Spatial Analysis of Coastal Environments

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Coastal environments, such as mangroves, coral reefs, wetlands, and dunes, are recognized as some of the most fragile and dynamic ecosystems on the planet. These environments face many challenges including land use development and sea-level rise. Sarah M. Hamylton’s new book, Spatial Analysis of Coastal Environments, applies her expertise in geospatial technology to coastal environments to provide detailed examples of ways to map, model, and monitor these systems. She presents geographical approaches to model, analyze, and predict changes in coastal features. The book aims to both raise awareness and inspire action to help protect and monitor coastal systems while also introducing and developing the readers’ technical means to apply geospatial tools. Hence, this book not only summarizes how to conduct spatial analysis in coastal environments, but why it is important to do so.

For example, Hamylton introduces readers to basic analyses of coastal environments such as point pattern analysis, network analysis, exploratory spatial data analysis, and trend surface analysis. In Chapter 3 the author also presents fundamental operations that can be conducted with spatial data that include distance, area, proximity, buffers, distance decay, overlay, and applications of conceptual operators. These basic geometric operations are also analyzed for understanding patterns of distribution and characteristics of coastal features. Hamylton also introduces basic geographic information systems (GIS) tools to work with multivariate data sets like spatial and attribute joins. The author also addresses how data can be displayed to aid visualization and analysis of patterns. There are several methods explained in this chapter including how point pattern analysis is used for determining whether arrangements of points are statistically significant (e.g., clustered, random, or dispersed). The example provided by the author of barnacle distribution is a clear and well-explained introduction to pattern analysis. Hamylton uses this example throughout the sections to show how different methods of point pattern analyses can influence results and therefore interpretation of data. The second case study presented in this section examines clusters of shark attacks in California and Florida, highlighting how pattern analysis can also be practically applied to prevent future attacks.

Coastal scientists are aware of the importance of monitoring dynamic coastal environments, and the book does an excellent job at conveying that information to readers. Adaptation is at the center of any attempts to manage or mitigate coastal change and depends greatly on the ability to monitor these systems. Hamylton does a good job explaining the challenges of monitoring coastal environments, which include the collection and analysis prior to establishing an equilibrium profile of the system as well as the continuous, systematic observational records over short- and long-term periods of time (depending on the study) to determine how the systems are changing. The book also introduces remote sensing change detection techniques, which are, according to Hamylton, the most common application of remote sensing for coastal man-
management. She proceeds to explain the advantages and disadvantages of employing raster- or vector-based approaches for change detection. Figure 5.1 (p. 128) handily summarizes a typical workflow to detect change over time with multitemporal data sets.

This book provides readers with a comprehensive summary of the available sources to from which to acquire historical information to create baselines of the study area. It summarizes the capabilities of available data sets (i.e., Table 5.1, Satellite Sensor Attribute, p. 131) and the importance of taking into consideration the spatial and spectral resolutions of the sensors when searching for data for change detection. Hamylton includes a summary from E. Green, Mumby, and Clark (1996) enumerating the limitations associated with using remote sensing for any form of change detection analysis. By including this, the author is once again giving the readers a chance to evaluate the pros and cons of the analysis and therefore allowing them to make more informed and prepared decisions in the future. This section is followed by a review of techniques available for measuring change over time. A complete summary is offered of methods like univariate image differencing, image regression, and image rations index differencing, among others.

Hamylton not only demonstrates for her readers the benefits of spatial analysis, but also summarizes some of the “pitfalls” or limitations inevitably encountered. For instance, coastal scientists should be cautious as to assumptions of the magnitude of observed coastal changes, and critically assess observed versus real change in terms of measurement error or uncertainty and change detection data and methods. A further caution is also beneficially noted, to be aware of the spatial and temporal scales at which the change quantification takes place and to include an estimation of the magnitude of error and uncertainty in the results. Both perspectives have important implications for coastal science and management, yet are seldom covered in an accessible, demonstrative way in a book.

Spatial Analysis of Coastal Environments offers a much-needed synthesis on current GIS and remote sensing methods and techniques, combined with geostatistical tools, used to study our coasts. Most books on this topic focus more on marine ecosystems and dynamics, often disregarding or minimizing the role of spatial analysis of coastal systems, or they are less current as to literature and data. There are a couple of exceptions to this statement (D. Green and King 2003; Hardin et al. 2014), but these examples do not provide a complete summary of the current methods used when studying coastal environments. Using case studies as examples of research conducted all over the world offers a broad yet concise overview of spatial analysis of coastal environments and helps communicate complex ideas useful to undergraduate students and full-fledged scientists as well. Hamylton is preparing university students or new professionals to the field with an empirical introduction to coastal environments while also providing a comprehensive overview of the available spatial statistics tools to study coastal features.

One minor drawback has to do with organization, specifically how the case studies are presented within chapters. Case studies lack a degree of consistency in how they are presented. Sometimes they were presented as their own section, in many cases followed by sections that continued the exploration of different methods or techniques presented in the chapter. In other instances they were presented as subsections immediately after the appropriate section. Although the case studies are relevant, these inconsistencies of presentation sometimes disrupt the flow and organization of chapters. One remedy could be presenting the cases either at the end of the chapter or as a subsection of the data or analytical section they exemplify.

Overall, I strongly recommend this book not only to its intended audience of undergraduate students, but to all coastal scientists seeking a comprehensive view of geospatial analysis techniques. Hamylton does an excellent job summarizing modern methods and techniques to study coastal environments. In general, the chapters are well written and usefully illustrated, with detailed and relevant examples of applications of the methods and techniques described here. In addition, for faculty or students desiring hands-on application experiences for presented case studies, a set of companion laboratory exercises using ArcGIS or other software are available on the publisher’s Web site. New generations of coastal scientists will benefit incredibly from this book, which was long overdue in the field.

References

