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LUDEPA, A JOINT PROJECT OF GERMANY AND ARGENTINA TO FIGHT AGAINST DESERTIFICATION IN PATAGONIA.

G.Oliva[1], P.Rial[2], L.Gonzalez[3], D.Cuadra[4].

EEA SANTA CRUZ. CONVENIO INTA-UFPA-CAP.
CC 332. FAX +54 966 22552.
9400 Rio Gallegos. Santa Cruz. ARGENTINA.
[1]Instituto Nacional de Tecnología Agropecuaria. [2]Ministerio de Economía y Obras Públicas- Santa Cruz. [3]Consejo Agrario Provincial - Santa Cruz. [4]Universidad Federal de la Patagonia Austral

ABSTRACT

Desertification affects seriously most of Patagonia. To assess the extent of this process we studied LANDSAT MSS images of about three million hectares of the Central District of Santa Cruz province (Argentina).

Landscape units were digitized from screen. Subsets of the LANDSAT image were obtained for each landscape unit and classification was performed.

Ground check included estimation of water and wind erosion and vegetation degradation.

About 75% of the area is affected seriously by desertification. Susceptibility and alternatives for sustainable use of each landscape unit are discussed. Most of the affected area should be protected and sheep grazing excluded.

INTRODUCTION

Extensive sheep farming has been the main economic activity in Patagonia since colonization, which started in the early 1900.

Stocking rates in the province of Santa Cruz, southern part of Patagonia, rose sharply in the early stages of colonization and reached about 7,5 million sheep. Until 1978 stocks fluctuated around this number . Since then, they have dropped to about 3,5 million. High mortality was caused by severe winters and by the eruption of Hudson volcano, in 1992, that covered about 10 million hectares of northern Santa Cruz. Most of the farms of this area still remain without sheep.

Although near causes of this reduction in stocking rates can be easily identified as climatic factors and natural catastrophes, it is evident that extensive desertification, caused mainly by overgrazing and shrub cutting for firewood, is widespread.

Desertification brings about degradation of the vegetation, water and wind erosion of the soils and causes loss of productivity, so that the original stocking rates of the area cannot be sustained at present. The extent of this process has to be taken into account to assure future sustainable use.

One of the objectives of the first part (1990-1994) of LUDEPA, a joint programme between GTZ (Germany) and INTA (Argentina), is to assess the extent of desertification in four areas distributed in Patagonia. In this paper we present a partial evaluation of desertification in one of these areas, namely, Gobernador Gregores - San Julian in Santa Cruz province, Argentina. Other teams are working on two aditional areas of Patagonia, and final results will be available in 1995.

MATERIALS AND METHODS

About three million hectares of one of the most degraded areas of the Central District (Soriano, 1956) of Santa Cruz province were studied (Fig 1). Anuall rainfall ranges from 100 to 200 mm. Mean temperature is 8.7°C (De Fina, 1960). High intensity SW winds blow all the year round, with higher intensities in summer. Vegetation has been described by Movia et al (1987).

A 1986 LANDSAT MSS image was used. It was rectified using 1st order transformation and georreferenced using a Transverse Mercator (Gauss

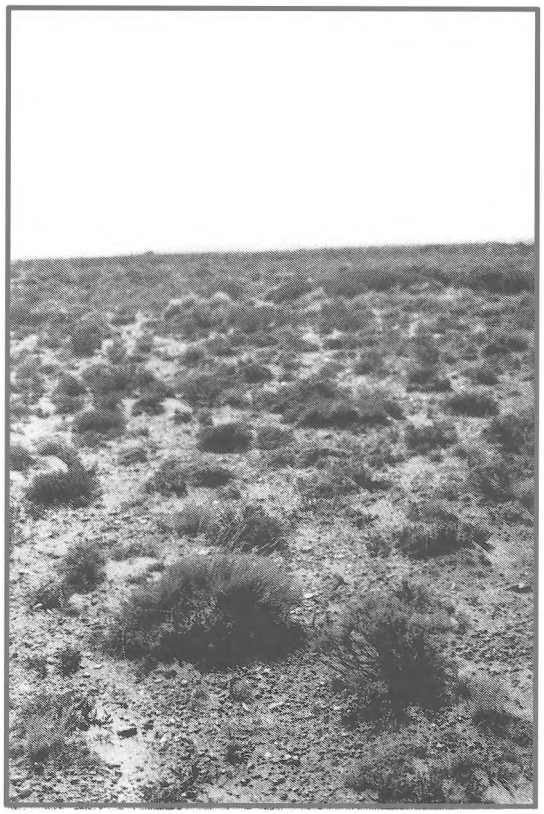


PLATE 1. **PATAGONIAN PEBBLE PLAINS**
Low shrubs of *Verbena tridens* and *Nardophyllum obtusifolium*

Kruger) proyection. Geological and topographical maps of the area were used to determine landscape units. Limits were digitized on screen. Subsets of the image were obtained of each landscape unit (MASK program, ERDAS 7.5). Spectral signatures were obtained for 6 classes in these subsets using a combination of unsupervised (ISODATA, ERDAS 7.5) and supervised methods. Classification was performed using maximum likelihood clustering techniques. (MAXCLAS, ERDAS 7.5).

Ground check was performed in 134 points of the area. Wind and water erosion indicators were recorded. Complete vegetation censuses were performed in each site, and vegetation degradation was estimated using hipothetical state and transition models for each landscape unit.

A desertification degree between 1 and 5 was assigned to each class, and initial classification was recoded. Final classifications for each landscape unit were merged into a single map.

Roads, rivers and farms were digitized from 1:100.000 maps and superimposed. The final map was printed at a 1:250.000 scale.

RESULTS

1) LANDSCAPE UNITS INCLUDED ARE (FIG 1):

Basaltic table-lands:

Upper Tertiary volcanic events originated these high table-lands, that range from 500 to 900 m.o.s.l. Soils are shallow and there is a high proportion of rocks on the surface. Low *Verbena tridens* and dwarf *Nassauvia glomerulosa* shrubs dominate the vegetation, with higher areas covered by tall grasses such as *Stipa speciosa* and *Festuca pallescens*.

Sedimentary table-lands:

Elevated marine sediments from the upper Tertiary Period form this landscape unit. Soils are deep and rich in organic matter. Mean rainfalls are somewhat higher in this area (about 200 mm), and vegetation includes tall grasslands of *Festuca pallescens*.

Patagonian pebble plains:

These extense sedimentary areas are covered by layers of glacifluvial originated pebbles known as "rodados patagonicos". Altitudes range between 200 and 300 mosl. Soils are coarse textured and shallow. Vegetation is dominated by dwarf shrubs of *Nassauvia glomerulosa* with some grasses, mainly *Stipa speciosa* in less degraded areas.

River valleys and terraces:

Only one permanent river flows through the study area: Rio Chico. Its wide valley has been excavated by glacifluvial action. Soils include fluvial sand and gravel deposits. Some of them have high levels of salts. Vegetation is formed by patches of *Festuca pallescens* and *Juncus balticus* meadows, and high shrublands dominated by *Lycium chilense*, *Berberis heterophylla* and *Verbena tridens*. Completely degraded areas are common, where tall shrubs have been cut down. These deserts include *Chuquiraga aurea* and *Lycium repens*. Extense terraces show vegetation

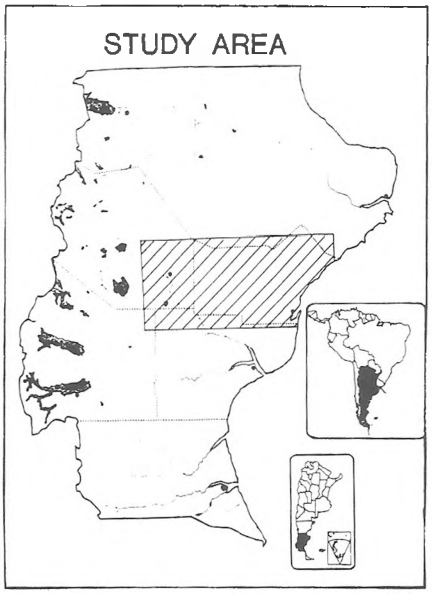
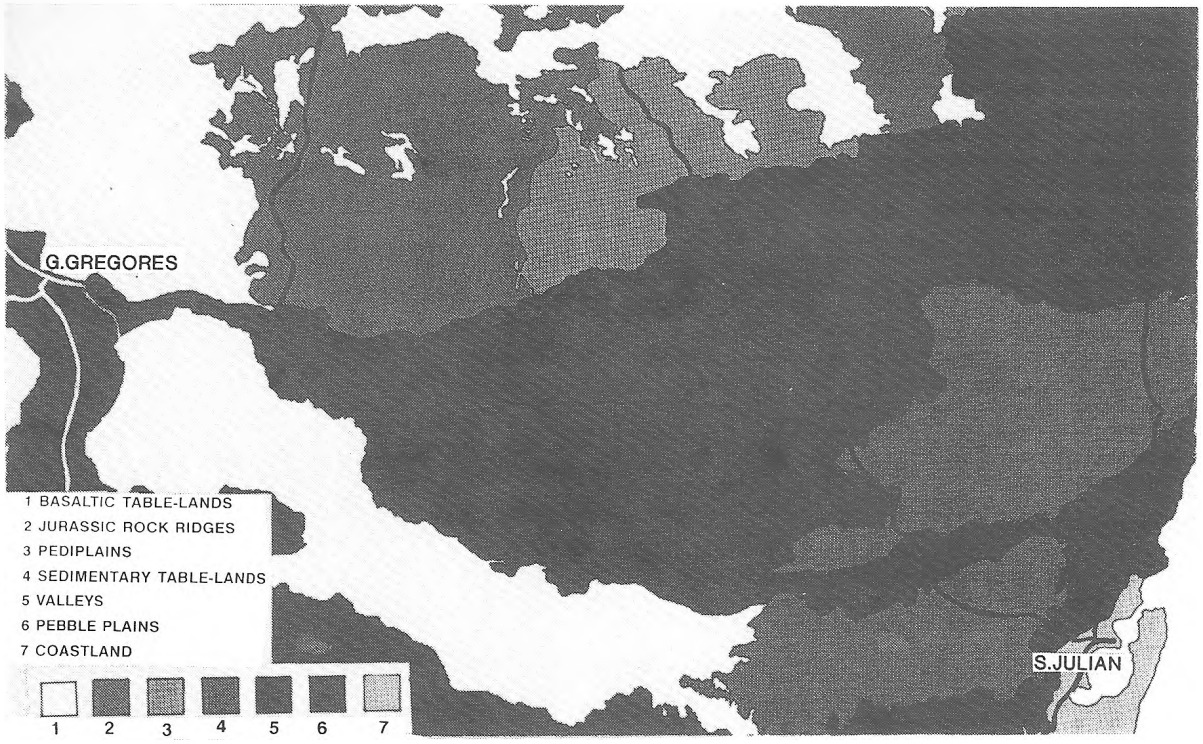
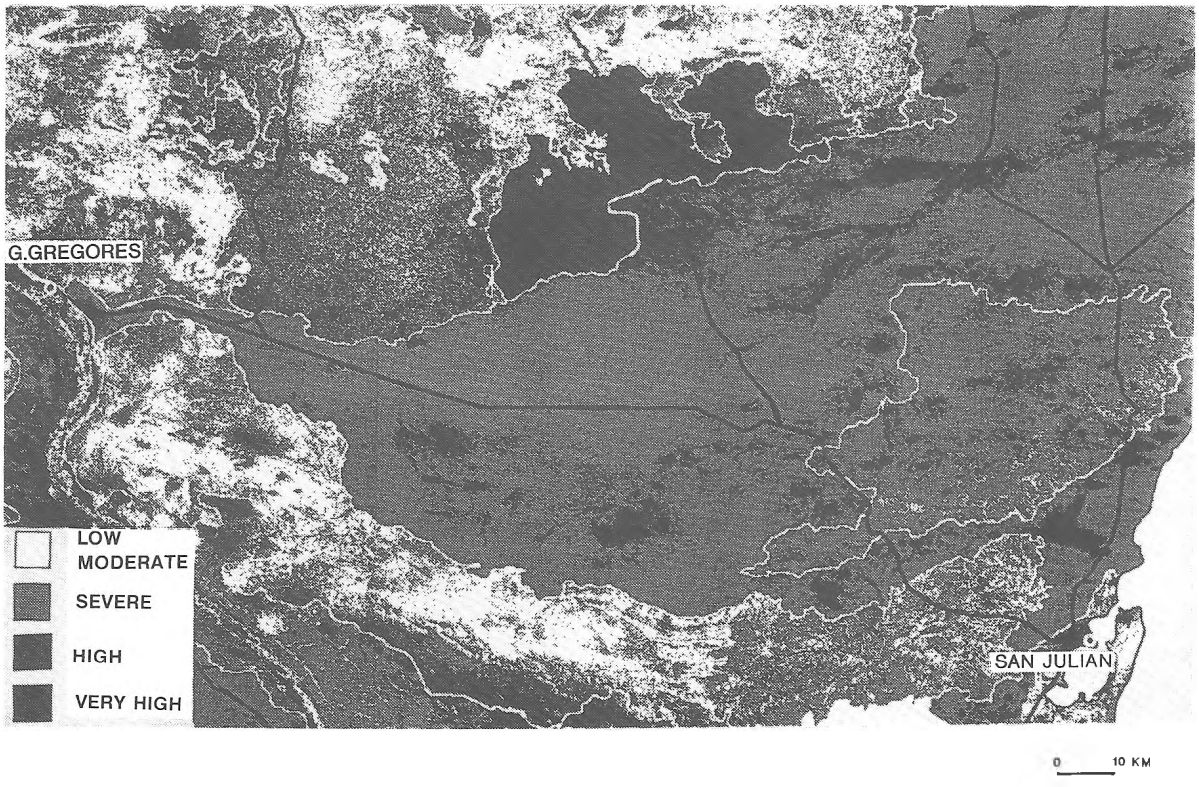


PLATE 2. PEDIPLAINS.
Shrubs of *Lycium chilensis* cling to the ground near a temporary stream.

LANDSCAPE UNITS
S.JULIAN-GOB.GREGORES AREA



DESERTIFICATION DEGREES
S.JULIAN-GOB.GREGORES AREA



and soils very similar to those described for the Patagonian Pebble Plains.

Jurassic rock ridges:
Old effusive acid rocks that were formed in the Upper Jurassic dominate this hilly landscape. Soils and vegetation are distributed in patches. Higher sites are exposed, and bear shallow soils with dwarf shrubs of *Nassauvia glomerulosa*. Slopes have tall shrubs of *Verbena tridens* and *Berberis heterophylla*. Small *Festuca pallescens* and *Juncus balticus* meadows are found in the bottom of the valleys, where temporary streams flow in springtime.

Pediplains:
These extense depressions were excavated by combined wind and water erosion on the pebble plains, in areas where they contact with basaltic plateaus. They are mainly "badlands" with little or no vegetation or soil. Dwarf shrubs of *Nassauvia ulicina* and *Chuquiraga aurea* and some grasses are found in these harsh habitats.

Coastland:
Low, rounded hills formed on Tertiary calcareous sediments. Soils here are sandy and shallow. Vegetation includes tall shrublands of *Verbena tridens*, dwarf shrubs of *Nassauvia glomerulosa*, and salty marshlands of *Salicornia ambigua*, *Distichlis spicata* and *Lepidophyllum cupressiforme* near the sea.

2) DESERTIFICATION DEGREES

Fig 2 and 3 show that about 75% of the area is highly impacted by desertification.

The most affected landscape units are pediplains, where human impact and geologic degradation processes, driven by climatic change have produced intense erosion.

River valleys show extense denuded areas and have wide flood plains where agricultural activity can be developed. Human activities effects are significant in this once-productive lanscape where sheep find refuge in winter, and shrub cutting for firewood is common. Fluvial terraces have been abandoned, as grazing is no longer sustainable once the shallow soils erode and the palatable grasses dissappear.

Most of the pebble plains, where grazing is managed on a year-round basis and overstocking is common, show severe desertification. Soils of this arid landscape unit have eroded, specially those in contact with basaltic table-lands. The drainage system of these plains gives way to shallow pools with underlying sediments exposed, where wind and water erosion combine and desertification processes are enhanced. In some areas, only desert pavement is left, with no more than 30% dwarf shrub cover. Shrublands, once associated with a diverse grassland community are now degraded. In some areas the only survivors are the tall, unpalatable shrubs, with bare soil that is constatly blown away and rediposited between them.

Sedimentary table-lands have lost a great part of their rich, organic soils, and their tall grasslands have been replaced by dwarf shrubs.

Jurassic rock ridges, show intense degradation. Slopes easily loose their shallow soils and

PLATE 3. **BASALTIC TABLE-LANDS.**
Low shrub and grass communities in basaltic rock surfaces.

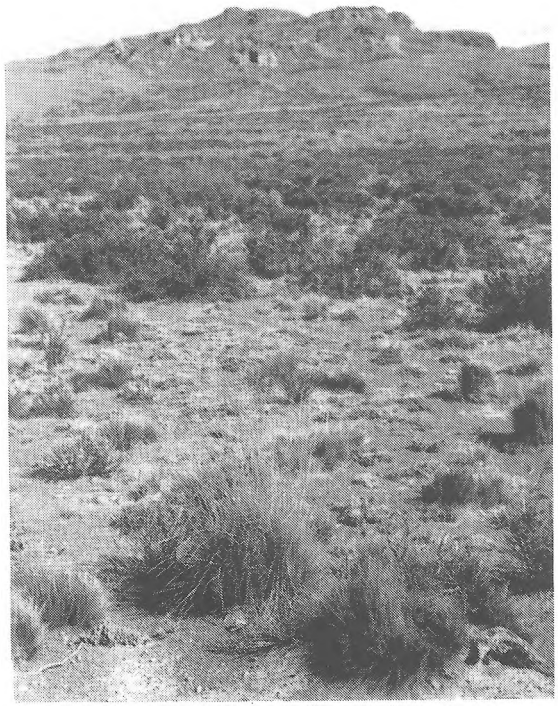
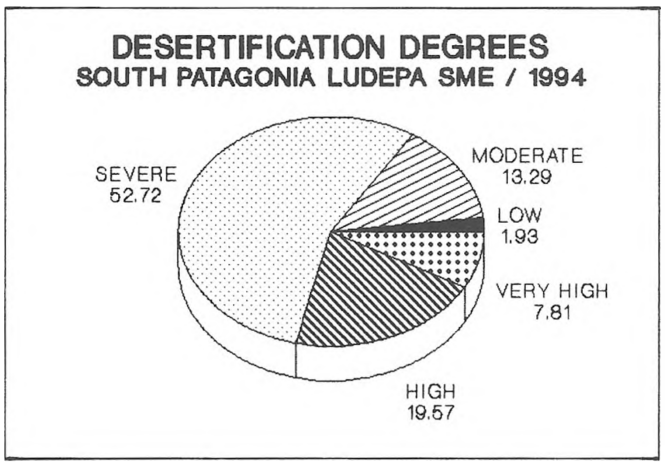


PLATE 4. **JURASSIC ROCK RIDGES**
Low *Verbena tridens* shrublands near a shallow pool in volcanic jurassic rocks.

PLATE 5. **VALLEYS.**
Lycium chilensis shrub community in developing sand dunes in Rio Chico valley.

PLATE 6. **SEDIMENTARY TABLE-LANDS**
Highly degraded *Festuca pallescens* grasslands on soils originated on Tertiary marine sediments.



vegetation, leaving exposed rocks and stones. Small meadows in the bottom of valleys, dissappear with overgrazing and with reduced infiltration rates, that boost surface runoff and water erosion.

Higher basaltic table-lands still show areas of grasslands with light or moderate desertification. Higher rainfalls provide a better regeneration of the vegetation, and as snow accumulates in winter, grazing management includes stock rotation with long rest periods. In the lower basaltic table-lands, desertification is severe, with very high degradation of the vegetation.

CONCLUSIONS

One hundred years of overgrazing in these fragile ecosistems have led to widespread and irreversible desertification processes. The productivity of the area has been falling. Present sustainable stocking rates are no more than 0.1 sheep/ha. With this carrying capacity and present values of wool and meat, most of the farms in the area are to small to be economically feasible so farmers have to overgraze or rely on government loans or subsidies to keep in business. This process is coming to an end, as government money is being cut down and sheep have not been replaced after the Hudson volcano eruption and the harsh winters that depleted the stocks.

The less susceptible landscape units may allow sustainable grazing, after a concentration of properties. Rest rotation grazing systems with low stocking rates may be suitable and complemented with pastures in appropiate areas.

It is not reasonable to follow on with sheep grazing in landscape units that have a high susceptibility to desertification. The low productivity of these areas cannot compensate the high cost in loss of biodiversity, vegetation cover and soils. Traditional grazing systems must be avoided in these regions to stop further degradation, and alternative sustainable uses (tourism, recreation, cientific research) should be encouraged.

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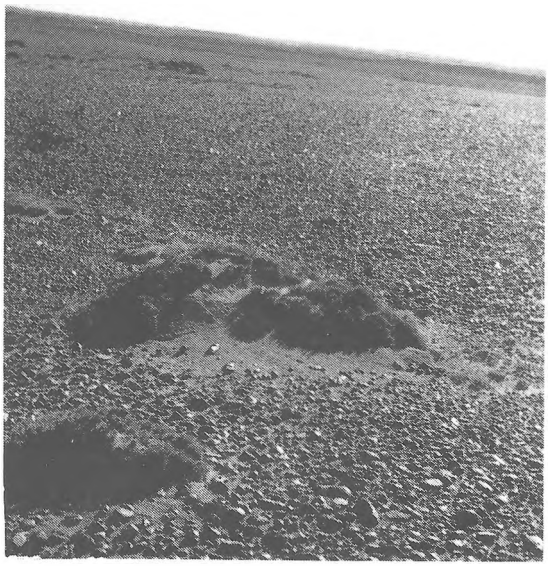

PLATE 7 **VERY HIGH DESERTIFICATION**
Extense desert pavements are the result of an irreversible process of anthropic degradation.

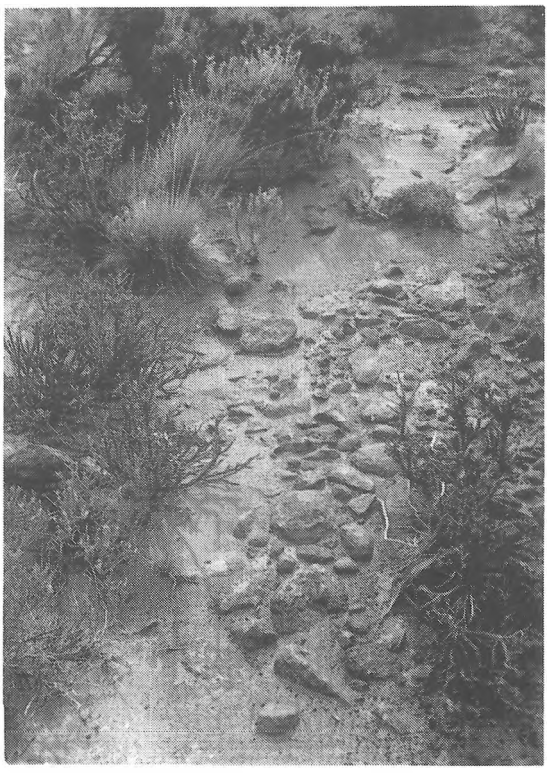

PLATE 8 **MODERATE DESERTIFICATION**
Rich and diverse shrub- grassland communities still persist in shallow soils of less accesible basaltic surfaces.