Chapter 85
Mining Climate and Remote Sensing Time Series to Improve Monitoring of Sugar Cane Fields

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ABSTRACT

This chapter discusses how to take advantage of computational models to analyze and extract useful information from time series of climate data and remote sensing images. This kind of data has been used for researching on climate changes, as well as to help on improving yield forecasting of agricultural crops and increasing the sustainable usage of the soil. The authors present three techniques based on the Fractal Theory, data streams and time series mining: the FDASE algorithm, to identify correlated attributes; a method that combines intrinsic dimension measurements with statistical analysis, to monitor evolving climate and remote sensing data; and the CLIPSMiner algorithm applied to multiple time series of continuous climate data, to identify relevant and extreme patterns. The experiments with real data show that data mining is a valuable tool to help agricultural entrepreneurs and government on monitoring sugar cane areas, helping to make the production more useful to the country and to the environment.

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INTRODUCTION

Brazil is an agricultural country. It is a leading corn and soybeans producer and the main sugar cane and coffee producer. According to official data (IBGE, 2007), the agribusiness segment contributed with 23.3% of the national Gross Domestic Product (GDP), 42% of exports and 37% of jobs in 2007. Significant advances have been made in determining suitable areas for agricultural crops development through agricultural zoning program, developed by the Brazilian Ministry of Agriculture (Rossetti, 2001).

The Brazilian agricultural zoning program aims at reducing agriculture losses caused by two climatic-associated risks: dry spells during the reproductive stage and excessive rainfall during the harvesting periods. This official program defines planting calendars for the main crops in the country, which have been calculated to achieve risk rates lower than 20% regarding climate problems, based on climate data and agrometeorological methods. However, after planting the crop, it is extremely important to monitor crop yields.

Reliable estimates of agricultural production are powerful tools to guide producers on issues related to planting and also to assist agribusiness in operating and marketing sectors. They may generate reliable data to support the government in the decision making process, aimed at reducing negative impacts on the economy or to take advantage of favorable situations in the weather and in the agricultural market.

In addition, the crop forecasts performed by agrometeorological agents in the country appear as an effective mechanism for protection of domestic production. This occurs because they generate a frame capable of preventing or reducing the reaction caused by speculative estimates from external agents, often owned by competing countries in the international market.

Developing countries, like Brazil, usually do not have a well-distributed network of meteorological stations. Therefore, monitoring the weather conditions is one of the main difficulties that decision makers must face. In particular, we observed that data from surface networks are not enough to appropriately solve small-scale variability. Such variability includes strong gradients of rainfall intensity, the small size of cells and a short precipitation cycle time, which are characteristics of convective rainfall, responsible for much of precipitation that occurs in tropical regions. Moreover, experts are becoming increasingly concerned about the negative impacts of the meteorological conditions and of the natural disasters.

Using remote sensing data is an alternative to more conventional methods, because the sensors have an excellent spatial and temporal coverage. These sensors also make it possible to obtain continuous information from the country land, with spatial resolution of few kilometers and temporal data in order of minutes. However, measurements obtained from remote sensors are indirect and, therefore, it is necessary to develop models to relate the features available in the satellite spectral channels to parameters associated with the required information.

In this scenario, several satellites are being used to assist in land monitoring and climate forecasting. The NOAA (National Oceanic and Atmospheric Administration) satellites, originally designed to act as meteorological satellites, have been widely used for vegetation monitoring on both regional and global levels and, more recently, to monitor agricultural crops. The AVHRR (Advanced Very High Resolution Radiometer) on board of the NOAA satellites includes two channels in the red and near-infrared spectra, which are adopted in studies of the vegetation. The frequency of AVHRR imaging varies from 2 to 4 images from the same place per day, increasing the probability of obtaining good quality images throughout the development cycle of commercial crops.

According to Fontana & Berlato (1998), the inclusion of spectral variable into agricultural models of monitoring aims at estimating parameters that cannot be fully represented in agrometeorological