GIS APPLICATION FOR IRRIGATION DEVELOPMENT IN NEUQUEN PROVINCE, ARGENTINA*

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ABSTRACT

Neuquen Province in southwestern Argentina lacks adequate precipitation for sustained agricultural production. The Government is interested in the assessment of the region for irrigation development. The analysis reported in this paper is a portion of the information provided to assist with that assessment.

A Geographic Information System (GIS) was developed using the Earth Resources Data Analysis System (ERDAS) to interact data from a variety of resource maps. The Landsat image was analyzed for basic cover types. These cover types were matched with the resource maps to provide a basic assessment and prioritization of the areas suitable for irrigation development.

The land cover information from the Landsat data was combined with slope information to illustrate where conservation practices would be needed before any irrigation development could take place. An overlay of vegetation and drainage showed suitable sites for development of surface water for irrigation purposes. Additional overlay capabilities were developed to assist the Province in planning for many future agricultural production activities.

1. INTRODUCTION

Neuquen Province is located in southwest Argentina as shown in Figure 1. Chos-Malal in Figure 1 is located at 37°23'S, 70°17'W at an elevation of 848 meters. The study area is located in northern Patagonia, an area which is characterized by dryness, intense solar radiation and high velocity of the prevailing westerly winds. The mean annual temperature for Chos-Malal is 13.6°C (mean maximum in January, 21.2°C; mean minimum in July, 6.6°C), and the mean annual relative humidity is 44% (with a maximum of 58% in July and a minimum of 33% in January).

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LOCATION OF THE STUDY AREA IN NEUQUEN PROVINCE, ARGENTINA.

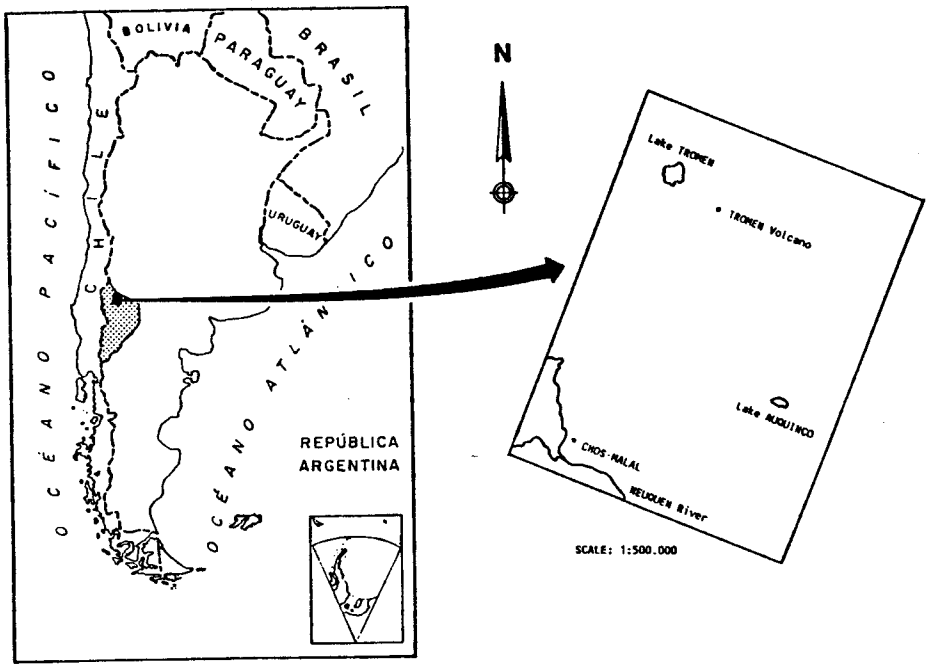

Figure 1

The total annual precipitation is about 240 mm with the highest rainfall concentration between May and August. The summers are dry: between 6-10 mm per month from December through February. The average wind speed is 2.5 meters per second annually with the prevailing direction from the northwest. These winds are characterized not only by their presence all year round but also by their intensities.

Goats, sheep, and some cattle occupy the rangeland areas. In the valleys, particularly in the Neuquen River valley, agriculture is practiced. There appear to be possibilities for more irrigation for growing horticultural crops, cereal grains, and orchards.

The predominant vegetation types of the area are shrubs and grasses with sparse vegetation in areas where the water table is near the surface ("vegas" or "mallines", organic soils). The geology is characterized by sandstone and limestone from the Cretaceous Period with volcanic basalts, andesites, and similar volcanic materials from the Pleistocene Period. There are also accompanying sand, gravel, and silt alluvial material with extensive areas of sand- and mudstones. The geomorphology is characterized by areas of relief of volcanic fields, lava flow with many terraces and alluvial plains. Erosional surfaces are common in some of the steeper areas.

The major objectives of this study were to:

1. Create a geographic information system for the study area in Neuquen Province as an aid to management decisions.
2. Demonstrate useful applications in the form of interpretive maps for development, management and conservation of natural resources.

2. DATA PREPARATION

A Landsat frame dated 20 January 1976 was obtained from the EROS Data Center. Data from band 4 (0.5-0.6 micrometers), band 5 (0.6-0.7 micrometers), band 6 (0.7-0.8 micrometers), and band 7 (0.8-1.1 micrometers) were downloaded to a cassette tape for use on an ERDAS analysis system.

A subset of the Landsat scene covering the study area was used in the analysis process. This subset containing 1,024 x 1,024 pixels was rectified to match the maps which were digitized for use in the study. Eight ground control points were used to compute the transfiguration matrix. All control points were easily identified on the Landsat image and on all the maps.

The image was rectified, rescaled to a 100 x 100 meter pixel size in order to match the data base, and a new subset of 512 x 512 pixels was obtained and incorporated into a data base. A land cover classification was formed from the original Landsat scene using a combination of unsupervised and supervised approaches or "modified supervised approach" as defined by Fleming et al., 1975. The Fleming approach is essentially a hybrid of supervised and nonsupervised analysis methods. A "cluster" algorithm was used in the nonsupervised approach. This algorithm classifies individual data points into a predefined number of spectrally separable clusters. A "supervised" approach was used to generate statistics of 3 cover types: lake water, river water, and lava flows.

Statistical files produced by these two approaches were used to run a "nearest neighbor" algorithm to classify the entire area. Thirty-three classes were obtained and analyzed and then combined into 17 final classes. This land cover classification was then stored as a GIS file.

The maps obtained from the Government of Neuquen Province, the Military Geographic Institute and the Federal Council of Investments were digitized using a GTCO digitizing tablet. A cell size of 100 x 100 meters was used to create a data base of 1:500,000 scale. The data were rasterized and stored in a grid cell size structure.

The following maps were digitized:

Map	Scale	Source
Vegetation	1:500,000	Government of Neuquen Province
Drainage	1:500,000	Government of Neuquen Province and Federal Council of investments
Geology	1:500,000	Government of Neuquen Province
Geomorphology	1:500,000	Government of Neuquen Province
Elevation	1:500,000	Government of Neuquen Province
Slope	1:500,000	Government of Neuquen Province
Topographic	1:500,000	Military Geographic Institute

Interpretive maps were obtained using different programs. The erosion and slope maps were first obtained using the matrix program which analyzes two GIS files and produces a new one which contains classes that are combinations from the input files. The map was then produced using an overlay program which

allows one to combine the GIS files and create a new file by masking out information. The overlay program was used to combine the following files:

geomorphology plus drainage
erosion classes plus slope classes
vegetation ("vegas") plus drainage
vegetation ("vegas") plus drainage plus roads.

The matrix program was used to combine erosion classes plus slope; and vegetation ("vegas") plus elevation.

3. RESULTS AND DISCUSSION

The first visible product of this project was the ability to provide all the maps and the Landsat raw data and classification at the same scale. This capability does not exist in developing countries that one can provide maps of the same scale or even overlays in a system to interact information from two or more maps.

The geomorphology map provided some general characteristics about the soils that one can then expect to find within the different regions. If a detailed soil map were available, one could make maps showing the suitability for different crops based upon soil properties. In view of the situation in the study area, it should be noted that the maps accumulated for this study would be extremely useful to a soil scientist in the field for developing a mapping strategy and for accomplishing a detailed map with greater predictability. The use of the geology, geomorphology and topographic maps would also greatly aid the mapping process.

The Landsat image was extremely useful for differentiating areas that support healthy green vegetation. By looking at the geology maps and land cover maps, one could readily determine some possibilities for irrigation, especially when viewed in relationship to the proximity to water. In this case, the proximity to water could be determined by the possibility of constructing reservoirs along the major streams. Ground surveys in conjunction with these maps would be invaluable in planning for expanded irrigation in this province.

Some general conclusions drawn from this effort are:

1. Maps from a variety of sources can be combined for producing useful products.
2. Incorporation into a data base makes it possible to understand and display relationships between and among landscape parameters.
3. The maps developed for the study area are useful for soil scientists formulating a strategy to produce a detailed soil survey.
4. Combining existing information in a GIS consists of forecasting potential areas for agricultural development.

REFERENCE

Fleming, M.D., J.S. Berkebile, and R.M. Hoffer. 1975. Computer-aided analysis of Landsat-1 MSS data: a comparison of three approaches including a modified cluster approach. LARS Information Note 072475. Laboratory for Applications of Remote Sensing, Purdue University, W. Lafayette, IN USA

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