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# Delimitation of the hydric erosion using Digital image processing of Landsat TM, in the aluvional plain of Valle Fértil Dept. - San Juan. Argentine.

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**Abstract:** This work forms part of the Project: The Desertification in the Great Oriental depression of the Valle Fertil Department. State of situation and suggestions.
This project is being carried out since the end of 1993 by a multidiciplinary group of biologists, geologist and sociologist, belonging to the National University of San Juan.
The area under study, a zone of 100 km length and 20 km width, with general direction N-NO S-SE, located in a tectonic depression to the east of the Valle Fertil-La Huerta range, constitutes a wide plants and animals ecotonal affected by processes of desertification.
In the zone exists a delicate equilibrium among surface water, summer rains, the limous soil, natural vegetation and the anthropic action (through the agricultural exploitation, forestry and cattle feed).
The process of hydric erosion has acted in different ways. In higuer areas with major erosion (excavation) is produced, with massive loss of soils. In areas with intense anthropic actions, the agricultural work, cattle overfeeding and pruning. In the down stream areas the transported sediments produce filling of stream beds.
Through the digital processing of images Landsat MSS y TM, the erosion textures diferenciated using contrast streching, spatial filtering and spectral ratioing.
In order to achieve satisfactory results, numerous campaigns were performed with field works in the zone under study in order to carry out observations and fittings to the satelite information.
From the analysis of differents zones, it can be observed clearly that both, in the north zone of minor arboreal cover, with presence of White Quebracho of great development and also in the south zone characterized by a great homogeneous and dominant arborea cover, three different zones can be noted, following a general W-E direction. First, the zone of major erosion (excavation); then the area of agricultural exploitations with presence of water place, zones of sacrifice and denude lands. Ending in the zones of stream beds filling. The diferentiation was done as a function of their texture, tonality and drainage design.
The indicators used during the stage of field supervision were of great utility in order to describe and correlate the field information with the zone observed in the image. The supervision method used in the study has the advantage of maximize the principal needed resources this is time and budget.

**Keywords:** Desertification, Image prossesing, Hydric eosion, Semiarid climate.

## 1-Introduction

This research shows the materials, methodologies and technics used in the study of desertification of a considerable area of the Province of San Juan after having carried out the tasks of the second year of research of the Project called "Desertification of El Gran Bajo Oriental del Departamento de Valle Fertil. Estado de situacion y propuestas". (The Desertification in the Great Oriental Depression of Valle Fertil Department. State of Situation and Proposals). This project is being carried out by a multidisciplinary group of biologists, geologists and sociologists of three Schools of the National University of San Juan since the end of 1993.

At this stage of research, it was studied the effect of hydric erosion and it was made use of the data

coming from the digital processing of Landsat MSS and TM images and of land studies in detail.

The images show different features of tonality, texture and drainage design. The erosive activity is shown with a dendritic design while the sedimentation activity is shown by an interlaced design of the river-beds. The topographical features, the distribution of shallow waters and the infiltration create different conditions of fertility in the soil which are reflected in the vegetation, by vegetated gullies, high grounds with little vegetation and vegetation in islands.

The satellite image shows the horizontal order in the vegetation where the proportion of ground free of vegetation and the lateral proximity between the plants are clearly shown and can be calculated, Salinas de Salmuni et. al.(1995). Keeping in mind this concept, it is possible to talk about communities more or less open or close. The detailed horizontal differentiation of the species in apparently homogeneous vegetable communities allows to know a micromosaic with typical, partial communities, Strassburger (1993).

The changes caused by erosion affect this communities differently depending on the fact that they are more or less xerophilous. In the Grounds of Gullies, where the most severe erosion took place, the soil profiles have been destroid, except between gullies, Aguilo Alonso (1992), where it is possible to observe bare lands caused by the death of the large part of the plants, these spaces are more obvious while the original vegetal community was less xerophilous. In the siltation areas, several conditions for the flora such as loss of infiltration and salting are generated. Besides, the degrading processes take place at a fast speed, therefore, the vegetation is often removed completely, except in the islands of *Geofroea decorticans* (Chañar) or of *Atriplex spp* (Zampa), very resistant to drought and salts, Kiesling et al.(1994), which are clearly shown within the image.

The study in the image and the delimitation of the homogeneous areas aim at gathering evidence that backs up the hypothesis of this research: in the alluvial Plain of Chaco Arido, the areas under the effect of the processes of hydric erosion, when the areas are hydrologically related, follow a typical sequence in the slope direction, starting in the grounds of gullies (upstream), following in an area of farming and cattle raising and ending in an area of low grounds silting up.

## 2 Characterization of the area under study

The area under study is situated in el Gran Bajo Oriental at the east of Sierra Valle Fertil- La Huerta, that are a part of las Sierras Pampeanas Occidentales of the province of San Juan in the Center-West of the Argentine Republic (Figure 1).

El Gran Bajo Oriental, where the area under study is situated, is a wide area where four types of surroundings can be seen, mountain chain, foot of the mountain slope, alluvial plain, and dunes.

The area under study of 20 per 50 km large is situated whithin a tectonic hollow with an average slope of 1% at the foot of the mountain chain with a predominant direction of NNW-SSE, and with an average height of 1200m.

At the North, it borders on the Dunes, at the East on the Plains of the Province of La Rioja, at the South on the Foot of the Mount of Sierra de la Huerta and at the West on the rocky outcropping of 2 to 3 kms wide per 30 kms large that separates it from the main Sierra causing differences in their hydrological features; only small basins that drain limited flows during the rains are noticed in the area. The soil is ordinarily muddy, showing local characteristics ranging from mud-clayey to sandy. The predominat climate is semiarid with annual rains of about 300mm that are recorded only during the summer frequently and torrentialy. In this area the hydric erosion is basic while the aeolian erosion is of little importance.

This area is situated inside the Formacion del Bosque Subtropical Seco, Stassburger (1993), in the Phytogeographic Province of Chaco Arido. The typical surrounding is that of the Forest Plain and the Vetch Fields, Pastran et.al.(1992), with timber-yielding species of average value. The main economic activities are timber industry and cattle raising and on a smaller scale,farming.

The main economic activities of the area are related to bovine exploitation for breeding and to ovine and caprine exploitation for sustenance. Therefore, the forage plants are the most important vegetal resourse. Keeping in mind the ecological characteristics of the area, the ligneous-bushlike plants constitute a significant component in the amount of forage available, Marquez J.et.al.(1995).

## 3 Materials

The processing is carried out on images stored in digital support therefore, data processing systems are used. The system used is the ERDAS VGA processor.

The work was made with an image Landsat, sensor TM from the month of April.

From the original image 231-081, it was extracted a subset between 30º 10'and 31º South Latitude and 67º 10' and 68º West, corresponding to the east flowing of the Sierra de Valle Fertil.

## 4 Method

The individual features of each channel was analysed and combinations of color (RGB) and operations between channels were tested.

It was made use of sparkles that allowed to stand out characteristics of interest such as vegetation state or soil features in order to help visual and spectral discrimination of determined features.

In order to get a good display of the analised features, tonalities and textures related to phenomena of hydric erosion, the images were digitally processed producing an image combination 4,3,1 with the Channel 3 highlighted with a high- pass filter that allowed to mark lineaments, borders and edges.

A method based on a zoning of the area under study was used for the analysis.

The image shows a longuitudinal zoning where two zones with different features of tonality, texture and drainage design are clearly defined.

The North Zone with a smaller arboreal covering is depicted by light tonalities of grey. The Prevailing texture is a fine doted line due to the presence of white Quebracho of a big size, distributed in mosaic all over the area and depicted as spots in a darker grey. The drainage design is of an erosive nature of dendritic type.

The South Zone is characterized by a large arboreal covering depicted by an homogeneous and prevailing dark grey, with smooth texture and drainage design covered by plentiful vegetation.

The areas in acute red in the image belong to the zones with an arboreal covering of more than 20% that is mainly situated in: North Zone, in the river-banks and gullies; South Zone, homogeneously distributed, with bare lands due to the loss of humidity caused by the interruption of draining and gullies development, Salinas et.al.(1995)

The areas in mid red belong to the zones located mainly in the South Zone where samples of bush of more than 5m high grow.

The green blue areas belong to the zones where there are bushes with little foliage mainly constituted by *Larrea divaricata* (Arum) and *Bulnesia retama* (Broom) and they are distributed along the whole zone under study.

The area in dark green belong to an area with bush-like stratum of more than 90% and arboreal stratum of small size that represents less than 10% of the whole vegetal covering situated in the river-beds and gullies in the North Zone.

The red spots belong to areas with an arboreal stratum of less than 10% *(Aspidosperma quebracho blanco)* and bush-like stratum of more than 90% situated mainly in the North Zone.

The area ranging from a very light blue to white represents the the zone with scarce vegetable covering made up of xerophilous communities of *Larrea cuneifolia* (Arum) of small size, and with abundant muddy soil (Salinas et.al. (1995).

**Supervision in the ground:**

Observations of the field were made in order to supervise the research carried out at studio. Such reasearch was carried out by means of a line in a slope direction approximately from West to East, going through areas hydrologically related and by keeping in mind the indicators that arose from the visual interpretation of the image. They are:

- Difference between river-beds and gullies that can be seen from the transversal profile of the meanders.
- Form of the accumulations of fine material as indicator of silting up areas.
- Bush base, buried or on pedestal, as an indicator showing erosion or accumulation.
- Bare lands formation due to the death of bushes as an indicator of ground of gullies.
- Bush colonization by Senna aphyla (Bass broom) as an indicator of overgrazing, Kiesling(1994).
- Shape and location of bare lands, as an indicator of farming, stockbreeding and human settlings.
- Distribution, location and vegetal covering of the gullies.

Three lines of about 10, 14 and 9 kms were traced in slope direction keeping in mind the delimitation of the homogeneous areas of the images.

## 5 Results, Conclusions and Suggestions

A good visualization of the analized features, tonalities and textures related to hydric erosion phenomena was achieved by processing digitally the image combination 4,3,1 where channel 3 was highlighted with a high pass filter allowing to mark again lineaments, borders and edges.

The indicators used at the stage of supervision of the field (difference between river-beds and gullies; shape of the accumulation of fine material; bush base: buried or on pedestal; bush colonization by Senna aphyla (Buss broom); shape and location of bare lands; distribution, location and vegetal covering of the gullies), played an important role in the description and correlation of the information of the field with the subzones seen on the ground.

As from the analysis, it is possible to distinguish three zones following an intinerary from west to east beginning at the gullies area (zone a - fig 1), following through the zones of agricultural exploitation (zone b - fig. 1) with watering places, zones of sacrifice and bare lands and ending at silting up areas (zone c - fig. 1) and

river-bed of del Valle river. This zoning was clearly remarked at the North Zone of poor arboreal covering with white Quebracho of a big size as well as at the South Zone characterized by a privailing, homogeneous and abundant arboreal covering.

As from the stage of ground supervision, it is deduced that the direction followed on the lines in slope direction was the most appropriate because it allowed the supervision of the three areas hereinabove mentioned.

It is convinient to stand out that the profit of the method of supervision used is to make remarks taking the maximun advantage of time and budget.

When the silting up zone was examined

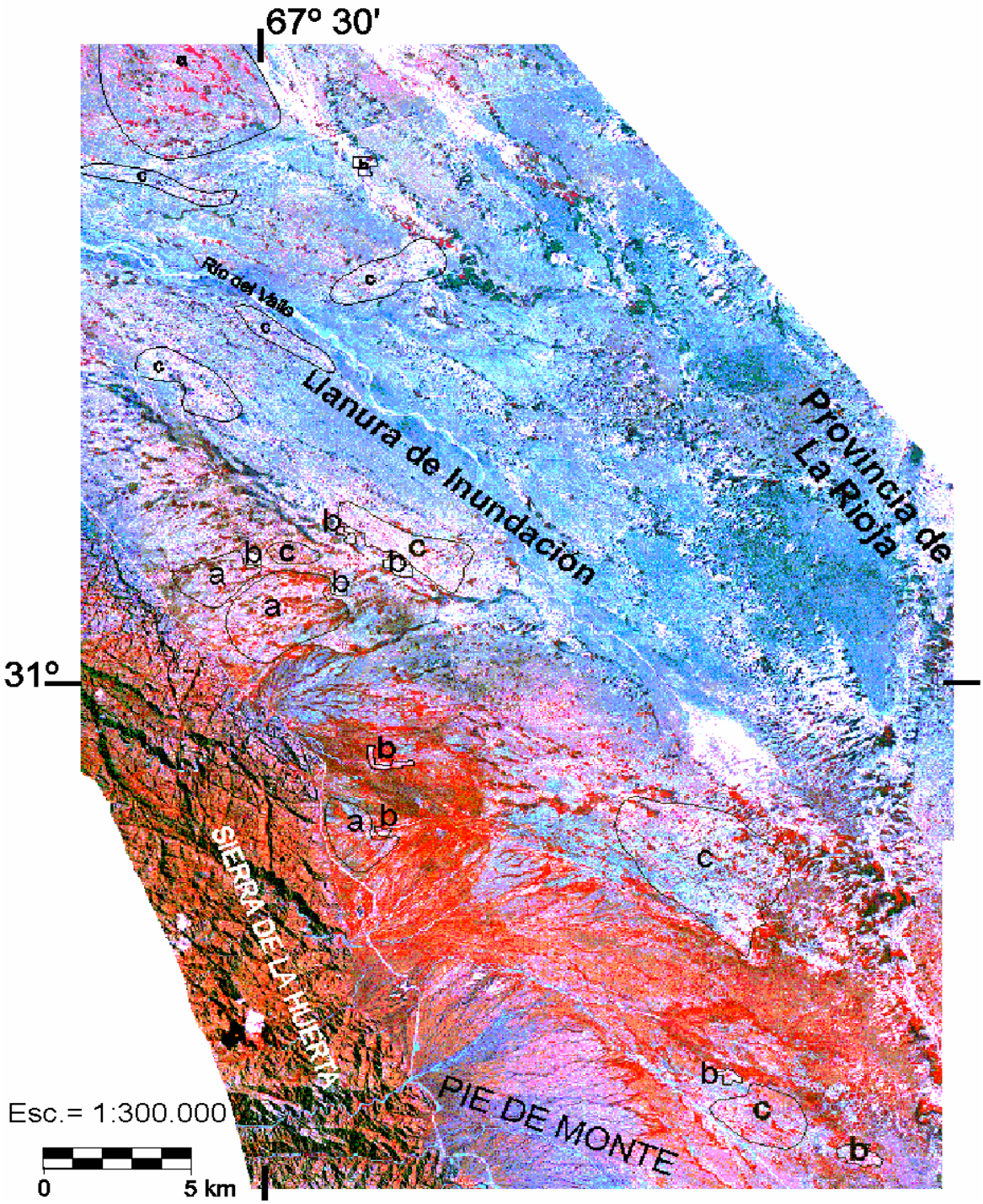


Fig.1- a)- Ground of gullies, some with a defined texture just by disordered bare lands, others by an abundant vegetal covering along the gullies. b)- Exploitation areas, with even textures and borders, with the biggest proportion of bare soil. c)- Ground of river-beds and low grounds siltation with bare soil and vegetation in the from of islands.

transversally during the supervision stage, it was distinguished due to the existance of accumulation of fine, compressionless material, from 2 to 5m wide, that alternated between 10m to 100m along the whole trail. Besides, it was found that there were buried bushes in this zone. However, it was also found that there were bushes on pedestal and accumulations of fine, silting up material in the areas where erosive processes superposed to sedimentation cycles are taking place.

The horizontal relationships of the bounded areas continue to support the hypothesis of this research. This together with the information provided by the image processing will allow the elaboration of a successional pattern in second degree where the later development of the area will be determined by the current state and will depend on how such state is reached.

This pattern will allow the prediction of the development of the areas keeping in mind the type of usage and the management of the neighbouring and hydrologically related areas of exploitation.

The knowledge provided by the processing of multitemporal images together with this pattern will improve the way of management and recovering of forests and grazing fields in the arid and semiarid alluvial plains.

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Fig.2- Panoramic photography of the South of the area under study, Alluvial plain and temporary river with a small slope, the vegetal formation is that of the dry Tropical wood.

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