

Chapter 1

LINKING HOUSEHOLD AND REMOTELY SENSED DATA

Methodological and Practical Problems

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1. INTRODUCTION

Changes in global land cover (biophysical attributes typically observed remotely) and land use (human purpose applied to these attributes) are occurring at a rate, magnitude, and spatial extent unprecedented in human history (Lambin et al. 2001). When aggregated globally these changes impact biodiversity (Sala et al. 2000), contribute to local and regional climate change (Chase et al. 1999) as well as to global warming (Houghton et al. 1999), and affect the ability of biological systems to support human needs (Vitousek et al. 1997). Such changes also determine in part the vulnerability of places and people to climatic, economic, ecologic, or sociopolitical perturbations (Kasperson et al. 1995).

Land-use and land-cover change has become part of the global science agenda on environmental change. Research activities fall under the auspices of the International Geosphere-Biosphere Program (IGBP), the International Human Dimensions Program (IHDP), and the Intergovernmental Panel on Climate Change (IPCC)—especially the Land Use/Cover Change program jointly sponsored by IGBP and IHDP and various parts of the IGBP's Global

Change and the Terrestrial Ecosystem (GCTE) program (Turner 2001). That human activity has a profound effect on patterns of land cover is now undisputed (e.g., Lambin et al. 2001; Giest and Lambin 2001). But it is critical to move beyond this accepted fact to understanding when and under what circumstances human behavior and land cover are interrelated.

Studying the effects of human activities on land-use/cover change typically involves joining social science data with remotely sensed and other spatial data (e.g., Walsh et al. 1999; Liverman et al. 1998; Turner and Meyer 1991; Fox et al. 1995; Skole et al. 1994; Moran et al. 1994; Guyer and Lambin 1993). These are quite different types of data that are typically collected by scientists with very diverse orientations, and linking social science, natural science, and spatial science data has proven a major challenge. This chapter and this volume address the issue of linkage across these scientific domains at a micro scale.

A common solution to linking social, natural, and spatial data has been to use census data gathered at the household level, aggregate them to some administrative boundary, and link them to remotely sensed and GIS data for the same administrative unit. One can then relate changes in land cover to changes in demographic and socioeconomic indicators. While much can be learned from such linkages at the administrative level, there are also some drawbacks. One is that remotely sensed data provide information on land *cover* but not necessarily on land *use*. Another is that numerous land-use decisions are made at the household level—and others at the community level—and aggregating up to administrative units renders household and community decision making invisible.

Further, there is no reason why an association at the administrative level would necessarily be the same as that found at the household level. This is a well-known problem that goes by different names in different disciplines. To fix terms, we will use the definition of “ecological fallacy” given by Gibson et al. (2000): ecological fallacies are those that impute the cause of lower-level (or micro) patterns to be the same as those operating at a higher (or macro) level. Using aggregated census data to impute household-level relationships is perhaps the earliest identified form of ecological fallacy (Robinson 1950).

A fundamental premise of this volume is that households—and household decision making—are critical to understanding the changes in land use and land cover that are occurring throughout the world and contributing to such problems as global warming, loss of biodiversity, and increased vulnerability. This volume brings together research teams that have linked household-level social science data and remotely sensed (and other spatially explicit) data, sometimes at the household level and sometimes at the community level. These researchers come from diverse backgrounds ranging from sociology to ecology and from geography to

agronomy. They have diverse theories and substantive interests, yet they all recognize a need to link specific remotely sensed pixels and spatial coordinates to local decision makers. Why? It is because many important land-use/cover decisions are made at the micro level.

This book examines methodological and practical issues that face researchers who design studies linking microhuman behavior and remotely sensed data. In laying out these issues, we hope to begin a process that leads to a better understanding of the theoretical and substantive implications of the methodological and design decisions being made by those in the emerging land-use/land-cover change field. We start the chapter with a brief theoretical discussion to place the methodological focus of the volume in broader perspective. The remainder of the chapter examines methodological and practical issues that affect how we choose to link social, natural, and spatial science data at the micro level.

2. THEORETICAL FRAMEWORKS AND SUBSTANTIVE QUESTIONS

The guiding theoretical frameworks used by the authors in this volume come from various disciplines and, because each project represents an interdisciplinary team, numerous and sometimes overlapping theories are often used in a single project. For example, both Lambin (this volume) and Turner and Geoghegan (this volume) use economic approaches, while Walsh and his collaborators (this volume), Liu and his collaborators (this volume), and BurnSilver and her collaborators (this volume) work within landscape ecology. One common theme that runs through all the frameworks employed by the authors is an emphasis on multiplicity: multiple responses to social change, multiple levels of analysis, multiple aspects of the life course of individuals, households, and land parcels, multiple connections in social and geographical space, and multiple ties between people and land in rural agricultural areas.

To set the orientation of the present volume in the broader theoretical and substantive space within which land-use change research is set, consider Figure 1. This figure is not meant to represent any single theory or framework but rather is a stylized version of many. It is here for heuristic purposes. Figure 1, as is the practice with numerous authors (e.g., Meyer and Turner 1992; Ojima et al. 1994; and Lambin et al. 1999), has both proximate causes and more distal driving forces of land-use and land-cover change. Proximate causes include human activities (land uses) that directly affect the environment and thus constitute proximate sources of change. They can also include biophysical or other factors. Proximate causes are usually seen to

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