Available online at www.sciencedirect.com
SCIENCE DIRECT®
Ecological Modelling 186 (2005) 3–15
ECOLOGICAL MODELLING
www.elsevier.com/locate/ecolmodel

Esteros del Ibera: hydrometeorological and hydrological characterization

Rosana Ferrati *, Graciela Ana Canziani, Diego Ruiz Moreno

Mathematical Ecology Group, Facultad de Ciencias Exactas, Universidad Nacional del Centro de la Provincia de Buenos Aires, Campus Paraje Arroyo Seco, 7000 Tandil, Argentina

Available online 26 February 2005

Abstract

The objective of this work is to analyze at a regional scale the hydrometeorological and hydrological characteristics of the Esteros del Ibera, a vast freshwater wetland located in NE Argentina. Since water is the main driving force in the inland wetlands and variations in water level impose conditions on the behavior of vegetation and animal populations, the knowledge of the main hydrometeorological variables that affect the hydrology is essential. Data correlation analysis makes it possible to evaluate the observed changes in the wetland and to infer its response to regional climatic change. As a first approach, the construction of a topo-bathymetric map provides a basic tool for developing a digital elevation model (DEM) using a geographic information system (GIS) and models that are based on a spatial scale.

Keywords: Esteros del Ibera; Wetland; Hydrology; Hydrometeorology

1. Introduction

Esteros del Ibera is one of the largest isolated inland freshwater wetlands located in South America. It is quasi pristine as it has not suffered negative impacts from superficial inflow from water courses nor industrial activities in its borders.

Wetlands are broadly defined as a transitional ecosystem between aquatic and terrestrial environments characterized by permanent or temporary inundation. In other words, a wetland is a terrestrial ecosystem with water-saturated soils that hosts plants and animals adapted to live in such an environment (Lewis, 1995). Species that form wetland communities are adapted in varying degrees to live in a flooded environment. These phenomena show large spatial variability, and different species show varying degrees of susceptibility to them, so it is not surprising that wetland vegetation exhibits such a high degree of variation in species composition (Crawford, 1983).

Wetlands cover 6% of the world's land surface and contain about 12% of the global carbon pool, playing an important role in the global carbon cycle (Sahagian and Melack, 1998; IPCC, 1996). When coastal wetlands and peatlands are included, wetlands represent

* Corresponding author. Tel.: +54 2293 447104x415; fax: +54 2293 446317.
E-mail address: rferrati@exa.unicen.edu.ar (R. Ferrati).

0304-3800/$ – see front matter © 2005 Elsevier B.V. All rights reserved.
doi:10.1016/j.ecolmodel.2005.01.021

the largest component of the terrestrial biological carbon pool (Dixon and Krankina, 1995).

Pressures on wetlands are likely to be mediated through changes in hydrology, direct and indirect effects of changes in temperatures, as well as land-use change. There would be interactions among these pressures and subsequent impacts on services and goods from these ecosystems. Consequently, land-use and climate change impacts on these ecosystems can be expected to be mediated through changes in the hydrological regime (IPCC, 2001). From the ecological perspective, the changing wetland communities result largely from their occurrence in environments where a single extremely variable habitat factor – water supply – is predominant (Tallis, 1983).

Climate change will affect the hydrology of individual wetland ecosystems mostly through changes in precipitation and temperature regimes. From the perspective of assessment of climate variability and change of wetlands, these systems need to be viewed in the broader context of their hydrological setting (Woo et al., 1993). Because the hydrology of the surface layer of wetlands is dependent on atmospheric inputs (Ingram, 1983), changes in the ratio of precipitation to evapotranspiration may be expected to be the main factor in ecosystem change.

An important adaptation strategy is the prevention of additional stress that can reduce the ability of wetlands to respond to climate change. Reducing pollution, avoiding vegetation removal, and protecting wetland biological diversity and integrity are, therefore, viable activities to maintain and improve the resiliency of wetland ecosystems so that they continue to provide important services under changed climatic conditions (Kusler et al., 1999).

1.1. Location

Esteros del Ibera is one of the largest wetlands located in the south of Latin America. This wetland, together with the Pantanal in Brazil and the Ñeembucu in Paraguay, is part of the Del Plata basin, an extended watershed that covers more than 3.5 million km^2 within five countries of South America. The climatic and geomorphologic features of this basin are ideal for the formation of large inland wetlands.

The study site, Esteros del Ibera, covers approximately an area of 14,000 km^2, between latitudes 27°30′ and 29°S, and longitudes 56°25′ and 58°W and is located in the Province of Corrientes, in NE of Argentina. This wetland is associated to the Parana River. Its headwater is located close to the High Parana watercourse, and its natural drainage through the Corriente River flows into the Middle Parana watercourse.

The major components of the water cycle in a wetland are precipitation, evapotranspiration, surface-water flow and groundwater flow. The relative importance of each component in maintaining wetlands varies both spatially and temporally, but all these components interact to create the hydrology of an individual wetland (Carter, 1997). Due to the gradual slope that characterizes this flat system and as a consequence of the strong relationship between morphological, hydrological, climatic, and edaphic factors, the Ibera system is featured by a predominance of atmospheric vertical balance (precipitation–evapotranspiration) rather than overland flow and discharge.

1.2. Hydrology

The Ibera is a flat system with a very gradual general slope. The absolute altitudes between extremes are 72 m a.s.l. at the northeast and 50 m a.s.l. at Laguna Itati, to the southwest. More than 70% of its surface is permanent or temporarily flooded, yielding a fluctuant stage that oscillates up to 1 m in depth. This wetland is characterized by a deficient superficial drainage and a slow movement of masses of water, regulated by biotic effects.

The Esteros are a marshy depression located over the ancient bottom of the Parana River. In the Pliocene, the Parana River flowed towards the High Uruguay River. Later on, the water flow shifted towards the Uruguay River across of Aguapey River. Further on, divisions of the riverbed occurred and were maintained until the Pleistocene. When a geological uplifting of this region occurred, the Parana River shifted towards NW, finally forming the present river bed, and leaving NE–SW slopes with well marked lines of preferential flows, shallow lakes and ‘*esteros*’ systems. These are divided by ‘*lomadas testigos*’ (*elongated sandy hills*) in the NE and in the SW by collecting rivers (Santa Lucia, Corrientes, and others) that flow to the Middle Parana River.

The marshy formation started in the Holocene, beginning with the accumulation of *Lujanense* sediments that hinder the flow from the depression. The Esteros