Foreword

The maturity of remote sensing applications and technology has resulted in many innovative uses of satellite and airborne imagery. One particular use that has accelerated over the past few years is focused on time-sensitive remote sensing, which reduces the time for image acquisition, analysis, and product delivery. Bundling of these steps into an efficient remote sensing system has resulted in the capability to address questions for applications where the time from acquisition to information is critical.

While several broad applications benefit from time-sensitive remote sensing, one in particular is disaster response and recovery. Over the past 22 years there has been a remarkable change in the way we in the US emergency management and first responder community respond to disasters. Throughout my career, first with the National Aeronautics and Space Administration (NASA) and then with the Department of Homeland Security, Science and Technology (DHS/S&T), I have had the privilege to serve with first response teams using remote sensing technologies to aid the response and recovery operations of some of our worst national disasters. Throughout these events I have witnessed the convergence of technologically-maturing remote sensing capabilities and human effort to bring assistance to victims in need of relief. During the response to Hurricane Andrew in 1992 aerial imagery was acquired and processed primarily outside of the operational disaster response process to support the governor's request for Federal relief funds and to help put a face on the magnitude and extent of the event. At that time, digital multispectral scanner data could not be acquired at a spatial resolution adequate to address damage assessment requirements at a building level. Aerial photography was flown, processed overnight, printed and sent by special courier back to the governor's team building the damage assessment. In 1999, Hurricane Floyd resulted in extensive flooding that lasted several weeks. The duration of the event permitted the use of government satellite assets like Landsat and RADARSAT to provide a synoptic view of river systems in flood stage while airborne assets flew dedicated missions to detail the status of specific communities. These missions, again, were mostly outside of the operational disaster response, which focused on saving lives and property, but served to provide a compelling assessment of the magnitude of this disaster.

By 2003 the face of remote sensing had changed a great deal. Several commercial companies had made the shift to digital camera systems. Space Imaging had launched Ikonos and DigitalGlobe had launched QuickBird, a new generation of satellites equipped with high spatial resolution sensor systems. When NASA's Shuttle Columbia suffered a disastrous failure that year on February 1st, remote sensing assets were soon brought in to assist the extensive ground search operations. Image-based products from satellite and airborne systems were constructed on a daily basis and used to target optimal search areas. During the response to Hurricane Katrina, realization of the importance of imagery to the response process resulted in imagery being used to generate specific products, including siting temporary housing on the Gulf Coast of Mississippi and flood extent in New Orleans.

During Hurricane Sandy the use of remote sensing had evolved to the point of incorporation into the operational response flow. Since hurricanes rarely occur without notice, the DHS Federal Emergency Management Agency (FEMA) was able to pre-position aerial assets for post event acquisitions by taking advantage of the strong partnership formed with the Civil Air Patrol and the National Oceanic and Atmospheric Administration (NOAA) to fly missions over the areas of greatest impact. The maturity and capabilities of digital cameras used by these organizations and the ability to get the images into operations quickly that they enabled were critical to the response effort. These digital images were used to expedite the rental assistance applications for over 44,000 victims of that storm.

The evolution of disaster response, briefly described above, demonstrates that as the gap between technology and information (for example radar backscatter and residential damage, respectively) becomes smaller, the more the disaster management community will rely on remote sensing as a critical tool during response. That is because disaster response, like several other applications, is fundamentally a time-sensitive process where having 75 % of the answer at the time the decision has to be made is better than 100 % after the fact. Furthermore, what the disaster events described above all demonstrate is the need for rapid access to current information about the status of human health and infrastructure so that response resources can be allocated in the best possible way to minimize suffering and loss. One of the best sources of *current* information following a disaster is remote sensing imagery acquired, processed, and delivered within the timeframe of the specific event underway.

This book provides a detailed discussion of the topic of time-sensitive remote sensing. It describes methods for improving the delivery of image data and the structuring of acquisition methods to optimize disaster assessment procedures such as change detection. It contains information on a new sensor system for characterizing fires and also presents information on technology that leverages pre-event and post-event imagery to improve the acquisition of field data for applications such as preliminary damage assessment and search and rescue.

Time-Sensitive Remote Sensing also describes ongoing governmental programs constructed by NOAA and NASA to facilitate the use of remote sensing for disaster response. These programs serve as a guide for other agencies and organizations with remote sensing missions to follow. Furthermore, this section provides an overview of the International Charter and the role it plays in accessing international remote sensing assets for disaster response.

Disasters resulting from different hazard types (i.e. fire, flood, earthquake, hurricane) all have different timelines for the event; the time in which the event is recognized, occurs, impact are manifest, and in which response must occur to be effective. Efficient response to these different hazards must work within the timeline of the particular disaster to protect life and preserve property. Time-sensitive remote sensing methods identify the timeframe of a particular application, such as disaster response, and seek to provide information within the window of that timeframe. The final section of Time-Sensitive Remote Sensing presents four applications that illustrate the use of remote sensing for earthquake, fire, and drought as well as an overview of several other hazards. It describes unique approaches in the use of imagery and delivery mechanisms to address these needs. Although primarily focused on the application of time-sensitive remote sensing for disasters it is important to recognize that this approach to remote sensing applies broadly to a range of applications where the status of phenomena or change in land cover at specific times are critical, including for example agriculture, infrastructure monitoring, and environmental assessment. The discussions presented in this volume have relevance to a wide range of applications.

As disaster response organizations mature their Standard Operating Procedures and adopt new technologies to improve response operations the demand for more accurate and rapid information will increase. Approaches to time-sensitive remote sensing will guide the development of innovative sensor technology and analysis techniques as data providers seek to meet the requirements of this unique application area. The discussions in this book are the start of what will surely be a long-term effort to realize the full potential of remote sensing for disaster response.

Department of Homeland Security, Science and Technology Directorate (Retired), Washington, DC, USA

Bruce A. Davis

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Lippitt, C.; Stow, D.; Coulter, L. (Eds.)

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