

Chapter XV

The Application of Data Mining for Drought Monitoring and Prediction

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ABSTRACT

This chapter discusses the application of data mining to develop drought monitoring tools that enable monitoring and prediction of drought's impact on vegetation conditions. These monitoring tools help decision makers to assess the current levels of drought-related vegetation stress and provide insight into the possible future trends in vegetation conditions at local and regional scales, which can be used to make knowledge-based decisions. The chapter summarizes current research using data mining approaches (e.g., association rules and decision-tree methods) to develop these types of drought monitoring tools and briefly explains how they are being integrated with decision support systems. Future direction in data mining techniques and drought research is also discussed. This chapter is intended to introduce how data mining is be used to enhance drought monitoring and prediction in the United States and assist others to understand how similar tools might be developed in other parts of the world.

INTRODUCTION

Over the past few decades, many parts of the world have experienced devastating impacts from the frequent occurrences of both short- and long-term droughts, and decision makers such as policy makers and farmers are faced with the difficult challenge of dealing with these natural disasters. Although drought characteristics are complex and the prediction of such events is difficult, decisions must still be made to manage and mitigate drought impacts whenever this natural disaster occurs. With an increase in population growth and the resultant demand for natural resources (e.g., food and water), the vulnerability of people to natural disasters such as drought has dramatically increased. As a result, droughts of identical magnitude and spatial coverage will incur more damages and greater impacts today than they would a few decades ago.

There is a growing need for improved drought monitoring tools to assist people in making more informed drought risk management decisions. Such tools would help decision makers to implement effective responses (crisis management) that include technical, financial, and humanitarian assistance to drought-affected areas. Improved drought-related information is needed to make more efficient and effective planning and mitigation decisions. This requires new tools that can deliver more accurate and detailed drought information in a timely and reliable fashion.

Many studies have focused on developing improved drought monitoring tools that can assist in the decision-making process (Goddard, Harms, Reichenbach, Tadesse & Waltman, 2003). Most of these studies have relied on traditional statistical methods to build models based on the relationships of atmospheric, climatic, and oceanic variables to drought events. However, traditional statistical techniques are often insufficient for identifying drought and its characteristics (e.g., intensity) because of the complex interplay of these variables, which affect the occurrence, geographic extent,

intensity, and duration of drought. As a result, researchers are focusing on developing drought monitoring tools using new analytical techniques that can explore these complex relationships. Recently, data mining techniques were used to develop improved drought monitoring tools and better understanding of drought characteristics (Harms, Deogun & Tadesse, 2002; Tadesse, Wilhite, Harms, Hayes & Goddard, 2004).

The primary strength of data mining techniques is their capability to search databases for hidden patterns and find predictive information that experts may miss because it lies outside their expectations (Berry & Linoff, 2000; Cabena, Stadler, R., Verhees & Zanasi, 1998; Groth, 1998). In addition, data mining can be used to answer difficult questions or problems that would be too time-consuming and/or complex to resolve using traditional methods. The automated, prospective analyses offered by data mining move beyond the analyses of past climatic events commonly used for drought monitoring and allow complex relationships between many diverse variables (or indicators) to explore for this application. Data mining tools also have the potential to predict future trends and behaviors, and this information could allow decision makers to make proactive, knowledge-driven decisions (Tadesse, Brown & Hayes, 2005a).

This chapter reviews the use of data mining techniques for drought monitoring in the United States and highlights the challenges facing this application. The chapter briefly explains the potential of data mining techniques for drought monitoring and the current research activities in developing drought monitoring tools and integration systems to enhance drought assessment and prediction for the continental United States. The chapter also presents examples of the results of this ongoing collaborative research by computer scientists, remote sensing specialists, water resources specialists, and climatologists in the central United States.

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