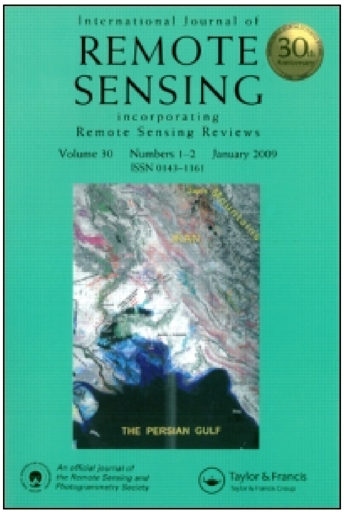

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Spatial information retrieval, analysis, reasoning and modelling

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Preface

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The 15 papers that constitute the present issue aim to show the importance of recent developments in remote sensing and image processing in Geographical Information Science (GISci). In the past 10 years, new sensors have appeared, based on lasers or radar, or using interference principles, and the resolution of the more conventional optical devices has dropped from 10 m to 0.70 m, while the number of accessible bands, in the visible and the infrared range, has multiplied by 10.

The availability of spatial data, for natural, anthropogenic and socioeconomic studies, from such a wide range of sources and a variety of formats opens new horizons to the GISci community. For example, urban areas, which the previous satellites used to resolve rather poorly, have become richer from year to year in significant details in shapes and contours. However, such new complexity leads to new problems.

In relation to spatial information, schematically there are four aspects, which are also four challenges that GISci scientists face. They have to retrieve this information, which is assumed to segment the space in homogeneous zones according to some criteria. This often implies filtering steps. They must analyse the selected regions, and associate with them certain numbers and numerical functions, such as size distributions. They have to apply the above geometrical descriptors in some specific context, such as 'what is the best place to locate a hospital, or to trace a road?' And, sometimes, they have to conceive random or deterministic models for synthesizing the results of the analysis phase, in order to make forecasts.

The authors provide short introductions to the techniques they use, but more extensive presentations may be helpful. Indeed, image processing, as well as GISci, has evolved considerably in the past two decades, and some difficult segmentations require up-to-date versions of wavelets or watersheds, for instance. The studies in this issue borrow their methodology from various sources, including wavelets, random sets (Matheron 1975), geostatistics, Radon transformation, and fuzzy geometry (Zadeh 1965). This list could have contained fractal geometry (Mandelbrot 1982) or rough set theory (Pawlak 1982) as well. Among the methods, mathematical morphology (Matheron 1975, Serra 1982) deserves a special mention because it stems from set descriptors, which have been extended to functions and partitions. Its origin makes it particularly convenient for handling high-resolution images, and the method is involved in the majority of the papers in this issue. In fact, many algebraic operations on maps (Tomlin 1983) involved in GISci-related analyses can be performed through mathematical morphology (e.g. Pullar 2001, Stell 2007). The reader will find a clear presentation of this theory in the book written by Soille (1999), a GISci scientist. We also recommend a recent text by Najman and Talbot (2010) that covers more topics, including connections, connective segmentation, random models and simulations.

In March 2009, the annual conference on Spatial Information Retrieval, Analysis, Reasoning and Modelling (SIRARM) was organized at the Bangalore Centre of the Indian Statistical Institute, focusing on the themes that this Special Issue covers. The aim of SIRARM is to bring together remote sensing specialists, GISci experts, and

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image analysts to enlighten an audience mostly interested in spatial information science. The Conference Proceedings for SIRARM (Sagar 2009) contain 19 articles, eight of which have been expanded in this Special Issue of the *International Journal of Remote Sensing*.

This Special Issue offers papers with various methodological orientations, where the four above-mentioned aspects are emphasized. The wide range of applications of these methodologies on remotely sensed data demonstrates their robustness.

The retrieval of meaningful information from remotely sensed data has been addressed in nine papers of this Special Issue. Saha and Bandyopadhyay (2010) tackle the problem of portioning Indian Remote Sensing satellite (IRS) images by using multiobjective simulated annealing-based clustering approaches. Jeganathan *et al.* (2010) used multitemporal MEdium Resolution Imaging Spectrometer (MERIS) Thermal Chlorophyll Index level-3 data products with coarse spatial resolution to map the phenology of vegetation in India. A latitude-dependent trend in the greenness of natural vegetation is observed. Couturier (2010) proposes an integrated scheme based on a fuzzy-based method for the regional validation of global products and for the assessment that produces an accuracy index with possibility margins. This proposed scheme proves to be efficient in evaluating medium-resolution images (e.g. MOD12Q1) to classify forest types/phenology. Gavrilova and Apu (2010) provide an approach to extract the boundaries (contours) of selected ground features from an image segmented using the DQ-CART method.

Five papers addressing information retrieval provide original approaches derived from mathematical morphology. Based, in addition, on wavelet analysis and Radon transformation, Corbane *et al.* (2010) develop a model to detect ships automatically from higher resolution optical imagery. Parvathi *et al.* (2010) describe an algorithm that rests on morphological reconstruction, to extract key features from satellite images. The extracted features are of use in digital terrain model (DTM) generation. Mering *et al.* (2010) develop a method based on conventional image thresholding techniques and mathematical morphology filters to extract the urban areas from Google Earth images. For suppressing parasite stairs that appear at the frontier of clear and dark segmented zones, Soille (2010) provides an integrated approach based on two techniques on constraint connective segmentation for multispectral images and iterative area filtering. Noyel *et al.* (2010) present a promising method by combining Monte Carlo simulations with a probabilistic version of watershed for segmenting multispectral remote sensing images.

Three papers in this Special Issue address both retrieval of information and its analysis by multiscale morphology. Castaings *et al.* (2010) discuss their experiments to establish a feature reduction method that would give the best results in terms of further classification of extended morphological profiles. Their approach is based on the well-known notion of granulometry, for reduced data. For urban analysis, in particular to map territory at three semantic levels, Kurtz *et al.* (2010) combine multiresolution segmentations and extract information at an intermediate level. Dalla Mura *et al.* (2010) generalize the notion of 'extended morphological profiles' and demonstrate it on the classical 'Pavia' image. The analysis is performed by means of area, rectangular convex hull, elongation, and standard deviation holding on grey values, and the granulometric sequences generated from these four attributes are classified by a random forest (RF) classifier.

This issue also includes three papers related to developing phenomenon-specific models. Wilson (2010) explains how remote sensing can be the 'X-ray crystallography' for the urban 'DNA', with reference to an urban retailing system (physiology) and the subsystem of a city (DNA). An interesting idea to create an Intelligent Information Warehouse (IIW) that should contain rich descriptions and data sources is proposed, and its potential to model urban dynamics is explained lucidly in this conceptual paper. Trianni *et al*. (2010) propose a geographic information system (GIS)-aided per-segment technique and demonstrate its potential on long multitemporal synthetic aperture radar (SAR) data series for rapid detection of change in urban areas through the study of temporal trajectories. Bin Suliman *et al*. (2010) provide a discrete stochastic model of random spread for both fire evolution and burnt-out areas, and apply it to forest fires, using risk maps and satellite data. This model is shown to yield efficient predictions of the burnt zones.

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