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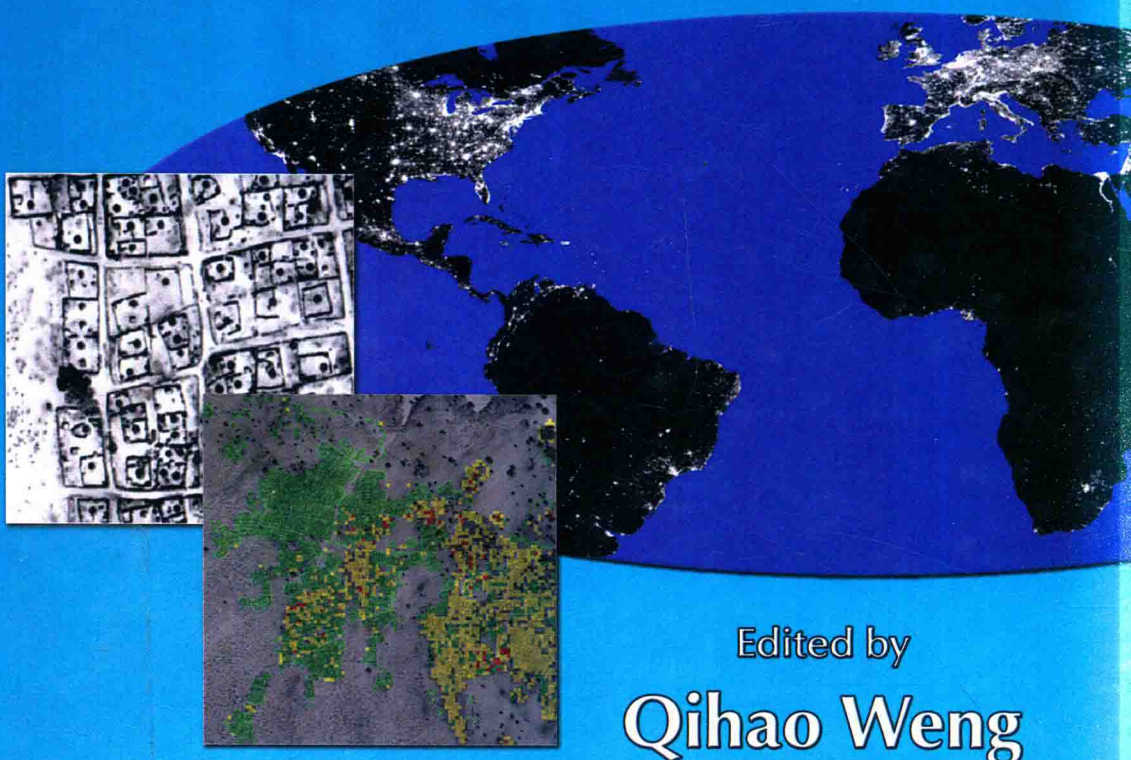
Global Urban Monitoring and Assessment through Earth Observation



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through Earth Observation

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Foreword: GEO—A Globally Integrated Approach to Urban Monitoring

Recognizing the growing need for improved Earth observations, 150 governments and leading international organizations have established the Group on Earth Observations (GEO) to collaborate and implement a Global Earth Observation System of Systems (GEOSS). Countries and organizations are sparing data from their respective Earth monitoring systems, including satellites in space and in situ instruments from terrestrial, oceanic, and atmospheric domains. They are interlinking these systems so that, together, they provide a more complete picture of Earth systems dynamics.

Universities, space agencies, and other partners are working together in the Global Urban Observation and Information Task (SB-04 of GEO), under the leadership of Professor Weng, to expand the use of Earth observations and remotely sensed data to provide information on urban environment characteristics and their change over time at various spatial scales. They are evaluating user needs and matching them with existing or planned technologies and data sets, and they are working with others in the GEO community to provide full and open access to data and services in order to expand and consolidate the network of researchers, stakeholders, and practitioners who are working for a more sustainable future in urban areas.

In fact, cities and densely populated areas are where the impact of human activities and the effects of natural forcing factors (including global climate change variability) are most directly felt by society. With half of the world's population living in cities today, urban observation and modeling is a key issue not only for the GEO but for resource managers and policy makers alike. Urban areas account for roughly 3% of the Earth's surface but host half of the global population. According to the 2011 revision of the *World Urbanization Prospects*,* in Europe, the Americas, and Oceania more than two-thirds of the population live in urban areas, whereas about one-third of the population of Asia and Africa lives in urban areas. Nonetheless, the most dramatic increase in urban population would be in these two latter continents. In Africa, urban population will increase from 414 million to over 1.2 billion by 2050, while in Asia it will soar from 1.9 billion to 3.3 billion by 2050. This fast and unprecedented dynamic is posing new challenges to governments, decision makers, and stakeholders. New settlements and the dramatic expansion of urban areas require feasible, affordable, and sustainable solutions for housing, energy,

* United Nations, Department of Economic and Social Affairs, Population Division, *World Urbanization Prospects, the 2011 Revision*.

and infrastructure in order to mitigate urban poverty, the expansion of slums, and a general deterioration of the urban environment.

Earth observations are key in this process since they provide a uniquely valuable vantage point for monitoring many kinds of large-scale dynamics. In situ and remotely sensed data can be provided with very little delay and can include raw data, maps, optical images, or radar images that accurately measure and track critical parameters like land use and classification, meteorological variables, heat islands phenomena, and trace gas emissions. Urban population growth is driven by a combination of factors usually related to local triggers whose long-term impacts on the environment and economy have a global effect. Growing urban populations will have a direct impact on biodiversity and ecosystem hot spots and will increase vulnerability and exposure of populations to the effects of climate change variability, including sea level rise in coastal regions, extreme weather events, more frequent or intense cyclones/hurricanes, longer dry periods and heavier rains that result in increased flooding, and large and uncontrollable outbreak and transmission of diseases and pandemics. High- and moderate-resolution imagery can be conveniently used to map and parameterize land use (including land use change), urban settlements, physical networks, wildland–urban interfaces, and urban patterns over time. In addition, deterministic or stochastic models (e.g., run-off models, meteorological models, tsunami models) can be used to design reliable and meaningful scenarios whose outputs can improve the adaptation and resilience of urban society even in a context where weather-related hazards might worsen because of climate change.

The Global Urban Observation and Information Task (SB-04) in the GEO represents a collective effort of tens of governments and organizations as well as many individuals to monitor the urban system, share and exchange data, and deliver useful information to society. Interlinking observation systems requires common standards for architecture and data sharing, but usually the architecture of an Earth observation system refers to the way in which its components are designed so that they function as a whole. Each GEOSS component, including those being contributed by Task SB-04, must be configured so that it can be linked with the other participating systems. In addition, each contributor to GEOSS subscribes to the GEO data-sharing principles, which aim to ensure the full and open exchange of data, metadata, and products. GEOSS disseminates information and analyses directly to users through its GEO Portal (http://www.geoportal.org/), a single Internet gateway to the comprehensive and near-real-time data produced by GEOSS. GEO Portal integrates diverse data sets, identifies relevant data and other portals of contributing systems, and provides access to models and other decision-support tools. GEOSS has enabled many countries to access information and thereby provide essential services to address challenges that otherwise would not yet have been met. Despite significant progress in recent years, there remain substantial gaps in ongoing national, regional, and global efforts to address these challenges. The GEO has demonstrated that it can play a key role in addressing these gaps in an effective and long-term manner through increased coordination and networking among its major stakeholders and by working together with other key international organizations.

The chapters in this book show the key accomplishments of some of the best researchers in this field and, as discussed earlier, on one of the most relevant phenomenon facing society in the future.

Barbara J. Ryan
The GEO Secretariat, Executive Director
Geneva, Switzerland

Editor

Dr. Qihao Weng is the director of the Center for Urban and Environmental Change and a professor of geography at Indiana State University, Terre Haute, Indiana. He was a visiting NASA Senior Fellow in 2008–2009. Dr. Weng is also a guest/adjunct professor at Peking University, Hong Kong Polytechnic University, Wuhan University, and Beijing Normal University and a guest research scientist at Beijing Meteorological Bureau, China.

He earned his PhD in geography from the University of Georgia in 1999. In the same year, he joined the University of Alabama as an assistant professor. Since 2001, he has been a member of the faculty in the Department of Earth and Environmental Systems at Indiana State University, where he has taught courses on remote sensing, digital image processing, remote sensing–GIS integration, GIS, and environmental modeling and has mentored 10 doctoral and 9 master's students.

Dr. Weng's research focuses on remote sensing and GIS analysis of urban ecological and environmental systems, land-use and land-cover change, environmental modeling, urbanization impacts, and human–environment interactions. He is the author of over 150 peer-reviewed journal articles and other publications and 6 books.

Dr. Weng has worked extensively with optical and thermal remote sensing data and, more recently, with LiDAR data, primarily for urban heat island study, land-cover and impervious surface mapping, urban growth detection, image analysis algorithms, and the integration with socioeconomic characteristics, with financial support from US funding agencies that include NSF, NASA, USGS, USAID, NOAA, National Geographic Society, and Indiana Department of Natural Resources.

Dr. Weng was the recipient of the Robert E. Altenhofen Memorial Scholarship Award by the American Society for Photogrammetry and Remote Sensing (1999), the Best Student-Authored Paper Award by the International Geographic Information Foundation (1998), and the 2010 Erdas Award for the Best Scientific Paper in Remote Sensing by ASPRS (1st place). At Indiana State University, he received the Theodore Dreiser Distinguished Research Award in 2006 (the university's highest research honor) and was selected as a Lilly Foundation Faculty Fellow in 2005 (one of the six recipients). In May 2008, he received a prestigious NASA senior fellowship. In April 2011, Dr. Weng received the Outstanding Contributions Award in Remote Sensing sponsored by the American Association of Geographers (AAG) Remote Sensing Specialty Group.

Dr. Weng has given over 70 invited talks (including colloquia, seminars, keynote addresses, and public speeches) and has presented or copresented over 100 papers at professional conferences.

Dr. Weng is the coordinator for the GEO's SB-04, Global Urban Observation and Information Task (2012–2015). In addition, he serves as an associate editor of *ISPRS Journal of Photogrammetry and Remote Sensing* and is the series editor for both the Taylor & Francis series in remote sensing applications and the McGraw-Hill

series in GIS&T. His past professional experience includes serving as the national director of the American Society for Photogrammetry and Remote Sensing (2007–2010), as chair of AAG China Geography Specialty Group (2010–2011), and as secretary of ISPRS Working Group VIII/1 (Human Settlement and Impact Analysis, 2004–2008), as well as a panel member of the US DOE's Cool Roofs Roadmap and Strategy in 2010.

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