Introduction

THE EDITORS

The chapters in the previous Section focused on the operational applications of GIS. This section takes as its theme the social and environmental applications of GIS. These chapters look at a series of application areas from a wider perspective, considering the ways GIS has been used in planning, decision support, and modelling environmental and social problems. The applications range in scale from the global (Wilson, GIS and agriculture), to the national (MacDevette et al, reconstruction and redevelopment of South Africa) and the local scale (Larsen, environmental monitoring and assessment of Ringkøbing Fjord, Denmark). Other chapters provide extensive, contemporary reviews of key GIS application areas: health and health care (Gatrell and Senior), politics (Horn), land cover and land-use (Bibby and Shepherd), landscape conservation (Aspinall), agriculture (Wilson), and environmental monitoring and assessment (Larsen). Collectively, these applications demonstrate a wide range of environmental and social uses of GIS.

In the opening chapter, David MacDevette, Robert Fincham, and Greg Forsyth examine the role of GIS in the reconstruction and development programme of South Africa (Chapter 65). Despite the succession of Nelson Mandela's government in 1994, South Africa remains a land of stark contrasts with classical first- and third-world elements. The chapter focuses on the role for GIS in development planning, management, and policy formulation at the national, provincial, and local levels. The examples highlight the role of GIS both in information dissemination and as an adjunct to the planning process, especially in the context of improved decision support. Two points illustrate clearly the issues associated with applying GIS in a third-world context. First, MacDevette et al argue that decision-makers in the Third World prefer to work from maps, because they are particularly effective for 'hands on' activities. Second, they highlight the need for customised mapping conventions which are sensitive to context – citing, for example, the need to avoid inappropriate Western symbology such as blue for rivers.

The health and health-care applications chapter by Tony Gatrell and Martyn Senior (Chapter 66) provides a wide-ranging and detailed review of the field of health research. In this chapter the authors review spatial databases for health research using the traditional organising framework of points, lines, areas, fields, and interaction data. They briefly review some of the spatial object transformations necessary to improve the usability of standard datasets (e.g. creating hospital catchment areas from point locations). The remainder of their chapter embraces two main areas of health research: spatial epidemiology (the incidence of disease) and the spatial operation of health-care facilities. In many respects the study of epidemiology poses classic geographical problems which can benefit greatly from the use of GIS. Gatrell and Senior discuss many examples of the use of GIS in visualising, exploring, and modelling the geographical incidence of disease. These range from studies involving the use of global positioning systems (GPS) to study malaria in South Africa, to the creation of improved disease maps in Britain, to the postulated effects of low frequency radio towers on leukaemia in Hawaii. The issues of accessibility and utilisation in the location, configuration, and planning of health-care facilities is addressed in the second part of the chapter. Using examples ranging from urban north-

west England to rural Goa, India, the authors show how standard GIS tools like 'drive time analysis' and 'polygon overlay' can be used to improve decision support of the planning process.

Mark Horn (Chapter 67) examines the role of GIS in defining and using electoral areas. His chapter is primarily concerned with the theoretical and practical challenges that arise in the delineation of electoral districts. The significance of geographical elements varies under different electoral frameworks. The creation of equitable electoral districts is an inherently geographical task. It involves consideration of several key factors including: economic, social, and regional interests; patterns of population; physical characteristics of areas (use of natural features such as rivers and mountains to delineate regions); and the paths of any existing areal boundaries. There are now several commercially available redistricting extensions to GIS software systems which can be used to create optimal districts. In the wrong hands, however, they can be subject to the abuses of gerrymandering (manipulation of electoral constituencies to pack and split voters with particular voting preferences) and malapportionment (substantial deviation from equal population representation). The chapter concludes with a case study of the use of redistricting techniques in Australia.

In Chapter 68, Peter Bibby and John Shepherd consider how GIS has been used in studies of land-use and land cover for urban and regional planning purposes. The authors describe how 'land-use' implies a social purpose rather than a set of physical qualities. 'Land cover', on the other hand, is the material which clothes the surface of the Earth, including vegetation, water bodies, and urban areas. Land-use information is vital for the development of planning policy rules and the application of planning policy to individual cases. The discussion and case studies draw on the English experience, although much of it is also applicable to other parts of the world. Bibby and Shepherd deal with examples such as the construction of land-use policy areas, the definition of rural settlements, synthesis of shopping centre areas, and projection of urban growth and change. The discussion highlights the importance of the conceptual distinction between land-use and land cover because the boundaries of geographical objects demonstrably expand and contract as purpose shifts. For this reason the notion that land-use applications of GIS are limited merely to vector mapping of land parcels should be rejected.

Closely related to studies of land-use and land cover is the topic of landscape conservation and Richard Aspinall reviews recent and current GIS usage (Chapter 69). The subject of landscape conservation is considered in its broadest sense in the context of integrated ecological systems that include both physical and human components. The chapter concentrates on three themes: how biodiversity and sustainability provide guiding principles in conservation efforts; the role of geography as an integrative science and 'landscape' as an object for analysis; and the role of ecological understanding for planning and managing specific resources in particular locations and contexts. The traditional approach to landscape conservation has been through establishment of designated sites that are considered independently of their surroundings and within which conservation is treated as the major, or sole, land-use. More recently the wider geographical context of designated sites has begun to be considered and approaches based on cooperation have replaced competition between land-uses. A particularly interesting application of GIS in landscape studies is the analysis of scenes based on viewshed analysis.

Agriculture is an inherently geographical phenomenon and it not surprising that this, together with the extremely large sums of money involved, means that it is a natural application for GIS. In Chapter 70 John Wilson reviews agricultural applications of GIS at global, regional, and local scales. Several projects have been initiated during the past decade in order to build spatially distributed databases that cover continents and, in some instances, the entire globe. These have concentrated on building global-scale topographic, climatic, soil, and land cover databases. GIS techniques have been used for farm-related assessments at national and regional scales for many years. These techniques have been combined with GIS and remotely-sensed data to support assessments of land capability, crop condition and yield, range condition, flood and drought, soil erosion, soil compaction, surface and ground water contamination, pest infestations, weed eradication, and climate change impacts. The number and variety of local agricultural GIS applications have increased dramatically during the past five years. Some applications target individual farms. Most of these field- and subfield-scale applications are connected with precision or site-specific farming, which aims to direct the application of seed, fertiliser,

pesticide, and water within fields in ways that optimise farm returns and minimise chemical inputs and environmental hazards. Most site-specific farming systems utilise some combination of GPS receivers, continuous yield sensors, remote sensing, geostatistics, and variable rate treatment applicators with GIS.

In the final chapter in this Section, Lars Larsen examines GIS in environmental monitoring and assessment (Chapter 71). The emphasis of monitoring systems is placed on data collection, pre-processing, and quality control. Analysis systems focus on using tools to manipulate and model data. There are many different types of monitoring systems, most of which automate the process of data collection and (pre-) processing – a task often hidden from the ordinary user. By introducing GIS as this stage it is possible to utilise mapping functions to display objects such as measurement stations. Because environmental monitoring operations are expensive to set up and maintain, a reduced field-based monitoring programme is often combined with mathematical modelling which can be used to estimate parameters. The author describes the application of environmental monitoring and modelling in the Ringkøbing Fjord, a lagoon area in the western part of Denmark. The monitoring system installed has the dual purpose of documenting the state of the environment and functioning as an alarm system should a critical situation arise. Data collected using this process are fed into a GIS database which organises and stores the data.