according to the Poverty Map, can be considered as having regular to poor living standards.

The data on deforestation shows that the extraction rate has reached ten thousand hectares/year or 2m³/hectare/year (Algarrobo. 1996).

Nevertheless, the total spreading of the dry forests in this region has changed dramatically in the last three decades due to the influence of the “El Niño” phenomenon. Up to 1983, people believed that the dry forests had disappeared in Piura but El Niño changed this picture. The Forest Maps show that there are now 2.32 million hectares (1995) as opposed to 1.18 million hectares in 1975. (See Graph 3).



Fig 10a: The Spectre of Deforestation



Fig 10b: The Specter of Deforestation

b) Forest Fires

Another human activity that has a negative impact mainly on the dry forests is the inefficient burning of scrub and stubble vegetation during the dry season which becomes even more dangerous when there is a carpet-like layer of herbaceous vegetation on the ground. The dry pastures turn into a real “powder keg” that can go off at any moment. From the beginning of the year (1998) until now, 80 thousand hectares of dry forest, mainly of *algarrobo* trees, have been lost due to fires. This contributes to the processes of desertification just at the time when the forests were barely recovering thanks to the extra-ordinary “El Niño” of 97-98. See Fig. 11.

c) Poor Management of Water Resources

Water in Piura is a relatively scarce resource, especially on the Coastal plains and in the

Sierra, which is mostly dependent on the season (three months of rainfall per year, mainly between January and March). In spite of this well-known fact, it cannot be said that the irrigation water is used at a maximum level of efficiency even though very sophisticated systems to collect water have been built in order to make it available on the Coast. There are two dams: The Water Reservoir of San Lorenzo and the Dam of Poechos. The latter is Peru’s biggest dam and has a capacity of 1000 million m³. There is also los Cocos with a capacity of 250 million m³ planned for the regular irrigation of 111,000 hectares, making this area the biggest irrigated zone in Peru (Pineda. R. 1996). However, this has led to processes of salinization, sodification and loss of soil fertility both in the San Lorenzo irrigation area as well as in the lower Piura area irrigated by Poechos.

In the Sierra, the problem of the inappropriate use of the soil, where steep slopes and the farming of various crops (e. g. corn, lima beans) are combined, has caused soil loss due to hydrologic erosion: laminar erosion caused by the furrows leads to grooves which lead to true desertification processes.

d) The Inappropriate Use of the Land/Soil

The irrational exploitation of agriculture, stockbreeding and forest resources both on the Coastal plains as well as in the Sierra has led to processes of soil loss, (hydrologic and wind erosion), due to the felling of trees and the tearing up of the vegetation layer covering the ground around the trees, especially in areas that were not naturally fit for production, either because they consist of steep slopes or because the soil is too thin and poor in quality.

The agricultural and forest activities that arose with the so-called “expansion of the agricultural frontiers”, meaning the felling of the dry and cloud forests as well as brushwood, have caused alterations in the appearance of Piura’s landscape. It has also affected the water balance, the food cycle, and has caused micrometeorological changes that have not yet been quantified but can be estimated based on the ravages left behind by natural phenomena such as El Niño and other natural processes like droughts when they hit natural ecosystems that have been weakened.

Graph 3: **Changes in the Surface Covered (in Hectares) by the Dry Forests in the Last 23 Years in Piura (1975 -1998)**

Reference Type of Forest	Forest Map (Ing. Malleux) 1975 ⁽¹⁾	Forest Map (INRENA) 1975 ⁽²⁾	Dry Forests Map Piura (Proj. Algarrobo INRENA) 1998 ⁽³⁾
Dry dense forests(1) Dry hill forests(2) Dry semi-dense hill forests(3) Dry sparse hill forests (3)	317,620	99,114	245,236.38
Dry savanna-like forests(1) (2) Dry sparse hillock forests (3) Dry very sparse hillock and hill forests(3) Dry forests in conservation areas (3) Dry sparse forest of alluvial plains(3) Dry sparse forest of aeolic plains (3) Dry very sparse forest aeolic plains(3)	550,198	1,440,350	1,281,961.27
Dry mountainous forests (2) Dry semi-dense mountainous forest (3) Dry very sparse mountainous forests (3)	0	556,806	554,260.93
Chaparral (1) Brushwoods dry(2) Brushwoods (3)	318,643	246,608	554,260.93
TOTAL	1,186,461	2,342,878	2,165,570.41
Deserts			
Deserts and other non-productive land (1) Desert on the coast (2) Areas without vegetation(3)	1,204,913	515,917	438,518.98

Fig.11: **The Fires**

Lima. Tuesday
November 24, 1998
Year 159 No. 82,944

IT CONTINUES TO DESTROY ALGARROBOS (Locust Trees) Piura. Members of the Armed Forces equipped with shovels and picks are trying to put a stop to the fire that for the last five days has been destroying dry grasslands and algarrobo (locust tree) forests located in the district La Matanza, Province of Morropon; approximately 60 kilo-meters to the east of Piura. Up to now, the flames have burned approximately 15 thousand hectares of green vegetation. Civil Defense has not reported any damage to persons but they are on the alert because they might have to evacuate approximately 50 families that live in the settlements of Ternique and Monte Azul, only one and a half kilometers away from the fire area. This year, some 80 thousand hectares of algarrobo forests and dry grasslands in this part of the region have fallen prey to fires that were mainly caused by the farmers. They originally only want to burn the weeds and scrubs but end up losing control of the fires.



e) Overgrazing

Certain soil erosion processes (e.g. compression. etc.) are the result of overgrazing, especially in areas that are close to the valleys or to water sources. Nonetheless, there are experts who maintain that this is not a generalized process and that there are mechanisms to control livestock populations which can be used by the stockbreeders in order to increase or decrease the numbers, depending on whether there is a drought or a “El Niño” phenomenon. These are “very complex, extremely elastic adaptation systems that involve severe fluctuations with respect to the herd’s size and composition as well as migration and other mechanisms” (Nolte, E. 1991).

Goats, which are the main livestock in this region, are animals that are extremely well adapted to arid and semi-arid conditions. When these animals are associated with problems of desertification, it is mainly due to the fact that they are not being properly kept.

In 1993 there were 293,675 goats in this region. In 1995 and 1996, the number increased, reaching 385,000 and 392,000 respectively, and stayed at that level, hardly changing (392,296) until 1997. There are no official numbers as to the current situation after the extreme El Niño phenomenon of 1998.

Overgrazing processes have also been registered in some focal points of the mountainous area (Sierra), where the effects have been even more negative due to the steep slopes where the soil is even more fragile.

Other authors such as Dr. Ricardo Pineda (1996) maintain that “for quite a number of years, the animal population of our region has been diminishing at a very fast rate. Climatic (droughts), economic (the sale of animals in times of crisis) and other factors have contributed to create this situation”.

f) Demographic Pressure and a Low Standard of Living

It is well known that demographic pressure plays an important role in the process of desertification but it cannot be considered the main cause. The data collected by the census show that the population has increased more than a threefold since the last count 53 years ago. See Graph 4.

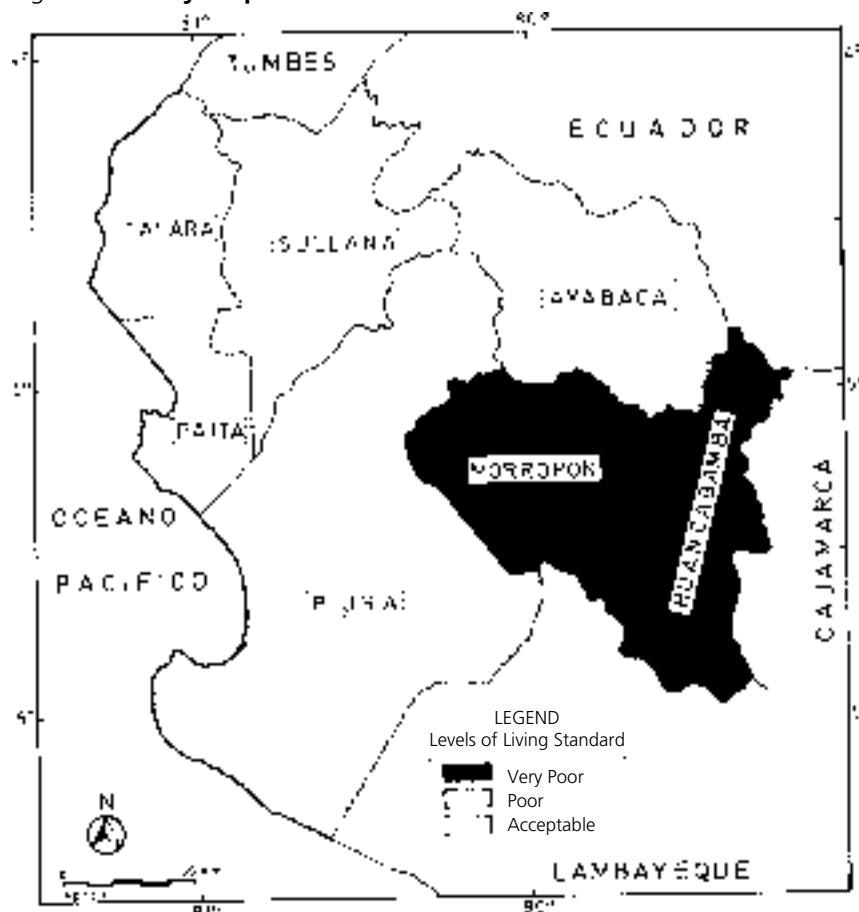
In spite of the fact that the demographic pressure has diminished, it is still necessary to take it under into account. The potential threat of deterioration as a result of demographic pressure or an overload of the ecosystems due to high poverty levels generated by an inequitable distribution of produced wealth contributes to the emergence of what economists have called the perverse cycle: Poverty – Desertification – Poverty.

According to the poverty maps of Peru, Piura is one of the poorest regions of the country and the poorest on the Peruvian Coast. Only the Talara province offers acceptable living standards (thanks to its oil activities). The rest of the region ranges from poor to very poor, especially in the Sierra of Piura (See Graph 12).

Graph 4: **Department of Piura:**
Total Population and Growth Rate according to the Censuses of this Century

Year	Total Population	Increase between Growth Censuses	Rate between Censuses (Annual Average)
1940	432,844		
1961	692,414	259,570	2.3
1972	888,006	195,592	2.3
1981	1,155,682	267,676	2.9
1993	1,409,262	253,580	1.7
Source: INEI: National Census of 1940, 1961, 1972, 1981, 1993			

Fig. 12: Poverty Map of Piura at Provincial Level



6. Proposals to Combat Desertification

Living with Aridity and El Niño

a) On the Coastal Plains

Develop a culture that respects the Coast's aridity.

It is necessary to develop an awareness for the fact that we live in an arid environment where the dry forests (the main vegetation that covers the ground) constitute the only delicate vegetation layer that we have. We must also be aware of the fact that life in Piura is concentrated in basically two large basins: Chira and Piura.

How aware are we of this reality? If we truly were aware of it, then saving water would be a central issue in everything we do, ranging from agricultural production, stockbreeding, forest industry to city planning and education programs.

As part of our acceptance and understanding of aridity, we should create special types of stockbreeding, agriculture and forest industries which would adapt to the characteristics of arid zones and promote those species which have already become adapted to aridity. We also need institutes and professions that specialize in arid zones (e.g. agriculture and stockbreeding in arid zones).

We should follow the same approach with respect to the "El Niño" phenomenon or episode by accepting it not as a problem but as a working condition in this region. This means that we should prepare ourselves for its coming in order to reduce its negative impacts to as great an extent as possible, and we should try to benefit instead from the advantage of having such extraordinary amounts of water at our disposal. If we organize ourselves well, we can definitely live with this natural phenomenon (see Graph 5).

Graph 5: **Phases of the Coexistence with the “El Niño” Phenomenon**

Organization Level	Phases		
	Before	During	Afterwards
Without organization	Ignorance	Panic	Chaos
● organization	● Preventive measures	● Alert ● Activation of a Protection Plan	● Logistic support ● Rehabilitation Reconstruction

b) Living with Semi-aridity and the Mountains

The Sierra of Piura is the type of system universally known as a mountainous ecosystem. This type of ecosystem makes up 20% of the earth’s total surface and is home to more than 10% of the world population.

The Sierra of Piura is part of the Andean mountain system known as the Andes and is located in the so-called “green Andes” which is the utmost southern part of this mountain chain (See Fig 13). The Piuran Andes are relatively low (3500 - 400 m above sea level) compared to those in the middle and the southern part of the chain. This is also where the Andean chain reaches its lowest point in Peru, the Porcuya mountain pass (2138 m above sea level). Their climate, furthermore, ranges from humid to cold (average temp.: 10°C) with precipitation rates attaining 2,000 mm a year at altitudes as high as 500 m above sea level, a clear contrast to the aridity of the coastal plains where there is an average of less than 150 mm of rainfall per year. We must not forget that the “El Niño” phenomenon can reverse the whole scenario and cause precipitation rates on the Coast above 2,1400 mm in only six months, as was the case in 1983, or even up to 3,197.5 mm of rain, which is what happened in just six months in San Lorenzo. Piura (December 1997 - May 1998).

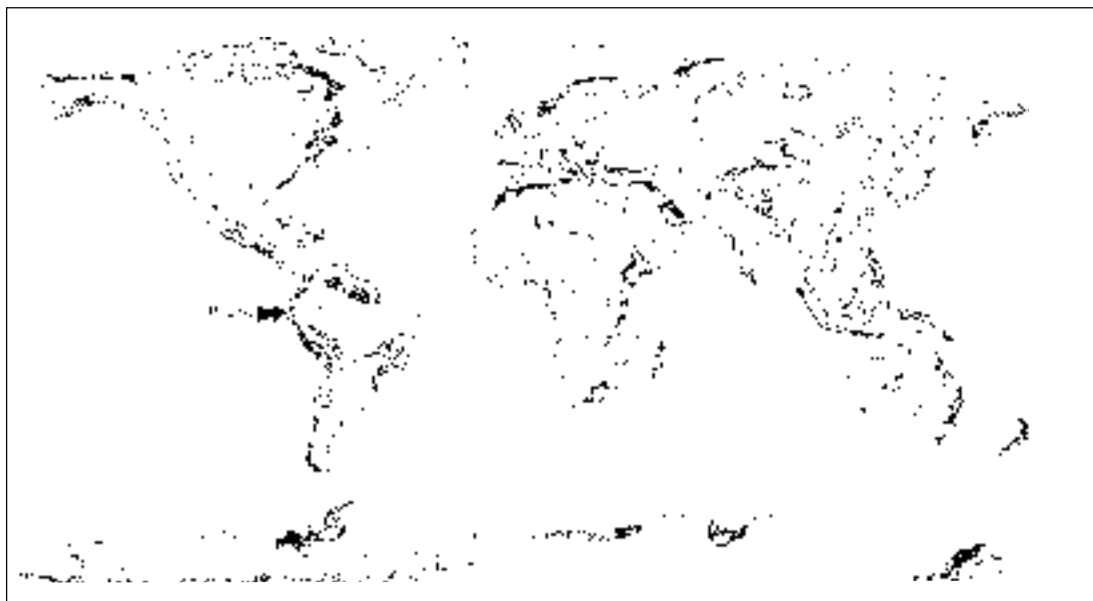
These beautiful spots make up 29% (10,653 km²) of Piura and are home to 18% of the Piuran population (269,369 inhabitants). They shelter a vast biological diversity made up of brushwood, forests and pasture land, as well as native crops or crops that have been introduced into this region such as coffee beans.

A New Dialogue with the Sierra:

The specific characteristics of our Sierra must be understood when planning its utilization. Not having followed this approach in the past has led to serious mistakes which have resulted in the denudation of its forests and brushwood. This was due to excessive and irrational felling and overgrazing which brought about soil erosion and the loss of its plant and animal diversity. All of this resulted in a situation of total disagreement between our proposals and the particular laws that govern this mountainous ecosystem.

These events have forced us to enter into a context of NEW DIALOGUE with our Sierra. We cannot continue to treat it as an endless source of resources but rather as a natural ecosystem that we have to learn to use and preserve. After all, we are just “passing through” and the next generations also should have the right to enjoy it. Moreover, as was mentioned earlier, the future of our Coast depends on the Sierra.

Fig.13: **The Mountains of the World**



The management of the basins is part of this respectful approach that we want to develop towards our Sierra. *Food Security* is also an integral part of living together with the prevailing climatic instability of this kind of mountainous ecosystems. This is the only way to guarantee an acceptable living standard for those people from Piura who, in spite of living in these beautiful areas so rich in resources, are among the poorest in Peru and have one of the highest child mortality rates (93/1000 according to UNICEF FONCODES. Inst. CUANTO 1994)

The management of the basins and microbasins. A proposal to combat desertification and to achieve a sustainable utilization of the Sierra of Piura.

The administration of such complex landscapes requires excellent organization and, above all, good coordination. The basins are spaces that have been naturally delineated by water courses and are intrinsically related to them. This is the reason why it is easier to reach consensus as to their management.

Focusing on basins is a good basis for coordinating measures regarding the framework for planning such issues as the appropriate management of water resources, the preservation of soils, the utilization and conservation of the biological diversity, food security and market access under better conditions. Four basins cross Piura. These are: the Chira, Piura, Quiroz and the Hancabamba basins. There is also an endless number of microbasins and well-known pools such as “Las Huaringas” which illustrate the fundamental role that the Sierra plays in the Piuran water cycle.

Experiments have been conducted in the Piuran Sierra with varying degrees of success. Some have covered the diagnostic stage with a certain level of precision and have started an area-by-area transformation process that often depended on the type of professional experience of those who participate in the projects. The most frequently treated areas are irrigation, infrastructure, soil conservation and reforestation, although there are also some representative comprehensive experiments that can also be mentioned.

The Case for Shrubs and Trees in Fighting Desertification

Given the variety of these ecosystems whose climate is characterized by instability and the existence of a large biological diversity, agricultural activities should also be diversified. This is the reason for concentrating on polycultures and agro-forest pasturing systems based on wood. Monocultures, moreover, especially if they are based on annual herbaceous

species, are not an alternative for us. In such an unstable environment where more than 50% of our agriculture is based on crops for dry farming, it is too risky to develop highly homogeneous systems based on species with a high demand for water.

The approach here instead should be the combination of perennial species of wood (scrubs and trees) with herbaceous annual species (potatoes, beans, corn, barley, lima beans). On the Piuran Coast, there are small farms where scrubs such as the *leucaena* (fodder) and “stalk beans” (as foodstuff) are combined with annual crops such as corn, beans and sweet potatoes. Another alternative is to mix annual crops with fruit trees such as the lemon tree (see Fig. 14).

In the case of the Sierra, the combination of annual crops such as beans, corn and potatoes with natural hedges mixed with brushwood such as alder, walnut, *pajul* and avocado trees are another proof of the feasibility of these proposals. Their success is more reliable than dealing exclusively with annual crops.

In conclusion, one could say that the best way to deal with an environment where the level of rainfall is so uncertain every year is to choose plant species that do not rely heavily on this factor. This gave rise to the proposal of gradually developing the kind of agriculture and stockbreeding that would depend on woody species (brushwood, scrubs and trees), both as fodder and foodstuffs, that could guarantee at least a minimum production in case of a water deficit. Under this perspective we must consider annual crops a “yearly gift”; that means that if they do arrive, they are very welcome but we cannot always depend on all of them to come as this would be “playing with the dice” as the farmer’s saying goes.

Food Security and the Fight Against Desertification

In an environment of great climatic instability, it is logical to be greatly concerned by the food supply since there are months of the year where food abounds and months when it is scarce.

As has already been mentioned, many phenomena such as droughts, floods, freezing periods and the “El Niño” phenomena are caused by processes that can not necessarily be controlled. Thus, we have to develop strategies of *coexistence* that will allow us to reap the benefits of an excess of resources (for instance water abundance) in order to endure the phases when there are deficits. In other words, we must implement a plan for food security which is understood as guaranteeing enough food to meet people’s needs in phases of both economic and climatic crisis. This requires us to reach a state of self-sufficiency with

Fig 14: **Agriculture and Stockbreeding on the Coast and Sierra of Piura Based on Shrubs and Trees – The Agro – Forest – Pasture Systems**

STRATEGIES OF THE ECOLOGICAL ANDEAN AGRICULTURE FOR THE SEMI-ARID ECOSYSTEMS OF PERU’S NORTHERN COAST: PROPOSALS, GRAU REGION UNALM-CEPESER PROJECT 1993

Diversified productive systems for utilizing the arid ecosystems with plant and animal species that adapt to hydrologic stress.



The main objective is to try to create artificial ecosystems that are as similar as possible to the original system in order to be able to adapt to the aridity of the environment. In order to do this, the best solution is to plant shrubs and trees indigenous to the area itself which would yield perhaps not the maximum production but would certainly guarantee a basic minimum - much better than facing extreme losses in the case of a catastrophe.

products that are considered strategic for each sector (proteins, carbohydrates) without disturbing the continuity of the natural system.

It is necessary to resuscitate a number of food species that have been lost, in many cases due to cultural and market factors. The number of plants and animals that can be used as foodstuffs should be increased by learning how they used to be prepared in the past. The same applies to the preserving techniques that were in use for hundreds of years (e.g. salting, drying, smoking, etc.), storing in pouches, granaries and attics in order to guarantee food security for the population. See Graph 6

Graph 6: **A Case in Ayabaca**

**Food Security in the Cuyas-Cuchayo. Ayabaca Community and the Grau Region
PROPOSALS**

Strategic Foodstuffs:

Source of:	Plant Species	Animal Species	Derivatives
1. Carbohydrates	Sweet Potatoes, Potatoes, Olluco, Yucca, Corn, Bananas, Sugarcane, Zambumba, Arracacha Sugar		Sugar
2. Proteins	Beans, Peas, Wild Tarwi, Pachui, Wheat.	<ul style="list-style-type: none"> ● Cattle ● Fowl: Ducks Chickens, Doves ● Carachupa ● Armadillo ● Pava del Monte 	Cheese
3. Fats			Lard
4. Vitamins and Minerals	Vegetables (Carrots, etc.) Fruit: Bananas, Oranges, Lemons, Limes, Chirimoya, Papaya, Passion Fruit		

Local Governments, Cities and Desertification

The municipalities which constitute the local governments are a very important element in fighting desertification. The Organic Law of the Municipalities (N°23853) confers on the municipalities the duty of "...planning and fostering the integral development of the provinces and districts of this country, that is, of the local regions" (Díaz P., 1998). After the Rio Conference of 1992, some municipalities have introduced the concept of a sustainable development into their framework of action (*ibid.*).

In Piura, until now, the municipalities and one or two provincial councils have been the most active in terms of environment issue. However, it must be kept in mind that they are not yet using the concept of desertification. People talk about the conservation of natural resources and the environment, about the loss of soil and forests, about pollution (e.g. waste, sewage, etc.), but they do not mention the concept of desertification as such.

The following is a detailed analysis of the relationship between desertification, cities and local governments in Piura.

Consequences of desertification in the cities of Piura

1. The process of loss and deterioration of the soil as well as deforestation (e.g. hydrologic erosion, hills, etc.) cause a decrease in the natural basis for agricultural, animal and forest production in this area, forcing the *emigration* of the people who live in the countryside (where there are no towns) into the cities – in this case into Piura. At the same time, this encourages the process of slum formations on the outskirts of the cities ("young towns") which lowers the living standards of those who live in the cities.

2. The deterioration of the natural ecosystems outside the cities (e.g. dry or mountainous forests) creates favorable conditions for natural phenomena such as “El Niño” which, by the same token, cause the destruction and loss of the service infrastructure of the cities. As a result, this creates the scenarios of poverty, slum formation, lower living standards and unemployment.
3. *Health* problems: the inadequate management of waste and sewage waters which are dumped into the rivers without any kind of treatment promotes the spread of infectious diseases, mainly among children.

City Life and Desertification

In Piura’s case, and in the case of other cities in the Departamento, the main reason for the dismantling and the pollution of the natural ecosystems that surround it is the lack of a *recycling* policy or culture.

Since Piura is located in an arid zone, we cannot “allow ourselves the luxury” of not recycling our sewage water, of not using it for irrigation or using it for new potential agricultural areas, of not “helping” develop the fertility of the sandy soils around the city by incorporating organic matter into the ground in the form of green fertilizers or organic manure produced with compost techniques that could be applied to the city’s waste. This would certainly be preferable to simply dumping it indiscriminately into the surrounding dry forests without any kind of selection criteria.

It is true that there has been some progress. To date, 10% at the most of the sewage water and waste produced in cities such as Piura is recycled; and much less than that or nothing at all is recycled in the provinces of the Departamento.

Local Answers and their Integration in the National Action Programs

There have been local initiatives which come from the grassroots of the population and from communities and municipalities already tackling the problem of environment protection and the fight against desertification. This is the case of the municipalities of Morropón, Piura, Chulucanas, Sullana, Santo Domingo and Sechura, just to mention a few. Moreover, there is also the National Action Program to combat Desertification in Peru (PAN-Peru) that offers alternatives at a national level and is based on regional proposals, one of which was presented by the city of Piura and reached the stage of conclusion and agreements. (See Appendix 1).

The petitions, complaints, and demands at local, regional and national level can be presented in two broad strokes:

- They do not use the concept of desertification but rather speak about loss, destruction, etc. of some their natural resources (e.g. soil, forests, etc.).
- The petitions and demands are still isolated cases, not integral parts of policy, and the problems are being dealt with only sector by sector.

There are local institutions (municipalities and communities) that are already working together with Non-Government Organizations (NGOs) on projects concerning soil conservation, reforestation or management of water resources, especially on larger projects such as the management of basins in the basins of Bigote, Simiris, La Gallega, Noma or in the large basins such as the Chira Basin.

The Control and Monitoring Systems of Desertification Processes

The question of control and monitoring has been widely discussed during the last two years due to the presence of the extreme “El Niño” phenomenon of 97-98. Environmental issues appeared on the front pages of almost all newspapers and turned them into an everyday topic. Even if the term “desertification” is still not used by people on the street, it is safe to say that the loss of soil due to heavy rainfalls, the effects of the rain, the plagues and diseases all have become part of everyday life of the last 24 months.

In the city of Piura there are institutions that are in charge of supervising an monitoring, among them the University of Piura, the National University of Piura, CEPESR, The Agrarian

University of Molina, the CIPCA and mass media such as the daily “El Tiempo” that launched “The Green Crusade” or the radio station Cutivalú which keeps everyone informed about environmental issues concerning Piura. Nevertheless, the information generated by the systems mentioned above is not necessarily used to its maximum potential by all the municipalities, the communities, the business community, the guilds, etc. There is no tradition on how to handle quantitative information concerning the environment and, lastly, we do not enjoy the best and most fluid dissemination and assimilation of information.

In conclusion, one might say that there are control and monitoring mechanisms in place but that in spite of the efforts of the mass media most of them are still to be found only at an academic level or restricted to a very limited circle of people.

Municipalities and Organizations of Civil Society: Cooperation

Coordination efforts have been made via seminars, courses and a number of projects such as those already mentioned (Park Kurt Bert of the Piura Municipality), but it would be misleading to say that the provincial municipalities already have a lot of experience with respect to coordination. On the contrary, however, the district municipalities already have some experience with joint projects (Morropón, Chulucanas, Santo Domingo, Frías, Sullana, Sechura...) between the municipality, the community, the church and NGOs, especially when tackling emergencies (as was the case, for example, during the “El Niño” phenomenon). Committees or commissions have been set up for this purpose. The type of cooperation known as Association is not very widespread.

Local Awareness Concerning Prevention of Resource Depletion or Conservation

There is an ancestral tradition dating back to 10,000 B.C. governing the management of the arid ecosystems of the Coast and the semi-arid mountainous systems of the Sierra. Techniques exist for irrigation (e.g., old irrigation channels), farming (e.g., polycultures adapted to arid conditions), stockbreeding, forest exploitation – the latter are more contemporary – as well as soil-conservation techniques for the slopes (andenes) and those to protect the biological diversity of the higher parts of the Sierra where a great variety of species has developed. This is of paramount importance in terms of nutrition, not only at the local, regional and national level, but also on a global scale because products such as tomatoes, potatoes, beans and a large number of fruit trees (papayas, custard apples, avocados) are very important to all of mankind.

Nonetheless, these techniques, even though they are still well known, are not widely accepted in situ, especially on the Coast where the more “modern” techniques, most of which are unfit for the specific characteristics of these ecosystems (e.g., monocultures, pesticides, etc.) have gained acceptance as a reference model, further accelerating the desertification processes.

Associations, Municipalities and Other Organizations

In Piura, the NGOs are the associations with whom the municipalities have the closest ties. They also associate with grassroots organizations (e.g. committees, communities, etc.) for concrete actions. These committees or commissions appear and disappear according to the given problems or situations which are, generally speaking, very specific. In many cases, the international community also cooperates.

Cooperation Options with other Countries in Fighting Desertification

When it comes to fighting desertification, there is the possibility of exchanging experiences with other countries, especially in the arid and mountainous zones, and specifically in fields such as the conservation of the soil on hillsides and the combination of agricultural, forest and pasturing production for arid zones. In these areas there has already been an accumulation of 20 years of direct experience.

Graph 7: The Case of the Municipality of Piura

Within the Dept. of Piura, there are seven municipalities at provincial level, of which Piura is the one that has the highest population concentration with 502,339 inhabitant according to the 1993 Census and a projected population growth to 557,453 by 1998.

The city of Piura, the capital of the Dept. with the same name has a population of 227,964 (1993).

The administrative structure is as follows:

- a. Municipal Council
- b. Mayoralty
- c. Municipal Director

Responsibilities

The responsibilities are divided into two levels. The political level lies completely in the hands of the Council, that is, the Mayor and the Members of the Council (19). Their mandate is based on norms determined by the Organic Law of Local Government and the provisions that are originated by the Executive. The second level is the Administration which, in addition to following norms regarding the budget and domestic policy, also incorporates the norms that have been decided upon by the Council and decreed by the local Mayor. All this generally acquires a definite form in what is known as the ROF (Rules for the Organization and Functions) and is complemented by the CAP (Panel for Personnel Appointments).

Field of Competence

Their field of competence encompasses the faculties vested upon them to hold office of government. This field of competence is included in both the Organic Law and in the complementary provisions. However, the assigned domains are basically related to the city administration and within these functions, there is a stipulation concerning the protection of natural resources. Thus, the local government is indirectly connected with natural resources and specifically linked to them because it has to take care of them. This further explains the management of the budget; that is, the annual Public Budget Law establishes the priorities for municipal expenditure which must abide by the national policies. This means that expenses which are not related to the *taking care of* natural resources, which in turn refers to the maintenance of the city's green areas, are not authorized. However, it is possible to dispose of resources that have been self-generated which in the case of the cities can be considerable.

Financial Capacities

The municipality has at its disposal of a small budget from the Central Government. It also has its own means which allow it to cover part of its programs. The Mayor can coordinate the cooperation of the public sector, the private sectors and even international bodies.

Strategies Concerning Environmental Issues: The Kurt Beer Park

In connection with this question it is important to highlight the educational approach taken by the municipality in its project "The Kurt Beer Park". The goal of this project is to find a representative example of sustainable development (e.g. productive, tourist, recreational, etc.) of a dry forest that is larger than 600 hectares. There are, however, environmental problems related to desertification which are still pending as, for instance, the management of sewage water and the recycling of the waste produced.

Source: Vilela, Alcides. 1998. *Local governments and desertification*. CEPESAR. Piura. Peru (unpublished)

The Important Projects

On the subject of desertification in Piura, it must be emphasized that even at a conceptual level the depletion of natural resources and the environment in Piura has been caused mainly by human beings. This fact must be treated separately from natural phenomena such as the "El Niño" phenomenon, earthquakes, freezing climatic conditions and others because the characteristics of these phenomena are not necessarily problems but rather *working conditions*.

If we accept the fact that there has already been a certain progress in fighting desertification by means of research, proposals and projects (even though there are still limitations such as the lack of more sophisticated supervision systems or the time limit of most projects) then, with this scenario in mind, we must recognize that there is a central component

common to everything we do in this region, namely COORDINATION. We must be capable of reaching a consensus, in this case in order to begin a phase based on a new dialogue with nature. The main protagonists of the rural and urban sectors of the different social areas must try to reach consensus on questions such as the utilization of natural resources and their relation with the environment. One of the achievements of this objective are the *hydrographic basins* created in natural spaces which could lead us to proposals for an integral management resulting from the coordination between all protagonists.

Among the large-scale projects we have:

1. The management of natural resources and the environment based on well-defined units with natural criteria: THE BASINS, especially those in the Sierra. The central goal is to achieve a better management of water, soil and plant resources; a better structuring of agricultural and forest activities as well as to improve organization (e.g., irrigation committees, autonomous bodies, etc.).
2. The use and conservation of the dry and low mountainous forests. This would guarantee a dynamic balance within the environment (e.g. climate, soil, biological diversity, etc.), regardless of whether we are dealing with the arid zones of the coastal plains or the mountainous areas of the Sierra of Piura. This would bring about productive activities that would be more compatible with ligneous vegetation..
3. Agriculture and stockbreeding based on ligneous species on the Coast and the Sierra: brush-trees or trees. Agro-forestry or agro-forest-pasture systems.
4. Cities should be designed according to the environmental features of the zone, e.g. aridity
 - Urbanization on agricultural fields should be forbidden
 - A policy of extreme water economy should be established: water saving campaigns
 - Gardens should be designed in accordance with arid conditions using species that have adapted to hydrologic stress (e.g., “papejillo”, “pasayo”, “ceiba”, “jacaranda”, etc.)
5. Maximum recycling of waste in urban centers:
 - Process of waste selection
 - Recycling of sewage waters
6. Education: incorporation of the topic of desertification into the regional educational system. (How to coexist with El Niño and ecology in arid zones as well as the history of the relationship between mankind and these ecosystems – 10,000 years)
7. Educational campaigns should be established with regard to the prevention of and coexistence with the “El Niño” phenomenon: learning how to reap the maximum benefit from its blessings, counting on the support of the mass media, the schools and other educational institutions.
8. Research: the different institutions concerned with the investigation of natural resources (universities and some NGOs) should carry out a study on the environmental impact of the main productive activities of this region using geographic information systems. Studies such as the Forest Map of Piura or the Ecological Soil Map do not exist at the moment but they are crucial to the elaboration of a more precise diagnosis of the environmental situation and the level of desertification in Piura.
9. The elaboration and maintenance of a monitoring system tailored to supervise this region’s environmental situation (especially the desertification processes) based on coordination between the different institutions that carry out periodic observations of the environment (e.g. meteorological stations, working with satellite images, etc.) such as universities, SENAMHI and special projects (Chira-Piura), Civil Defense, NGOs, local governments, etc.

Graph 8: **Desertification Processes in Piura**

Environmental Aspects	Characteristics	Desertification Processes	Causes	Proposals
Physical-Biological Resources CLIMATE	On the Coast, semitropical and arid climates. On the Sierra, semi-arid, subtropical, temperate, warm and cold climates.	Droughts Tendency to higher temperatures, less precipitation and less air humidity	<ul style="list-style-type: none"> Natural Inefficient management of prolonged droughts Wasting the benefits of El Niño Insufficient technology for storing resource abundance (e.g. water, forage, etc.) 	A prevention, warning and emergency system based on a meteorological and biological monitoring system of the "El Niño" phenomena and droughts.
WATER	<ul style="list-style-type: none"> Precipitation deficit (Coast) Excess during El Niño (2000 mm in 6 months.) Extreme precipitation fluctuations (2000-1000 mm/year) (Sierra) 	Water salinity (Coast) . Water pollution	<ul style="list-style-type: none"> Derivation of untreated sewage waters into the river beds Excessive use of pesticides and mineral fertilizers (ammonium nitrate, ammonium sulfate, potassium chloride) 	<ul style="list-style-type: none"> Integral management of the basins. Maintenance irrigation infrastructure for irrigation. Crops should be chosen according to water supply. Treatment of sewage waters. Strengthening of the organization of irrigation
SOIL	Coast: low level of organic matter (<1%) loose texture, sandy, alkaline . Sierra: medium to high level of organic matter, argillaceous, arenaceous, stony.	Soil salinity (Coast) Hydric erosion (Coast and Sierra) Soil compression.	Inefficient and inappropriate use of hydric resources (excessive use, pool watering, rice farming) in soils with superficial stratum layers (salinity) and in extremely steep soils (hydric erosion). Inappropriate use of the soil. The soil is exposed to heavy rainfall (hydric erosion) or high speed winds (aeolian erosion) due to the felling of forest areas or brushwood in very steep areas (Sierra) or in flat zones that have been exposed to the El Niño phenomenon. Overpasturing	<ul style="list-style-type: none"> Appropriate use of the soil according to its characteristics and possibilities Soil conservation measures (e.g. hills, valleys, etc.) Crops should be chosen according to the soil's make up Diversified systems. Agriculture, forestry and pasture Creation of natural curtains as windbreakers Reduction of toxic chemical products (e.g. pesticides)
VEGETATION	Great Diversity: <ul style="list-style-type: none"> Dry tropical forests in the coastal plains Mountain forests and brushwood in the Sierra and the high grasslands in the humid highlands 	<ul style="list-style-type: none"> Fragmentation of the vegetation Loss of biological diversity Reduction of flower diversity 	<ul style="list-style-type: none"> Expansion of the agricultural frontiers Forest fires caused by burning up of stubble in the fields (in 1998: 80 thousand hect.) Deforestation: Excessive forest felling (12-15,000 hect.) Substitution of native crops by commercial crops and monocultures. Cotton and rice take up 60,000 hect. per farming season. (Pineda, R. 1996) 	Reafforestation or reconstruction of the forests: <ul style="list-style-type: none"> Use and conservation of the dry and lower mountainous forests Use and conservation of the native crops and their related wild species Use of agroforest or agroforest pasturing systems Campaigns to prevent forest fires
FAUNA	Mainly of Amazonian origin and some of Andean, Patagonian or migratory nature. By creating an isolated environment, the Andes enable the existence many endemic species.	<ul style="list-style-type: none"> Destruction of the habitats Reduction of the population Extinction of native species 	<ul style="list-style-type: none"> Felling of forest and brushwood and fires Uncontrolled selective hunting Introduction of foreign species (goats: 293,600 heads, sheep, cattle) 	<ul style="list-style-type: none"> Protection of natural areas Control on hunting activities Sustainable management of introduced livestock
HUMAN RESOURCES	Coast: Shanty towns, established in the valleys with good communication means, and a good market economy, with commercial agriculture and immigration problems. Sierra: Geographic isolation, an economy based more on self-subsistence than on the market. Permanent migration towards the Coast (e.g. Piura, Lambayeque, Trujillo, Lima).	<ul style="list-style-type: none"> Food insecurity Unemployment Lower living standards (i.e. poverty, high child mortality: 91 in 1000) 	<ul style="list-style-type: none"> Migration (especially in la Sierra) Centralism Insufficient or non-existent services (e.g. education, health, means of communication, etc.) Inappropriate city planning without taking under account climatic instabilities such as El Niño, for example). Demographic pressure (growth rate: 17) 	<ul style="list-style-type: none"> Democracy (equal opportunities) Decentralization Services (e.g. education, health, etc.) Appropriate city planning for the arid conditions and climatic instability (El Niño) Waste and water recycling Education, research and monitoring systems appropriate for the ecological characteristics of this region, the struggle against deforestation and living with phenomena such as "El Niño".

Environmental Aspects	Characteristics	Desertification Processes	Causes	Proposals
The Ecosystem	This zone has 17 of the 84 living zones in Peru acc. to the Ecological Map of Peru (1996)	<ul style="list-style-type: none"> Reduction of the areas of ecosystems in the Dry Forests. Alteration of the water balance. Alteration of the food cycle. Changes towards dryer and more unstable conditions Lower living standards 	Use of inadequate agricultural, stockbreeding and forestry techniques not fit for the specific characteristics of the 17 living zones that make up Piura	<ul style="list-style-type: none"> Integral management of basins and micobasins The development of adequate technologies (agroecological) within the framework of proposals for an integral management of the basins, based on the specific features of the 17 ecosystems that make up Piura with the participation of all producers (farmers), technicians, and scientists, civil organizations, local governments, universities.

“El Niño's” Help in Fighting Desertification

The biggest “El Niño” phenomenon in terms of precipitation, second only to the one experienced in 1983, hit Peru in December 1997. It reached precipitation levels of up to 3,197.5 mm (in San Lorenzo) in just six months (December ‘97 to May ‘98), an even shorter period than with its predecessor in 1983 (7 months). This phenomenon triggered a large regeneration process of the main vegetation formation in this zone: the dry forest. It also generated an incredible green layer of herbaceous vegetation and registered productivity levels similar to the best grasslands of the world: 3.4 grams of dry plant material per square meter daily during the month of January. (Cárdenas. 1998). See Figs 15-16 and Graph 9. It is also true that “El Niño” caused the destruction of the infrastructure, mainly affecting the large population centers (Piura, Sullana, Talara, Paita, Tumbes, etc.) and clearly illustrating the lack of adaptation to this type of natural phenomena which are widely known in this zone. In terms of



Fig. 15: The dry forest before an “El Niño” phenomenon (February 96). Piura

our struggle against desertification, it is positive to underline that “El Niño” left behind approximately 700,000 hectares covered with grass, brought about natural forest regeneration (mainly *algarrobos* (locust trees) *Prosopis pailida*) and a large number of hectares fit for rainy weather farming in addition to a stratum bed that could last for up to two years. (See Fig. 17)

Graph 9: **Primary Net Productivity in the Herbaceous Sector (PPNA)**
Monthly Variation (Dec. 97 - June 1998)

Harvest Month	PPNS (gr. MSV/m ² /day)			
	Savanna-type dry forest		Dense dry forests	
	average	est. deviation	average	est. deviation
December	0.00	0.00	0.00	0.00
January	0.35	0.57	3.40	1.78
February	0.51	1.21	1.89	1.28
March	0.28	0.48	1.79	1.51
April	0.29	0.78	0.68	0.57
May	0.11	1.31	0.18	0.16
June	0.17	0.42	0.01	0.01

Source: Cárdenas. C. 1998

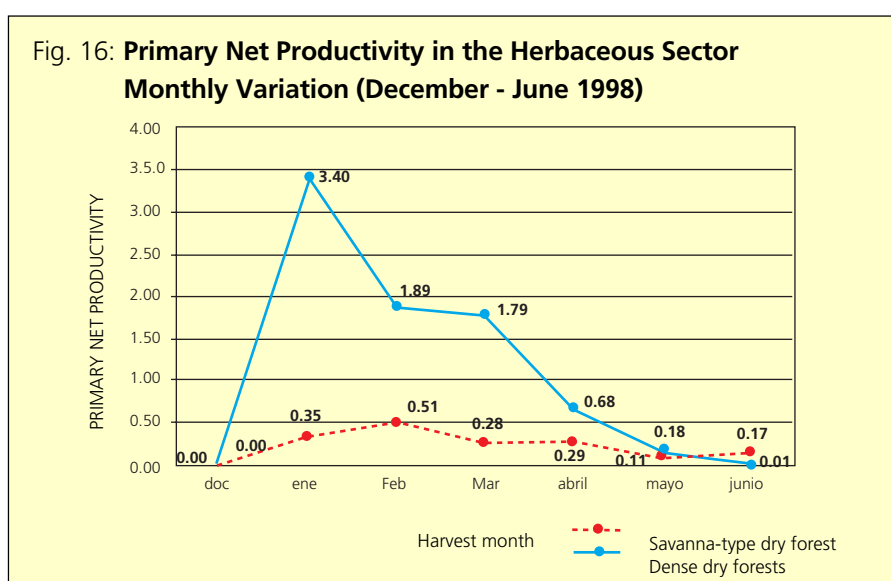


Fig. 17: **The Help of “El Niño” in Fighting Desertification in Piura**



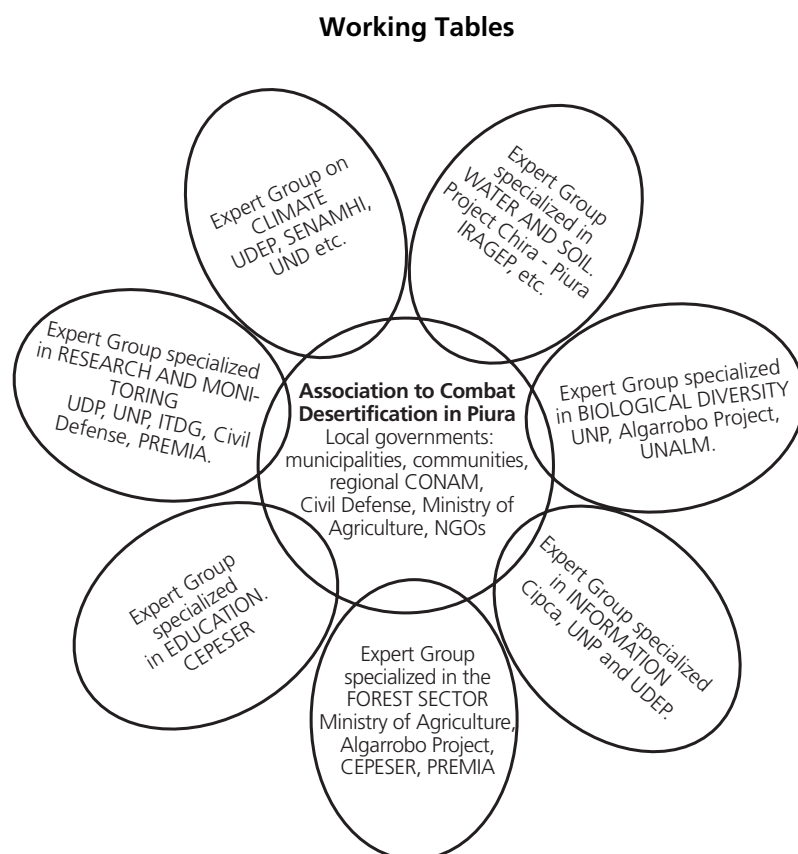
Afterwards, the coastal dry forest resembled a Middle American meadow San Lorenzo, Piura. January, 1998

Who Would Be in Charge?

The setting up of an association to combat desertification (depletion of natural resources and the environment in Piura) has been proposed. It would be composed of a system of expert institutions specializing in specific important components of deterioration (desertification) (See Fig. 18).

People would participate directly through their municipalities following the logic of the “down-up” approach and adhering to the general directives of PAN-Peru.

Fig. 18: **Association to Combat Desertification in Piura**



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8. Appendices

Regional Workshop on Desertification in Peru's Coast and Northern Sierra Nov. 2. 1995 - Piura

Organizers: ESQUEL INRENA; CIZA-UNAM. CEPESER

CONCLUSIONS

1. The problem of soil erosion due to salinity (Coast), deforestation (Sierra) and overgrazing (Coast and Sierra), is the most important process of desertification in this region.
2. Institutionalization. There is a need for a representative and prevailing authority as well as agreement among the productive sectors. Plans focusing on basins are also needed since this is one of the most important alternatives for controlling desertification.
3. Education, training programs and research are also among the most important factors because they are the basic elements of a plan towards controlling desertification.
4. The proposed monitoring system is the first step towards reaching an agreement concerning the pointers to be followed in the supervision of this process.
5. The first group (directory) of people has been set up. These are people who have had direct experience in production processes. These experts are willing to participate in the process to control desertification.
6. The foundation has been laid for setting up a regional partnership: The Coast and the Northern Sierra.
7. It is necessary to keep the producers who were invited and who participated in the Regional Workshop informed (from Cajamarca. Lambayeque. Tumbes and Piura) in order to set up: "The Information Network of the Northern Region on Desertification".
8. A new group of institutions has been identified who is willing to participate in this control and fighting process against desertification.
9. The participation of the productive sectors, new to this issue, has enabled us to open up a new front among the social groups involved in the struggle against desertification.
10. The incorporation of the criteria and the considerations contained in the International Convention to Fight Desertification was part of the idea behind this meeting's. They were a topic of reference throughout the Workshop. The realization of this working meeting itself was already a part of complying with the principles of the Convention.
11. The national meeting on desertification should take into account the results of this regional experience.