Remote Sensing of Urban Areas, Editorial

MATTHIAS S. MOELLER, Tempe, Arizona

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Since the mid 1990s, the analysis of urban areas by means of digitally remotely sensed image data has become popular amongst the scientific community. Application driven demands have evolved from the field of telecommunications, including the introduction of new radio techniques (UMTS) requiring very accurate and highly detailed geoinformation in both 2D and 3D (compare to RICHTER et al. in this issue), the development of location based services and wireless navigation systems that rely on precise geolocation information, and the improvement of virtual representation and realistic reproduction of real world objects.

This PFG special issue contains seven single publications related to urban remote sensing. Each of them represents excellent state-of-the-art information within their respective fields emphasizing, in an impressive way, that the evolution of urban remote sensing is still ongoing.

Almost every georelated research question – including the monitoring of urban areas – is strongly scale dependent. Scale in terms of remote sensing is inherently linked to resolution:

- spatial resolution,
- temporal resolution,
- spectral resolution and
- radiometric resolution.

Each of these study components has been improved significantly over the last half decade leading to interesting challenges for urban remote sensing research.

Pixel size determines the number and detail of detectable objects. As the number of objects increases and the pixel size decreases, remotely sensed images become more attractive to both scientists and the general public. A recent popular technological development called Google Earth (www.google.earth.com) provides, for the first time, imagery with a very high spatial resolution covering many parts of the Earth.

In fact, the availability of very high resolution optical imagery acquired from space started in 1999 with a series of three satellites all using roughly the same techniques: Ikonos satellite launched in 1999, Quickbird in 2001, and Orbview in 2003. This new kind of space borne imagery enables the clear detection and mapping of man made urban objects such as buildings, streets and even cars. LEITLOFF et al. have successfully used Quickbird imagery for the monitoring of traffic and the detection of vehicles. A differentiation of vegetation is also possible by the use of infrared vs. red spectral reflection highlighting the improvement of increased spectral properties. The limitation to three bands for aerial imagery (either true color or color infrared) is also no longer present. The Ikonos satellite in addition provides stereoscopic capabilities. First results of analyzed Ikonos stereo pairs will be presented in this issue by KRAUSS et al. from the German Center for Aerospace (DLR).

A key advantage of today's space borne satellites is an entire digital processing chain. After digital images are acquired (with high bit rates up to 2^{12}), data can be corrected for system inherited disturbances and geo-processed into products of different spatial position accuracy.

A higher temporal resolution is possible by increasing the number of space borne

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sensors, in effect equivalent to increasing the instrument repeat time. A series of small Rapid Eye satellites will soon provide daily images with a spatial resolution of 6.5 m. This will enable near real-time monitoring of temporally active targets, such as areas affected by earthquakes or volcanic eruptions or sites which are constructed on a temporal basis. In this issue, LANG & TIEDE demonstrate how remote sensing can effectively be used to help monitor a refugee camp in the Darfur region.

A limiting factor for most of these optical sensor systems is the apparent cloud coverage and the actual illumination. Active micro wave systems such as Synthetic Aperture Radar (SAR) can be used to acquire imagery with more consistent quality and fewer atmospheric limitations. The DLR operated Terra SAR X, the next generation SAR instrument, is scheduled for launch in 2006 and will provide spatial resolutions up to 1 m. At this resolution, radar data will provide a potentially powerful tool for urban mapping applications.

In monitoring urban areas, observations at a moderate scale (1:50.000–1:100.000) are also very important. SCHÖPFER & MOELLER (in this issue), perform LULC classifications for two rapidly growing cities of the southwestern U.S., Phoenix and Las Vegas, using multi-spectral data from the ASTER instrument. Object based image analysis methods appear to provide a more accurate detection and representation of urban objects compared to the common statistical image analysis approaches. Further, a number of adapted algorithms can be used in classifying multiple cities and ultimately to measure the growth of urban areas. In another moderate scale approach, FORSYTHE and WATERS utilized pan-sharpened 15 meter Landsat imagery for the differentiation of urban areas using textural measurements.

Other applications of new remote sensing technology for the urban environment include monitoring polluted air and water using better spectral and spatial resolution sensors, and even developing near real-time crime fighting tools. Future developments will also include unmanned airborne platforms temporary or permanently placed above metropolitan areas, equipped with multiple remote sensing instruments and telecommunication devices. Imagery acquired by these sensors can be used for real time traffic management or the monitoring for security issues like crime prevention at big events with many visitors. It must be emphasized, however, that the benefits, risks, and ethics of such security structures be discussed thoroughly before any systems are established. The notion of 'Big Brother' is controversial for most people, and with good reason. When examining the evolution of urban remote sensing, a number of application driven tasks should be considered. One big issue is the rapid speed of changes in terms of phenology for urban areas; cities contain some of the most dynamic landscapes and environments. The automated mapping of new construction on a cadastral scale level and processing those data to a Geographic Information System (GIS) ready database is an area of intense research. For longer term changes, remotely sensed images can be combined with other data inputs to create urban growth scenarios, one is presented by HEROLD in this issue. Important urban features, such as streets and vegetated areas (urban parks, yards and trees) change frequently, but can be mapped using the latest high spectral and spatial resolution imagery.

The scientific urban remote sensing community has established specific discussion and meeting platforms. One of this is 100 cities urban environmental monitoring project located at Arizona State University. The biannual URS and Data Fusion over Urban Areas conferences were merged into one conference in 2005 in Tempe, AZ, USA under the umbrella of the ISPRS. This PFG special issue is partly an outcome of this conference and it also gives an outlook to the next joint conferences which will be held April 11–13, 2007 in Paris.

Sources: Google Earth (www.google.earth.com)