APPLICATION OF THE USER-GIS INTERACTIVE PROCESS TO DELINEATE BOUNDARIES OF BIOPHYSICAL ENVIRONMENTAL UNITS FOR LAND MANAGEMENT: A CASE STUDY IN BAJA CALIFORNIA, MEXICO

Jorge López-Blanco
Institute of Geography, National University of Mexico.
Ciudad Universitaria, Ap.Postal 20-850, C.P.04510, México, D.F.
Phone (525) 6224335, Fax (525) 6162145, e-mail: jlblanco@servidor.unam.mx

Abstract

This paper presents the final results of the application of the User-GIS Interactive Process to delineate environmental mapping units using a geomorphologic approach. These units are the main spatial framework to search the landuse suitability for landscape sets. The results were the basis to propose natural resources management policies for the Municipality of Los Cabos, Baja California, Mexico. The use of a GIS was useful to interpret and determining the boundaries of environmental units, particularly in the interactive process of *on-screen digitizing*. The landscape unit map was crossed against several thematic maps to obtain a tabular database that describes area and cover percentage of each thematic class for each landscape. The map of landscape units and its database led, in further phases, to define landuse suitability related to an environmental land management approach by means of techniques of multivariate analysis.

1 Introduction

This research is part of the *Study of Environmental Management for Urban and Tourism Activities of the Municipality of Los Cabos, Baja California Sur, México* which was carried out under an agreement of technical cooperation between The Government of Mexico and The Organization of American States, with the objective of carrying out land management projects in priorities geographical regions [1]. Ecological regionalization is the first step in determining the environmental management of any portion of the territory. The process consists of delineating units with reasonable homogeneity with respect to parameters related to the biophysical environment. Geomorphologic approach has been applied in several fields of resource surveys and environmental research, particularly during the last few decades [2].

The aim of this paper is to present the final results from the application of User-GIS Interactive Process to delineate environmental mapping units in the context of a geomorphologic approach. These units are the main spatial framework for seeking the land use suitability for landscape sets in the context of a geographic information system (GIS).

2 Study Area

The study area is located in the cape region at the southern end of the Península de Baja California (Figure 1). It lies between 22°50' to 23°45' N and 109°25' to 110°15' W. Specific boundaries of the study area were defined for the external limits of the environmental mapping units, while trying to cover at least an area larger than the administrative limits of the Los Cabos Municipality. It has an extent of 4,768 km^2.

2.1 Biophysical and Human Environment

Climate types in the study area are mainly warm (arid or semiarid) with a summer rainy season. The average annual rainfall in the piedmonts and alluvial plains, ranges between

250 and 350 mm, and in the ridges from 650 to 750 mm. The altitude ranges from sea level to 2100 m. Dominant geologic features are Cretaceous granodiorite-tonalite (38%), Quaternary conglomeratic deposits (18%), and Cretaceous granite (11%). Mainly regosols and lithosols (FAO soil types [3]) cover piedmonts and ridges, respectively. On small areas fluvisols are located in the alluvial plains. Sarcocaulescent shrub and tropical deciduous forest are the dominant vegetation types; the former on piedmonts and hills, and the latter on mountain slopes. Pine and oak forest communities are located only in the highest areas of the Sierra de La Laguna.

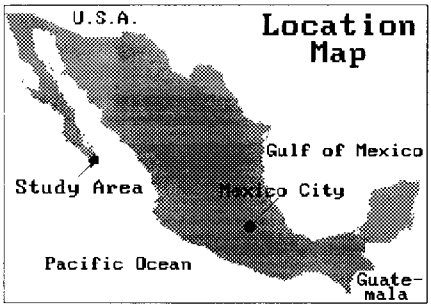

Figure 1: Location of the study area.

Due to the numerous natural attractions of the cape region, the government and private promoters have invested for the last 15 years in tourism and sports-fishing activities. These are the development axes of region. Such activities contribute significatively to the total production value in the state. Other productive activities in the cape region are livestock and agriculture. A tourism corridor exists between the two main cities in the region, San José del Cabo and Cabo San Lucas. This is the biggest tourist and urban area in the Los Cabos Municipality, and it is considered a touristism growth pole.

3 Methods and Materials

A GIS is a technology that permits one to collect, store, retrieve, and process different classes and multiorigin, spatially referenced data. In this context, GIS is the most useful tool with which to apply the geomorphologic approach to delineate environmental units. The information was processed in ILWIS [4], a GIS installed in a PC-AT computer. The following paragraphs explain the method used:

The existing data on geomorphologic studies and major environmental units were consulted and compiled. The following thematic maps at 1:250,000 scale were digitized: land use and land cover, soil classes, lithology and chronostratigraphy, climatic effects, climate types, isotherm gradient, and average annual rainfall. Contours from topographic maps (scales 1:250,000 and 1:50,000) were digitized, every 100 m contour line in steep mountainous areas and every 20 m contour in alluvial and coastal plains. The contour-segment file was rasterized and then interpolated to generate the Digital Terrain Model (DTM) [4, 5, 6].

The DTM of the study area was processed to create several relief-features maps using filtering and classifying tables with GIS capabilities. The maps generated were: altitude, slope gradient, aspect, hillshading, and three-dimensional sights [4]. Since the maximum resolution of the graphics screen was 640 columns and 480 lines, the pixel size of the raster

who serve the public in carrying out their research and teaching. The report, in fact, featured descriptions of several exemplar projects from across campus.

3 Definitions

In describing the favorable climate for service projects in higher education I have defined the term "outreach." But I purposely chose the word "service" in the title of my paper. The terms are closely linked but are not, in my mind, synonymous. Outreach refers specifically to a relationship between the university and the outside world. The term service implies doing something for someone else but could, potentially, be a much more private activity. Also, outreach tends to conjure up an image of a broad, institutionalized activity such as the agricultural extension service or a program of seminars for legislators or an offering of an educational degree at an off-campus location. I use the term service because it is a broader term. There is no doubt, however, that the outreach discussion in the U.S. is having a positive effect generally on the notion of including service projects of all sorts in one's teaching and research.

There are two categories of service that might best be distinguished for purposes of discussion here: public and non-public. When I use the adjective "public" I am referring to service to a non-profit organization, a charitable group, or a government agency or some entity that exists under the aegis of government at any level. The adjective "non-public" would refer to service to a commercial firm, an organization that is restrictive in membership, or some similar entity. Some cartographic projects are public service ones, others are non-public service.

4 Examples of cartographic service projects at MSU

Before describing several projects that students have carried out in my own classes, I want to stress that the notion of having students do this type of work did not originate with me. I suspect that many, if not most, cartography instructors have involved students in similar activities, and Bill Loy at the University of Oregon has shared with me some fine products from his class that fall into this category. I have numerous other role models as well who have influenced in one way or another the development of this service aspect of my classes. I hope, however, that my indulging in descriptions of my own students' work will be useful in promoting a dialogue about service activities in the cartographic classroom.

4.1 The full-color map project

In our current advanced course entitled Map Production and Design and in its predecessor entitled Map Design, a standard assignment has been a full-color map to be printed later (usually as postcards) by the Printing Department or commercial firm. Students must produce everything through plate-ready negatives or final computer file. Individual students must decide on topics for their maps, and they are strongly encouraged to pursue a map that will be useful to someone. "Someone" can be almost anyone, but students are particularly encouraged to seek out *either* organizations in charge of public sites or facilities *or* public or non-public organizations willing to help us with printing costs. Students are to work with a contact person to assure that the map is as useful as possible. They are also encouraged to do a "how-to-get-there" or similar map rather than a thematic map because they have already had considerable experience with the latter and the alternate type introduces a marvelous and informative new collection of design problems .

Examples (from the most recent offering of the class) of color maps that have been produced to serve others include:

"Dominican Republic" (Julie Burns). The state of Michigan has a special relationship with the Dominican Republic, which is noted on the postcard and which is promoted and served by the map.

"Credit Union ONE" (Chad Knott). Since the subject of the map is a commercial entity, this map is a non-public service project. It shows clearly the locations of all the Detroit metropolitan area branches of this financial institution.

"Frances Park" (Michael Clifford). A public park in Lansing, the postcard shows how to find it.

"Betsie River Public Access Sites" (Randy Harden). A recreational river in northwestern Michigan, the Betsie has several places where canoes can be launched. The map is a clear guide to finding them.

"Wilderness State Park" (Dennis Clark). A park with a variety of nature trails for public enjoyment, this map guides the visitor to the park and to trails of suitable length for individual level of fitness or time availability.

"Patriarche Park" (Kristie Pfeifer). A public park in East Lansing that is the site of many group gatherings from wedding receptions to family reunions to public gatherings, the map shows not only its location but the arrangement of facilities within the park.

"Community Based Programs--MSU College of Human Medicine" (Janet Murray). This map shows the seven sites, scattered throughout Michigan, where MSU medical students train. It is to be used by the College's admissions office as an informational piece.

"Central Michigan Earthquake, 2 September 1994" (Kevin Mackey). Earthquakes in Michigan are unusual, but one centered several miles to the southwest of Lansing and measuring 3.4 drew considerable public interest. Numerous people in the area contributed reports and descriptions that allowed mapping the impact, and the postcard will be used to thank those individuals for their contributions.

"4-H Children's Garden" (Devin Black). Depicting a small but highly varied area, this map is one of the most creative solutions to a tough design problem--showing 34 garden sections in the space of a postcard. The mimetic symbols on the map with descriptive labels nearby (but not placed as direct labels) should give children and other visitors just enough information to challenge them to notice more completely the garden's contents.

"W. J. Beal Botanical Garden" (Julie Flagg). An update and modification of an earlier map (by Mark Cowell), the new version will continue to serve MSU's botanical garden. The supply of the original map had been exhausted, changes had been made to the gardens, and the request from Garden personnel came at just the right time for a student to take it on.

"MSU Attractions" (Laura Clark). A map of the MSU campus showing sites to visit, this map will be used by such clients as the Kellogg Center, which has overnight accommodations for visitors to campus. The map shows where to find various gardens, sports and recreational facilities, and interesting but not so well-known displays such as the