

Mountain environments and geographic information systems

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The editors have organized this compilation of international papers into a cohesive flow of information useful for those experienced in Geographic Information System (GIS) applications, as well as people more interested in the subject of mountain environments themselves. The focus of mountain environments for GIS applications provides an excellent framework for those just wishing to learn more about GIS technology.

Like the environments discussed in this book, GIS technology is not one simple set of tools, but rather, a complex and often perplexing array of tools in a continuous state of evolution. The complexity of GIS permits the use of the technology in diverse applications. These can be as diverse as planning the use of urban utilities, to mapping the potential effects of global environmental change. However, the complexity of most current GIS technology often limits the use and understanding of GIS applications. In this book, the complexity is reduced by limiting the discussion to a subset of potential GIS applications. The features of mountain environments provide a natural focus for understanding the capabilities and applications of GIS technology. As mentioned by the authors, the investigations described in the book may not always represent the state of the art, but give actual results using GIS technology, rather than only suggestions of potential applications.

Just as the specific applications of GIS to mountain environments are explained, the capabilities of GIS are an integral part of the chapters. This book uses the focus of mountain environments to explain how GIS systems work. The structure and content of the book chapters provide an important flow of information. The layout of the book eases nontechnically oriented people into the applications of GIS by giving a general introduction, and walking the reader in a logical progression through the GIS applications. The range of GIS applications are examples of current research associated with mountain environments. These include watershed management based on ecological modeling, land use classification and regional planning, natural hazards including fire prediction, research and management of protected areas, analysis of deforestation, and the impact of climate on local and regional ecosystems. The international perspective provides an impor-

tant diversity to these applications.

The introductory chapter covers specific elements of mountain regions and their relation to aspects of GIS technology. The importance of considering the temporal and spatial in GIS analysis is stressed and related to the complex structure of mountain environments. After providing background for various applications of GIS in mountain environments, and explaining what type of information is important, a chapter is presented on how this type of information is used in various model scenarios for planning purposes. In a logical sequence, a chapter then explains important aspects of terrain analysis and provides information on how terrain data are generated for use in the GIS. This is followed by a chapter to explain a method of transforming integrated GIS data including, but not limited to, satellite remote sensing data. The process of classifying these data into thematic GIS information using current technology is explained. The chapter presents the advantages and limitations of the method used and provides the reader with an overall view of how "correct" such data are.

Chapters on specific applications of GIS to the mountain environment give examples of how GIS projects are managed. These include international perspectives from both academic and commercial levels. Applications of visual quality and viewsheds lead into applications of redevelopment, for example of past mining regions. Incorporating economic considerations related to topography for areas in Japan provide additional examples of GIS applications. This particular focus at the international scale demonstrates the need to include cultural values and recognize that these values may vary between international boundaries and with time. Incorporation of these cultural values is not unlike other subjective values that need to be included in statistical and model analysis.

The need for multi-discipline approaches in GIS applications is evident in examples of assessment of landslides - both in their causes and their results. Causes of landslides can include earthquakes, rain, rain on snow events, associated floods, disturbances due to logging, road building and other activities. This again emphasizes the importance of spatial scale in the specific applications. High resolution information is needed for specific applications such as stability of forest roads, while large scale, regional hazard data may be more important for applications of urban property protection, disaster potential or evacuation needs. A similar analysis of fire potential involves many issues linked to terrain analysis - for determination of details such as forest fuel types and loads, moisture content and overall heterogeneity of potential fires. An excel-

lent example of complex issues in spatial analysis and modeling is given in a chapter focused on Glacier National Park. A diversity of examples is used, from integration of climatic variables related to avalanche potential, to assessment of water turbidity in the alpine lakes. An excellent example of comparing model output of predicted vegetation at treeline with observed conditions from satellite information is given. In these examples, importance of integration of diverse information is emphasized, including that from satellite data. The methods for integration of satellite information, and the expertise that is involved, is perhaps underplayed in most of the examples listed.

An experience from the Wildlife Service of New South Wales points out an important problem associated with GIS use. The expertise required for actually using current GIS information is often quite high, as are costs associated with the hardware and software. By reducing the complexity and improving access to software and databases, the results of the GIS investigations and investments were applied on a much wider basis. This included field staff working with the data on the "ground level". On the other side, is the need to realize that specific research applications involving complex modeling and data integration are, by design, complex. Several investigations are described in the chapters, which include the powerful features of GIS tools for modeling applications and integration of model output from other analytical tools. These examples include spatial results with fractal analysis, deforestation rate and risk potential models, and use of models within the GIS for analysis of topographic influences, and further integration with climatic data. These studies also cover results of scale dependencies, including limitations of the datasets.

Although a good introduction is given for the papers of the book, perhaps one weakness is a need for a concluding chapter. The applications presented in this book vary widely in scope and application. The complexities presented within the chapters of the book provide an opportunity for several approaches and conclusions. An important message conveyed in the forward of the book, but sometimes lost in later chapters, is a paradox that often exists in GIS applications: The technically oriented application of GIS technology is often needed for basic, non technical, bottom line results. This is implied in many of the chapters, but needs to be stressed. Complex analytic procedures often need to generate a simple yes or no answer. As part of this, the results may need to be conveyed to a nontechnical audience. To make it more difficult, even with advanced tools, satellite information and complex model output, many GIS applications need to include or rely on information of uncertain validity. This might include historical data of undocumented spatial accuracy or resolution, undocumented transformations, or even anecdotal information. The result of the analysis must include this level of uncertainty and must convey the meaning of this uncertainty to a nontechnical audience. The chapters of this book present excellent examples of the power of GIS in complex mountain environments, but GIS technology still needs a better interface for more widespread access to the digital information and results like those presented in these chapters.

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