FIRST 12 MONTHS ACTIVITIES REPORT
EC Contract number ERB IC18 - CT98 – 0262

UNIVERSIDAD NACIONAL DEL CENTRO DE LA PROVINCIA DE BUENOS AIRES (Partner 3)

Scientific Coordinator: Dr. Graciela Ana Canziani

The group at UNCPBA is formed by members of NUCOMPA:
Dr. Graciela Canziani, Professor, Mathematics and Mathematical Ecology,
Ing. Rosana Ferrati, Engineer in Hydric Resources and Graduate student in Mathematics,
Lic. Paula Federico, Graduate student in Mathematics,
Ing. Ana Canónica, Engineer, Computer and Systems Engineering.
Starting on November 1st. Diego Ruiz Moreno, advanced student in Computer and Systems Engineering will join this group.

And also by other Faculty members who devote part of their research time to the project:
M.V. Fernando Milano, Professor, Natural Resources and Sustainability, Facultad de Ciencias Veterinarias,
Dr. Marcelo Gandini, Professor, Ecology, Remote Sensors, Facultad de Agronomía,
Dr. Roberto Sánchez, Professor, Environmental Management, Facultad de Ciencias Humanas.

As previously assigned, this group participates in the development of several different tools and models to be used by other project partners:
i. Hydrological models
ii. Dynamic vegetation maps
iii. GIS to organize in systematic form data provided by previous and present studies on the region
iv. Population models for several species of macrovertebrates that are particularly important relative to the management of resources.

As stated in the work plan, in the first months we focused our efforts on gathering the largest possible amount of bibliographic data from previous studies and historical data series recorded by official institutions. Data has been duly organized for later use in models. At the same time we have exchanged information and opinions with other modeling groups in order to define more precisely the models to be developed based on actual reliable data. This is a process that begins with an initial rough approach and continues with steps of successive refinements. We already have some interesting partial results on the statistical analysis of data that are essential in the development of the hydrological model and the vegetation map. The tasks that are being carried on by this group are:

Historical Data Collection

Historically data have been collected and recorded by several different national and provincial public institutions and are therefore quite scattered. In general, it is difficult to have access to the information for the institutions are jealous of their property and often becomes necessary to take some indirect paths in order to convince them that we will make proper use of their data. Gathering the data series has been a time consuming task. We have organized them in a database that will be coupled to the GIS and the models. See Annex for list of institutions, data collection periods, localization and type .

i. Hydrological data

We have dedicated a lot of effort to the task of gathering hydrological data because it is essential to have a reliable hydrological model as the basis for all the other models. This is an aquatic ecosystem so that practically all the processes considered in the project are related to water levels. Available data corresponds to:

(a) Hydrometric levels:
- Laguna Iberá at Colonia Pellegrini. The time series was collected from 1968 until today, with some important gaps (see Plot 1)
- Rio Corriente at Paso Lucero. The time series was collected from 1968 until today.
- Other hydrometric level data have been collected during the period of studies performed for the Macrosistema Ibera Study but these are very short term series (1969-1979). The hydrometric scales have been abandoned since then.

(b) Volume of water at Paso Lucero control section (maximum instantaneous flow and minimum instantaneous flow). This series, collected from 1968 until 1995, is important because Rio Corriente is the only permanent surface flow out of the system.

(c) Bathymetries: They were performed as part of the Macrosistema Ibera Study (1981). There are 12 bathymetric profiles, 10 belonging to the region South of the Itati Lagoon, one from the Ibera Lagoon to the San Antonio Cue Estero, and one across the system from the Fernandez Lagoon to the Carambola Stream. All of them are on the Southernmost portion of the system (see Plot 2). No other bathymetries were ever performed within the Ibera system except those recently done by our partners at Laguna Ibera.

ii. Meteorological data

Meteorological data are collected nationwide by the Servicio Meteorologico Nacional (SMN), which charges very expensive fees for it. We have obtained our data from secondary sources, which have worked with the SMN data and checked for consistency. Available data were obtained

(a) from meteorological stations in the peripheric region of the Macrosystem Ibera, at Corrientes, Gral. Paz, Mercedes, Monte Caseros, Paso de los Libres, Ituzaingó, and Posadas. These stations belong to the Servicio Meteorologico Nacional. Data from the stations at Gral. Paz and Ituzaingó, which are the closest to the system, are incomplete. Available data series cover from 1900 till 1986.
Other historical data series have been obtained from NOAA.
Recent data (1994-98) obtained from NOAA Web Pages include:
Precipitation

Temperature (maxima, minima, mean, daily)
Dew point (mean)
Mean sea level pressure
Mean station pressure
Mean wind speed

(b) from stations within the Ibera bassin: Colonia Pellegrini (daily precipitation since 1968 with gaps), Chavarria (daily precipitations, 1976-98), Estancia Arroyo Pay Ubre (daily precipitations, 1984-99 with gaps). There are also registers of data in several other points published in the Macrosistema Ibera Study.
(c) from radio soundings performed daily and published in the Web by the University of Wyoming (the address is http://www-das.uwyo.edu/upperair/sa.html) and it includes information from Resistencia and Foz do Iguaçu..

iii. Soil data

A soil map (scale 1:500 000) of the Province of Corrientes was obtained from the Instituto de Suelos of the Instituto Nacional de Tecnología Agropecuaria (INTA). Classification is done on the basis of Subgroup level following the Soil Taxonomy System of USDA. Researchers working at Instituto de Suelos have volunteered their assistance in matters related to agricultural use of soils surrounding our study region.

iv. Bibliography on vertebrates

We obtained a reasonable amount of publications from different sources and contacted researchers working on the macrovertebrate species included in the project.

Satellite Images and GIS

In view of the launching of a scientific satellite, the Comision Nacional de Actividades Espaciales (CONAE) offered to the scientific community the possibility of participating in Mission SAC-C. A total of 81 proposals -- among which is this INCO DC project-- were selected to take part in the use of scientific data collected by a set of instruments furnished by Space Agencies of Argentina, USA, Brazil, Italy, France, and Denmark. Moreover, SAC-C, to be launched in mid-December this year, will be part of the International Morning Watch Constellation together with satellites Landsat 7, EO-1, and TERRA from the USA. This gives us an extraordinary opportunity for using high quality data and images almost in real time, and the possibility of exchanging information with many other research groups participating in Mission SAC-C.

The information obtained from satellite images is most valuable for our project, particularly considering that the region of study is vast and difficult to explore. We have found extraordinary support from Dr. Raul Colomb, Director of Mission SAC-C, and his collaborators, so we can anticipate a very fruitful working relationship with them.

i. Historical satellite images

We obtained from CONAE, LANDSAT images (all channels) from the years 1985-86. We chose these years because water levels were at one of the lowest levels registered since the use of satellites. We are also working with NOAA satellite images from 1992-93.

ii. Mission SAC-C images

Because of our participation in Mission SAC-C, CONAE has given us a false SAC-C format image for study. The SAC-C satellite will be launched next December and will provide images every 9 days. It is part of the International Morning Watch Constellation of satellites (CONAE, NASA, ASI) that will cover the region for scientific purposes.

iii. Digitalized topographic maps

We purchased from Instituto Geografico Militar a collection of topographic maps (scale 1:100 000) that cover the Ibera region. They are currently being digitalized in order to be incorporated to the GIS.

We are working on the development of dynamic vegetation maps using satellite images obtained from CONAE through our participation in Mission SAC-C. These together with by field data (GPS polygons) provided by Thomas Waller (Foundation Reserva del Iberá) and Patricia Gantes and Fernando Momo (UNLU) will allow the regional environment characterization. So far, field data is not complete, but we are attempting an initial subdivision in distinct environments from simulated images using the data we already have.

Hydrological Models

As stated in our previous report, we are working on the construction of a water balance model with monthly time step. From the existing bibliography on previous studies we can conclude that only yearly water balance models had been done until now. One problem we have encountered is due to insufficient or incomplete data on precipitations caused by isolation of the region and distance to meteorological stations. We have not been able yet to obtain historical series of temperature data. One considerable problem we face is the fact that both historical and current data are temporally and spatially meager. The reason for the former is that data series from local stations are short and hence not too reliable. Spatially, the long range series belong to stations located outside the system. Also no information about underground water flows seems to be available. We are attempting contacts with people from Ente Binacional Yacyreta (EBY), which controls the dam on the Parana River, North of the Ibera region.

If we can obtain the above mentioned data, the water balance model can be built and fed with data from peripheric stations as a first approximation and based on the previous study Macrosistema Ibera. Here the data provided by our own hydrometric and meteorological

stations located at Laguna Galarza, Laguna Ibera, and Concepcion are crucial, firstly because data needed to compute evaporation and evapotranspiration have to come from within the system, and secondly because precipitation data (historical and current) from within need to be correlated to data from the periphery in order to reflect spatial distribution and behavioral patterns.

The second model we are working on is a model for flows within the system. Again difficulties arise from the huge area of the system and the fact that studies performed cover only a reduced portion of it. As mentioned before, the only bathymetries ever performed have been concentrated on the Southernmost portion of the system. Other partners have done bathymetries on Laguna Ibera and Laguna Galarza. We are exploring the possibility of using object oriented programming to overcome difficulties that can not be handled through the use of classic models.

Ecological Models

Both the hydrological models and the vegetation map will be used to generate a Geographic Information System to be used as a basis for the population models with spatial structure (heterogeneity of habitat, habitat quality, etc.).

Our group is working on the models for populations of macrovertebrates for capybara or carpinchos (*Hydrochaeris hydrochaeris*) and marsh deer or ciervo de los pantanos (*Blastocerus dichotomus*) which represent a valuable attraction for ecotourism. The study of the dynamics of capybara populations will require a size structured model. Capybara reproduce very fast and might require some harvesting in order to keep the populations free from the threat of epidemics, so that a model of population dynamics with harvesting will also be developed in order to analyze the validity of this option. At this point we are reading the bibliographic material already gathered, consulting Dr. Ruben Quintana, expert on capybara at Universidad de Buenos Aires. We are focusing on the computation of parameters appropriate for the models, as well as the ranges for variation in the simulations.

Marsh deer, due to their very low numbers and habitat reduction caused by a rise in water levels, seem to be at risk of extinction. In particular we have to consider developing models that take into account habitat quality on one hand, and their complex social structure and behavior on the other, so that individual-based models seem appropriate for this purpose. We anticipate some difficulties arising from of the need of very detailed data, but bibliographic information and the studies previously and presently performed by researchers working with Fundación Reserva del Iberá seem appropriate and deep enough. All modeling groups (UNICEN, UNICAMP and UFRGS) are maintaining interactions with Dr. Marcelo Beccacesi and Tomas Waller who are carrying on field research.. The integration between groups of modelers is being assured by a partition of tasks covering different aspects of a single population in order to produce simulation scenarios that could answer the questions proposed by the users/managers.

Another point we are analyzing is the implementation of the interface between the layers of the GIS and the mathematical models. The interface between the GIS and the models

through scenario simulations should generate a visual output for easy interpretation by the user/manager. For each scenario analysis, the simulations will require that a set of parameters be attached to each pixel. Some of those parameters will feed the models, while others will be updated by the models' output as the simulations run.

Plan of Future Developments

From our point of view, the project started when we finally received the funds at the beginning of February 1999. We feel that we have been able to keep the pace of our work within the work plan and timetable of our project. Some delays are due to the difficulties in having access to historical data records, and to the gaps in some of the data series. Others are due to fact that some information is simply non existent. This affects mainly the hydrological models and forces us to look for alternative modeling approaches. We are somewhat behind schedule in the implementation of the GIS, but consider that this can be easily recovered. Besides we are expecting field data collections by other partners that have not been completed as yet.

It is worth noting that Lic. Paula Federico received a scholarship from the Comisión de Investigaciones Científicas de la Provincia de Buenos Aires for developing her research within the frame of this project and in view of obtaining her Masters Degree in Mathematics. This allowed our group to incorporate a young student, Diego Ruiz Moreno, who is working on his Thesis in view of obtaining his degree as Engineer on Computer and Systems Science.

The tasks to be developed by this group and numerous and time consuming, so there is a need for more people working on them. We will try to involve advanced students in short duration specific tasks, but is necessary to consider some retribution in order to assure their dedication.

Future work includes:

GIS and vegetation maps

Homogeneous zones within the Iberá macrosystem will be defined based on Reca and Pessina (1983), with best spatial accuracy, and discrimination between "bañados", "esteros", "lagunas" and "embalsados" will be attempted. This will serve as a basis for the calculation of total area covered by each type of environment. These data will be entered as ground truth for the classification of Landsat TM imagery, and a validation of low human intervention zones will be attempted, based on the variation of the greenness index (NDVI) at 1Km resolution. This variation, correlated with field data, will serve as estimate of the primary productivity of macrophytes. We expect this to be completed, at least for several well identified environments, in three months. Then we will continue refining the results by incorporating information received monthly from the satellites of the Morning Watch Constellation and field data from our partners.
We will develop other layers in the GIS, including the soil map, the topographic map, etc. We will analyze changes in the system by comparing historical satellite images and new images provided by CONAE.

Hydrological Models

(a) Global water balance

The Iberá Ecosystem behaves as a consolidated natural system responding to a function which main characteristic is the water storage. The main input variables are precipitation and the evapotranspiration demand. The main overflow is the discharge to the river Corrientes. The underground water may behave as an input or an output of the system and it is likely that it assumes both capacities in different places and times. In first instance it may be included as a variable of the state of the system, being assumed as making part of the storage. The underground input resulting from the Paraná river in Rincón Santa Maria is excluded, taking it as an input volume to the system.

(b) Evapotranspiation

In selecting the method to be used to evaluate a first approximation of the evapotranspiration due consideration will be given to the previous work developed in the study area and the available processed data. In the study " Macrosistema del Iberá", made in 1981, EVT was computed using the Thornthwaite´s method (1948), with the mean monthly temperatures from the meteorological observation stations in Goya, Corrientes, Posadas, Paso de los Libres and Mercedes, operated by the National Meteorological Service (SMN), as taken from the climatological series 1931-1960.

In this regard, there are two issues to be analyzed in the computation developed using this method. From one side, the Thornthwaite empirical method achieves good results under conditions different than those shown by the ecosystem. This method tends to overestimate EVT when the temperature mean monthly values exceed 26º.5 C. In addition, the above mentioned observation stations are outside the macrosystem. In this regard, recent studies undertaken in Brazil, propose a correction coefficient for temperatures above 26º.5 C and another one for the photo-period, which adjust the computed evapotranspiration taking into account the latitude and longitude of the station. Taking into account this point, the project will evaluate a first approximation of the EVT on the mean monthly temperature data, as published in **The 1961-1990 Global Climate Normals, of the WMO – CD-ROM**, for the stations Corrientes, Posadas and Paso de los Libres and an extrapolation with temperature data from NOAA, for the year 1994 to 1997, will be made.

FAO recommends the Penman-Monteith Method from a total of 20 methods to be applied in humid zones, based on studies performed by the American Society of Civil Engineers (ASCE), in 1990, and by the European Community, in 1992. On the executable form FAO offers in its WEB Page, the data obtained from the WMO _ CD-ROM for the stations at Corrientes, Posadas and Paso de los Libres will be plotted for comparing them with the values obtained by applying Thornthwaite's Method

The project's meteorological stations located in Galarza, Iberá and Concepción generate the data from within the ecosystem required to compute the evapotranspiration.

(c) Precipitation

Based on the rainfall data compiled up to date, the analysis of the historical series available from the neighboring observation stations will be undertaken both for the annual and monthly precipitation values.

In respect to the observation stations located inside the ecosystem, which, in a general way, are of short record, the data will be contrasted/controlled to analyze their consistency.

Ecological Models

We expect to complete in the following months the task of determining the parameters that will be used in the models. This will be done using data published in research journals and from information gathered from personal communications with experts in these species. Next we will build and validate the models and later tune them using field data. We expect to complete the process in the next 12 months.

We anticipate some difficulties in the determination of stage or size dependent fertility and survival rates because we have not found yet any specific studies, but will try to develop a methodology to obtain these from existing data.