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Using Markov chains to analyze changes in wetland trends in arid Yinchuan Plain, China

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ABSTRACT

Three wetland distribution maps were drawn using Two Land-sat 5 Thematic Mapper (TM) images from 1991 and 1999, and a China–Brazil Earth Resources Satellite (CBERS)-02B image from 2006. A transition probability matrix was constructed using two wetland distribution maps, one from 1991 and one 1999 and GIS (Geographic Information System). The trends in changes in wetland types and the distribution area were predicted using a Markov model. The prediction model was then tested for relative accuracy and the feasibility of a x^2 test. The prediction model's relative accuracy was 98.5%. The x^2 test results showed that both the simulated results and the actual wetland distribution area were in good agreement. Therefore, it is feasible to use the wetlands area transfer matrix to establish a transition probability matrix based on the Markov model and to predict the distribution pattern of the wetland in Yinchuan Plain. The results of this study may be helpful for local governments to develop wetland management policies.

1. Introduction

Wetlands are among the most important ecosystems on earth and are sometimes described as "the kidneys of the landscape" because they function as the downstream receivers of water and waste from both natural and human sources [1]. Wetlands are valued for their ability to store floodwaters, protect shorelines, improve water quality, and recharge groundwater aquifers [2]. Wetlands provide a habitat for fish and wildlife, supporting a rich biodiversity, including many threatened and endangered species [3]. The area of wetlands in arid and semi-arid areas is the basis of the maintenance of agricultural and oasis ecosystems [4]. In the last few decades, climate change and anthropogenic activity have resulted in a rapid reduction in the area of wetlands in Yinchuan plain. The degree and extent of wetland change over the last few decades has given a new urgency and relevance to the detection and understanding of wetland change [5]. Geographic information systems (GIS) and remote sensing (RS) are essential tools for monitoring the present wetland distribution area and spatial-temporal dynamic variety [6,7]. GIS also serves as a tool for predicting and analyzing wetland change and its underlying causes [8]. Other uses of GIS include determining methods of efficient storage, management, and analysis of spatial and non-spatial data [9].

Landscape ecology is an interdisciplinary study that includes geography and ecology. Some of the most important aspects of wetland change at the broad spatial level can be distinguished based on landscape pattern and structure [10]. However, it is necessary to monitor and assess wetland changes with a view toward the conservation and wise management of wetland resources [11]. The use of remote sensing technology for the identification, inventory, mapping, and classification of land wetlands has been a common application of satellite imagery [12,13]. In recent years, many studies have been conducted to

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