Biogeochemistry of the Madeira River Basin

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ABSTRACT: A biogeochemical characterization of the Madeira river basin has been made to evaluate the local and global effects of possible alterations in the ecosystem caused by recent intensive occupation in Rondônia state. During the period April 1983-January 1986, sampling was made both by land and river along the tributaries and main channel of the Madeira river. The parameters analysed lead to a detailed study of the physicochemical quality of the waters of the basin and their relationship with the local geology, associated with the transport of solid material and the hydrological behavior of the ecosystem.

Penman's method adapted to tropical rainforest conditions was used to evaluate the potential evapotranspiration for the basin. Estimated potential evapotranspiration was 1420 mm/y, 77% due to the energy balance. Real evapotranspiration was 94% of the estimated potential and the main residence time of the rain water in the basin was 2 months. The isotopic behavior of Hydrogen and Oxygen in the river waters of the region was typical of great rivers, the values being more positive during the dry season and more negative during the rainy season. An isotopic gradient of δ ¹⁸O 0.038 (%o)/100 km, was established from Porto Velho station to the estuary, which was considered low when compared with the value of 0.063 (%o)/100 km, obtained for the Amazon river.

In general, the waters of the tributaries were poor in dissolved ion species when compared with the main channel of the Madeira river. Seasonal variation in the transport of suspended sediment kept the same pattern, greater transport being observed on rising water than during high water. A transport of 2.85 million tons per day was observed in the Madeira river near the mouth.

Introduction

The recent increase in human population that has occurred in the Brazilian Northwest region has lead to gradual modifications in plant community structure, due to expansion of the agriculture frontier, where crops and cattle farms are substituting the natural ecosystems. The rate at which these activities are occurring, together with an inadequate land use pattern are potentially dangerous in causing disturbances in the present equilibrium ecosystem.

In Rondônia state, the deforested area increased from 0.5% in 1975 to 5.7% in 1983 (IBDF 1985). If this trend continues, it is believed that by the end of 1987 more than 20% of the entire state had been deforested (Leopoldo & Salati 1987). This was confirmed by recent estimations (Mahar 1988).

The high deforestation rate will be followed by an increase in the surface runoff, with faster loss to the rivers and oceans. The water infiltration to deeper soil layers will be decreased, the evapotranspiration will be
reduced and as result, a decrease in precipitation may occur (Salati et al. 1983).

Different methodologies may be applied to evaluate the possible changes in the natural ecosystem under intensive occupation. For this reason it is necessary to know the basic characteristics which control the mechanism of the dynamic equilibrium of the ecosystem. The aim of this paper is to evaluate the main biogeochemical parameters and their possible relationship to anthropogenic activities which are occurring in the region.

The hydrological characterization of the main tributaries of the drainage basin of the Madeira river and its behavior under different hydrogeochemical regimes, specially as related to seasonal and spatial variation, are of fundamental importance to verify the direct influence of deforestation (Brinkmann 1989).

Study Area

Rondonia state with an area of 243044 km$^2$, is situated between 7° 58' and 13° 43' S latitude, 59° 50' and 66° 48' W longitude, and is part of the Legal Brazilian Amazon.

Its pluviometry is continental with a warm climate. The rainy season occurs in the summer, while winter is the dry period. The precipitation in the W part of the basin is around to 1750 mm/y and 2750 mm/y for the E. The average temperature is around 29°C and the humidity 85% (Brasil-Ministerio da Agricultura 1980).

The predominant lithology is from the Pre-Cambrian where granitic rocks form the formation of the Xingu Complex. In the SE part, arenitic rocks from the Paleozoic are observed and in the N occurs the Solimões Formation with Plio-pleistocenic sediments and unordenated alluvion distribution (Projeto Radambrasil 1978). The relief can be classified as plane and slightly ondulated. In the N, the region is integrated to the Amazon plain with floodplain areas. In the NW, W and SW the mountain chains are covered by Mesozoic arenites which are the Parcis Formation.

The Amazon humid tropical forest with high trees predominate over the region, where several patterns of transition exist due to the intensive deforestation which has occurred in the region.

Experimental

Sampling stations were distributed along the main channel of the Madeira river, from Porto Velho to Urucurituba, approximately 1000 km downstream, and in the Jiparana and Jamari river basins, two important Madeira river tributaries (Fig 1).

From 1983 to 1986, eight terrestrial excursions were carried out along Rondonia state and two fluvial excursions were made along the main channel of the Madeira river using the “Amanai” research boat, from INPA.