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NEWSLETTER

European Association of Remote Sensing Laboratories

Front Cover – [1] Nea Kameni (Santorini), [2] The northern part of Nea Kameni island, Santorini, taken during an airborne survey mission in May 2012. The image shows the rugged shape of the island formed by lava flows from eruptions over the past 500 years.

Credits: [1]D. Pyle,
[2]NERC Airborne Research and Survey Facility

Source: http://www.esa.int/esaEO/SEMHR7AYT6H_index_1.html

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Editorial

Dear members,

During the 32nd EARSeL Symposium in Mykonos, a proposal for the foundation of an International Remote Sensing Academy (IRSA), an idea initiated by Rainer Reuter, was discussed with ISPRS representatives. A draft paper for this initiative can be found in this issue.

EARSeL has recently initiated a News Group to gather news information, which is believed to be of interest to the members of EARSeL, so that it can be distributed via various means. Moreover, a membership survey has been setup whose aim is for the Bureau to gain a better understanding of the memberships' wishes, the value of the benefits that are available to members and feedback on the recently initiated News Group. Both initiatives are headed by Samantha Lavender. Further details can be found in the "News from EARSeL" section.

A series of events from affiliated organisations have also been included in this issue such as: "The 35th International Symposium on Remote Sensing of Environment (ISRSE35)", during April 2013 in Beijing and "The Geospatial World Forum" during May 2013 in Rotterdam, The Netherlands. During November, a series of events are planned by the African Association of Remote Sensing of the Environment (AARSE), the Latin American Sociedad de Especialistas Latinoamericanos en Percepcion Remota (SELPER) and the AARS (Asian Association on Remote Sensing).

An article contribution from the University of Twente, The Netherlands, reporting on the recent developments in Earth observation satellites and sensors appears in the new rubric "Science Article".

Feedback from the EARSeL Linked Projects, "The MITRA Project", to preserve and valorize the natural and cultural heritage has also been included.

A reviewed contribution reprint from the "1st Workshop on Temporal Analysis of Satellite Images" that took place in Mykonos last May appears in this issue, as well as the most recently published paper on eProceedings.

The 33rd EARSeL Symposium, accompanied by four workshops, will be held in Matera, Italy, during June 2013, locally organised by Rosa Lasaponara. For more details on your contributions, please refer to the "Forthcoming EARSEL Conferences" section.

Last but not least, a list of conferences, summer schools and advanced courses to attend in the near future are included at the end of this Newsletter.

Please do not hesitate to contact us for any comments, suggestions or contributions to the EARSeL Newsletter.

Enjoy reading this September issue!

With best regards,

The Editorial Team

News from EARSeL

IRSA – Proposal for a Joint Remote Sensing Academy

At the ISPRS Centenary Celebrations in Vienna, July 2010, a Memorandum of Understanding was signed between the regional remote sensing organisations *Asian Association on Remote Sensing* (AARS), the *African Association of Remote Sensing of the Environment* (AARSE), the *Sociedad de Especialistas Latinoamericanos en Percepcion Remota* (SELPER) and EARSeL, where a joint interest had been expressed to establish an International Remote Sensing Academy.

A first draft of a concept paper for this initiative was discussed with ISPRS representatives during the 32nd EARSeL Symposium in Mykonos on 21 May.

Rainer Reuter

The International Remote Sensing Academy

1. Background

Remote sensing of the Earth covers many topics significant for all natural science disciplines at school and university. Prominent examples are atmospheric and oceanic circulation, which depend on physical forces. Vegetation on land and in the oceans as well as physical and chemical conditions driving biological productivity are of interest in biology, botany and geography. They are important for understanding the relationship between vegetation resources and their driving forces as well as for assessing the impact of climate change and other factors on vegetative growth and on biodiversity. Relevant examples in chemistry are the atmospheric gases and their reactions, for example freons and their interaction with ozone, and the impact of atmospheric pollutants (e.g., the sources and effects of greenhouse gases) as well as oceanic pollutants (e.g., hydrocarbons from oil spillages).

Remote sensing is hence a highly important tool for understanding the natural world, as much as for understanding the human impact. This includes information on land use and land cover, particularly over time, so as to relate the changes to economic, social, and physical driving forces.

Technical aspects are relevant as well, such as generation and detection of microwave and laser radiation, reflectance properties of materials at different wavelengths, methods of data transmission and of instrument design, the creation of mathematical and statistical tools for data analysis, and the role of models in understanding the environment.

These themes, which are but few examples from a much wider range of relevant subjects, are currently investigated in great detail using remote sensing. Satellite imagery and data derived from satellite sensors are available from studies of local, regional and even large scale phenomena, thus allowing to demonstrate the relations between local and global scales. Remote sensing data are used for explaining actual conditions on Earth. But they also provide information for outlining methods for the prediction of future developments – e.g., of the climate system – by using models.

2. Objectives

Expertise in all these fields of natural science is available in international scientific associations and societies engaged in Earth observation:

- the International Society for Photogrammetry and Remote Sensing (ISPRS)
- the European Association of Remote Sensing Laboratories (EARSeL)
- the Sociedad de Especialistas Latinoamericanos en Percepcion Remota (SELPER)
- the Asian Association on Remote Sensing (AARS)
- the African Association of Remote Sensing of the Environment (AARSE)

The organisations declare their great interest in advancing the use of remote sensing in the area of education and training, and promote the results of their scientific activities in public. With this aim, they jointly initiate and establish an **International Remote Sensing Academy (IRSA)**.

Each participating organisation will do its best to cooperate within the various meetings, symposia, activities of the partner organisations. This will enable a closer cooperation and a sustainable exchange of expertise among the member organisations.

IRSA will closely cooperate with national and international space agencies, and with teaching institutions engaged in environmental education.

3. Topical Framework

IRSA will be engaged in science education and training with emphasis on methods and results of remote sensing, and will make available products in the following areas:

a) education and training material for science and engineering disciplines at university level,
b) educational material for use in school at different levels, covering the curricula from elementary to high school, e.g., teaching units for teachers and students, eLearning tutorials, and worksheets for hands-on experiments and homework
c) training material for governmental organisations and authorities engaged in environmental protection and monitoring, e.g., through support of GMES services and similar international initiatives
d) organisation of educational workshops and summer schools on themes in the field of environment, technology, climate, impact on social and socioeconomic conditions, and other related issues
e) information on the various aspects of Earth observation for achieving a better understanding in the public on the status and evolution of environmental conditions on planet Earth
f) information on the specific expertise of member laboratories, and references to available training courses, practicals, master and PhD programmes, etc.

4. Organisation

a) IRSA will be established as an international non-profit Scientific Association. Registration will be at …
b) IRSA will be governed by a Supervisory Board. Every IRSA member organisation will be represented by four Board members. The term of Board members is two years, renewal is possible. The Supervisory Board shall elect the Executive Board among its members.
c) Every member organisation sends one delegate to the Executive Board. The Board has four offices: Chairman, Vice-Chairman, Secretary General and Treasurer. The term of Board members is two years, renewal is possible.
d) Communication and administration is done by the IRSA Secretariat. The initial seat of the Secretariat is decided by the member organisations through joint agreement; a change of the seat will be decided by the Executive Board later-on.
e) The budget resources required by the Secretariat are made available by the IRSA mother organisations. Missions of Executive Board members are financed by their respective mother organisations.
f) IRSA Workshops and Summer Schools are financed by registration fees of participants.
g) Costs for realising educational material etc. are financed by the IRSA mother organisations and through external funds.

5. Roadmap

- 2012: Proposal evaluation by AARS, AARSE, EARSeL, ISPRS and SELPER
- Jan 2013: Decision on work programme, statutes and registration procedures by the participating organisations, and approval by their Boards
- May 2013: Establishment of the IRSA Secretariat
- Sept 2013: Registration of IRSA
- Dec 2013: 1st meeting of the Supervisory Board, election of the Executive Board
- Jan 2014: Commencement of IRSA activities in Education and Training.

EARSeL News Feeds

EARSeL has initiated a News Group to gather news information, which is believed to be of interest to the members of EARSeL, so that it can be distributed via various means. The Group is headed by Samantha Lavender (Treasurer & Pixalytics Ltd) with support from Ioannis Manakos (Chairman & Center for Research and Technology - Hellas, Information Technologies Institute), Alata Elatawneh (Technische Universität München), Lachezar Filchev (Space Research and Technology Institute - Bulgarian Academy of Sciences) and Athanasios Moysiadis (University of Thessaly).

Initially this has included a:

- Company profile on LinkedIn at http://www.linkedin.com/company/earsel so that members can indicate their affiliation via their own LinkedIn profile;
- LinkedIn Group for the dissemination of information to and between members at http://www.linkedin.com/groups?gid=4538605 - please apply to join;
- Twitter feed for members and non-members as a means of promoting the Society to a wide audience @EARSeL_news - you are welcome to follow if you and/or your organisation have a Twitter account. Plus, it's also possible to pick-up an RSS feed via https://api.twitter.com/1/statuses/user_timeline.rss?screen_name=EARSeL_news

Please send any feedback, comments or queries to news@earsel.org

EARSeL Membership Survey

A membership survey has been setup via SurveyMonkey at:
http://www.surveymonkey.com/s/TSFSYKX

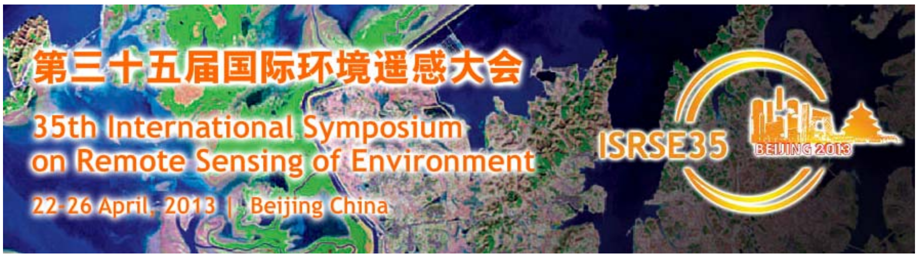
The aim is for the Bureau to gain a better understanding of the memberships' wishes, the value of the benefits that are available to members and feedback on the recently initiated News Group that aims to provide greater visibility for EARSeL on electronic networking platforms plus an alternative means for two-way information dissemination.

Please distribute this around your organisation as we would like to gather as wide a collection of views as possible. The final deadline for submission of responses, which should take no more than 5 minutes, is the 9th November 2012. The survey will be analysed and presented to the Council meeting in January 2012, and then the results will be presented at the General Assembly in Matera alongside a discussion on any key issues that arise.

Please send any feedback, comments or queries to samantha.lavender@earsel.org

News from Other Organisations

The 35th International Symposium on Remote Sensing of Environment (Beijing, 2013)



The **35th International Symposium on Remote Sensing of Environment (ISRSE35)** will be held in **Beijing** from **April 22nd to 26th, 2013**.

This is the first symposium in the series to be held in China, Beijing. With the expert guidance of the International Center for Remote Sensing of Environment (ICRSE) and International Society for Photogrammetry and Remote Sensing (ISPRS), the 35th ISRSE is certain to continue the excellent tradition established by previous symposia.

The theme of the 2013 symposium is **"Earth Observation and Global Environmental Change - 50 Years of Remote Sensing: Progress and Prospects"**. Back in 1962, the first ISRSE was convened in Ann Arbor, Michigan. The symposium brought together scientists from around the world to exchange technical information on an emerging technology called remote sensing, which provided the capability to view the Earth from high-altitude aircraft and, ultimately, spacecraft. In its 50 years of development, Earth observation has advanced significantly, and remote sensing has become a mature technology for observing the Earth and monitoring global environmental change. This symposium will review the progress of remote sensing and prospects for its future, and celebrate its half-century history.

For more information please visit: http://www.isrse35.org

The Geospatial Word Forum (The Netherlands, 2013)

Save the Dates for "The Premier Geospatial Industry Event"

The Geospatial World Forum will take place from **13 – 16 May, 2013** at **Beurs-World Trade Center, Rotterdam, The Netherlands**.

With the theme **"Monetising Geospatial Value and Practices"**, the conference will invite discussions and deliberations on the ways each geospatial stakeholder community, be it the government decision makers, end-users or technology providers can extract the maximum utility and benefits out of their investments into geospatial infrastructure and carry forward the value created by this industry.

Paper abstracts are invited on themes related to geospatial technology and its application by **15th October 2012**.

For more information please visit: www.geospatialworldforum.org

Annual Meetings of International Partner Societies

The **African Association of Remote Sensing of the Environment (AARSE)** will hold its 9th Conference on 29 October - 2 November 2012 in Eljadida, Morocco.

The **Latin American Sociedad de Especialistas Latinoamericanos en Percepcion Remota (SELPER)** will organise the Symposium 2012 on 19-23 November in Cayenne, French Guiana.

AARS, the Asian Association on Remote Sensing, will meet for the 33rd ACRS Conference on 26-30 November in Pattaya, Thailand.

Science Article

Satellites and Sensors

This article reports on recent developments in Earth observation satellites and sensors. Any input and comments can be sent to Wim Bakker bakker@itc.nl.

The Landsat Missions

In November 2010, the four-millionth Landsat image was downloaded from a USGS Web site at its Earth Resources Observation and Science (EROS) Center in Sioux Falls, South Dakota. When the U.S. Geological Survey (USGS) opened the Landsat archive to user access at no charge in October, 2008, nobody could have predicted that so many scenes would be distributed in such a short period.

Presently, more data are distributed in one week than in the year prior to the archive being opened.

Landsat 5

Landsat 5, launched in March 1984 with a three-year design life, continues providing imagery via its Multispectral Scanner. Landsat 5's primary instrument, the Thematic Mapper (TM), collected data for over 27 years until a data transmission problem ended its operation in November 2011. Landsat 5 was put into a safe state while the USGS did everything it could to restore imaging operations. The Multispectral Scanner (MSS) instrument on Landsat 5 was reactivated, with these data archived, but processing and distribution will not be possible until the USGS develops the necessary product generation capabilities.

Landsat 7

Landsat 7, launched in 1999 with a five-year design life, is still generating up to 400 scenes of moderate-resolution Earth imagery daily through its science instrument, the Enhanced Thematic Mapper Plus. On May 31, 2003 the Scan Line Corrector (SLC) in the ETM+ instrument failed. As a result, the instrument images the Earth in a "zig-zag" fashion. The net effect is that approximately 22% of the data in a Landsat 7 scene is missing when acquired.

Some sources suggest that Landsat 7 may be decommissioned after the launch of Landsat 8.

LDCM (Landsat 8)

The LDCM is fully assembled and currently undergoing validation and structural testing at Orbital. The satellite will be launched no earlier than February 2013. The LDCM satellite will carry two-sensors. One sensor, the Operational Land Imager (OLI), will collect image data for nine shortwave spectral bands (0.43 to 2.3 micron) over a 185 km swath with a 30 m spatial resolution for all bands, except a 15 m panchromatic band. The other sensor, the Thermal Infrared Sensor (TIRS), will collect image data for two thermal bands (10.5 and 12 micron) with a 100 m resolution over a 185 km swath.

The A-Train

The "A-Train" (from Afternoon Train) consists of a series of satellites flying relatively close in the same orbit. The satellites are spaced a few minutes apart and cross the equator at around 13:30 solar time. Hence the name, in which the "A" stands for "afternoon". Because the satellites are flying close together, their observations may be used together for scientific observations of the Earth's atmosphere and surface. The A-Train currently consists of the following satellites: Aqua (studying the water cycle), Cloudsat (measuring cloud properties), Calipso (NASA and CNES satellite for monitoring aerosols and clouds) and Aura (observing ozone, air quality and climate). One satellite, PARASOL launched by CNES on 18 December 2004, which for some time was part of the A-Train, was moved to a lower orbit in December 2009. Unfortunately, two other satellites that were meant to take part in the A-Train were lost during launch. OCO, NASA's Orbiting Carbon Observatory, was destroyed by a launch vehicle failure on 24 February 2009. Glory, NASA's mission for aerosol observation, failed during launch on 4 March 2011.

The counterpart of the A-Train is the Morning Train consisting of four satellites, Landsat-7 launched 15 April 1999, Terra launched 18 Dec 1999, and EO-1 and SAC-C both launched 21 Sept 2000. All these satellites have far surpassed their design life-time.

ENVISAT Roadmap

ENVISAT stopped working earlier this year on 8 April 2012 right after its tenth operational anniversary in space, which was double the five-year planned life-time of the satellite. It was the successor to ESA's ERS satellites. With its 10 instruments and its weight of eight tons it was one of the largest if not the largest of the civilian Earth observation missions. Now that ENVISAT is gone there is a need to fill in the gaps in the data stream that it supplied. One of its instruments, the Advanced Along Track Scanning Radiometer (AATSR), was used for measuring sea-surface temperature (SST).

Sentinel-3

The next ESA mission foreseen to continue the SST dataset is Sentinel-3, being developed under Europe’s Global Monitoring and Environmental Security (GMES) program. Planned for launch in April 2014, the Sentinel-3 Sea and Land Surface Temperature Radiometer (SLSTR) extends the capability of AATSR, having a wider swath and more channels.

ALOS

Advanced Land Observing Satellite (ALOS), also called "Daichi", is a Japanese satellite. It was launched on 24 January 2006. The satellite carries three remote sensing instruments, the Panchromatic Remote-sensing Instrument for Stereo Mapping (PRISM, resolution 2.5 m), the Advanced Visible and Near-Infrared Radiometer type 2 (AVNIR-2, resolution 10 m), and the Phased Array type L-band Synthetic Aperture Radar (PALSAR, resolution 35-150 m). In 2008 it became clear that the images it produced were of insufficient quality for map-making at a scale of 1:25,000. On Thursday 21 April 2011 the satellite automatically switched to a power-saving mode at 2230 GMT. Later that day, all onboard power was lost.

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Feedback from EARSeL Linked Projects

The MITRA project

The MITRA project, funded by the Basilicata Region, aims to develop tools for the preservation and valorization of natural and cultural heritage. EARSeL is an active partner of the project and will be involved in a number of education and dissemination activities which are directed to the distribution of the project's research results and foresee:

(a) the creation and periodic updating of an interactive web-site with material for research, students and the general public
(b) the creation of a documentary video of the research activities conducted in some test sites selected from within the Basilicata Region
(c) the designing and distribution of educational material made available at no charge
(d) the organisation of a workshop, lectures, disclosure texts, interviews and reports

The Project rationale is based on the fact that the preservation and enhancement of the natural and cultural heritage is one of the topics of great economic and social significance, especially in this complex global financial crisis. Recently, the debate on strategies for the development of integrated environmental and cultural heritage has seen increasing importance mainly due to the fact that:

(i) cultural heritage has an increasingly significant role in the context of economic development models based on local identities;
(ii) environmental heritage is regarded as a key factor in the development of local resources. Heritage can be a resource for economic development based on the principles of sustainable use of unique non renewable resources not only for the benefit of society, but also as a useful source of human development.

Examples of the methodological approaches, adopted in the MITRA project to improve both preservation and smart management of natural and cultural heritage, can be found in a number of publications by Rosa Lasaponara (scientific coordinator of the MITRA project), among them are investigations [Lasaponara and Masini 2006, 2007, 2009, 2011, 2012] carried out near the medieval village of Monte Irsi or Yrsum, located in the Basilicata Region (Southern Italy).

For this test pilot area, analyses were performed using historical documentation along with data from non invasive remote sensing technologies, such as satellite imagery, aerial photos and LiDAR surveys in order to detect unknown features (see figure 1), reconstruct the urban shape of the village and monitor the evolution of the palaeo-landslide (see figure 2) that can adversely affect the archaeological area. Finally, the virtual reconstruction (see figures 3-4) enables the valorization of the site including a museum exhibition and/or touristic purposes and the educational activity.

Rosa Lasaponara (CNR-IMAA)
EARSeL Secretary General

References

Lasaponara R., Masini N. 2007, Detection of archaeological crop marks by using satellite QuickBird, *Journal of Archaeological Science*, 34, pp. 214-221 [ISSN: 0305-4403] [10.1016/j.jas.2006.04.014].

Lasaponara R., Masini N. 2006, On the potential of Quickbird data for archaeological prospection, *International Journal of Remote Sensing*, 27 (15-16), pp. 3607-3614. [ISSN: 0143-1161] [DOI: 10.1080/01431160500333983].

Lasaponara R., Masini N. 2009, Full-waveform Airborne Laser Scanning for the detection of medieval archaeological microtopographic relief, *Journal of Cultural Heritage*, 10S, pp. e78–e82 [doi:10.1016/j.culher.2009.10.004].

Lasaponara R., Masini N., Satellite Remote Sensing: A New Tool for Archaeology, Springer Verlag. 360 pp, 2012.

Lasaponara R., Masini N. 2011. On the Processing of Aerial LiDAR Data for Supporting Enhancement, Interpretation and Mapping of Archaeological Features. In B. Murgante et al. (Eds.), Computational Science and its applications - ICCSA 2011, Part II, LNCS 6783, pp. 392–406, Springer-Verlag Berlin Heidelberg, ISBN 978-3-642-21886-6, doi 10.1007/978-3-642-21887-3.

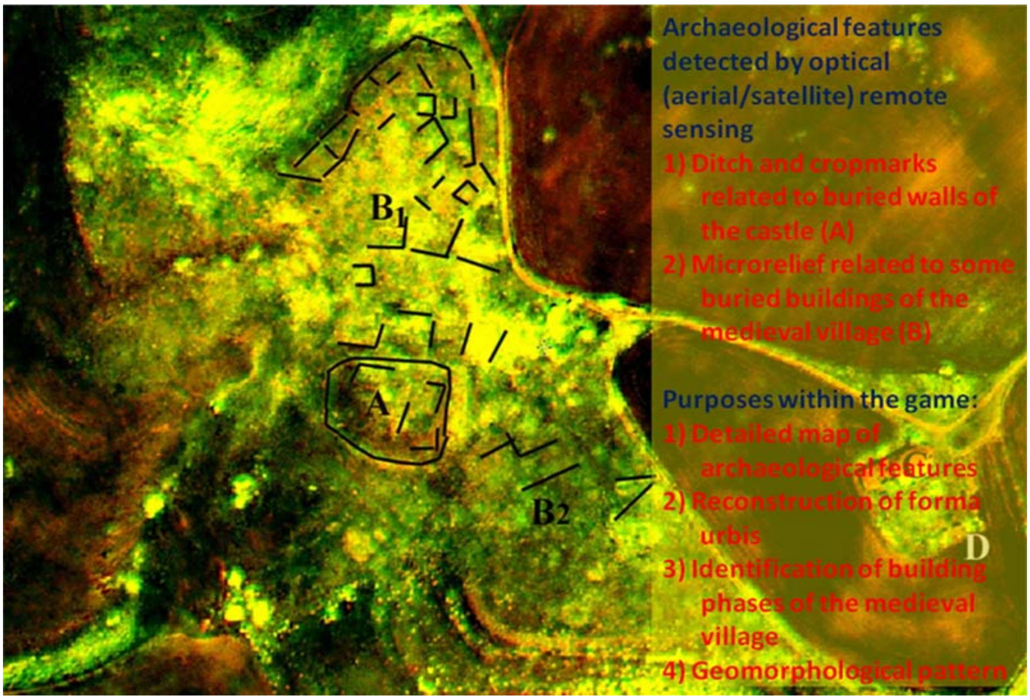

Figure 1: First approach: discovery of unknown archaeological features using VHR satellite data more details at Lasaponara and Masini, 2006.

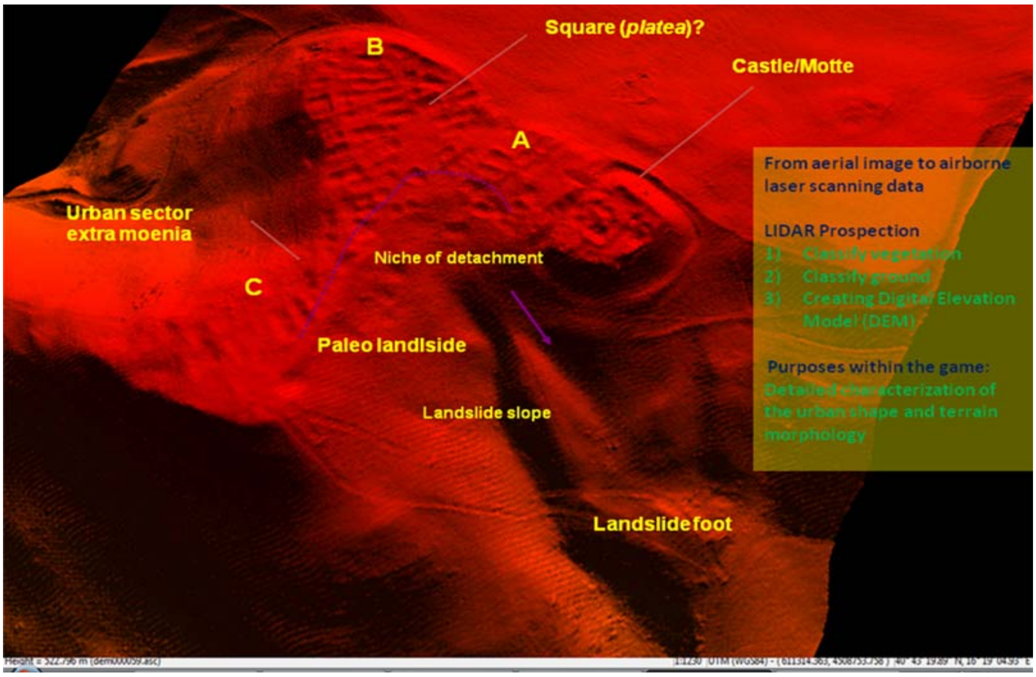

Figure 2: Identification of urban shape of the lost medieval village and palaeo-landslide, more details at Lasaponara and Masini, 2009.

Figure 3: Reconstruction of urban shape based on LiDAR survey.

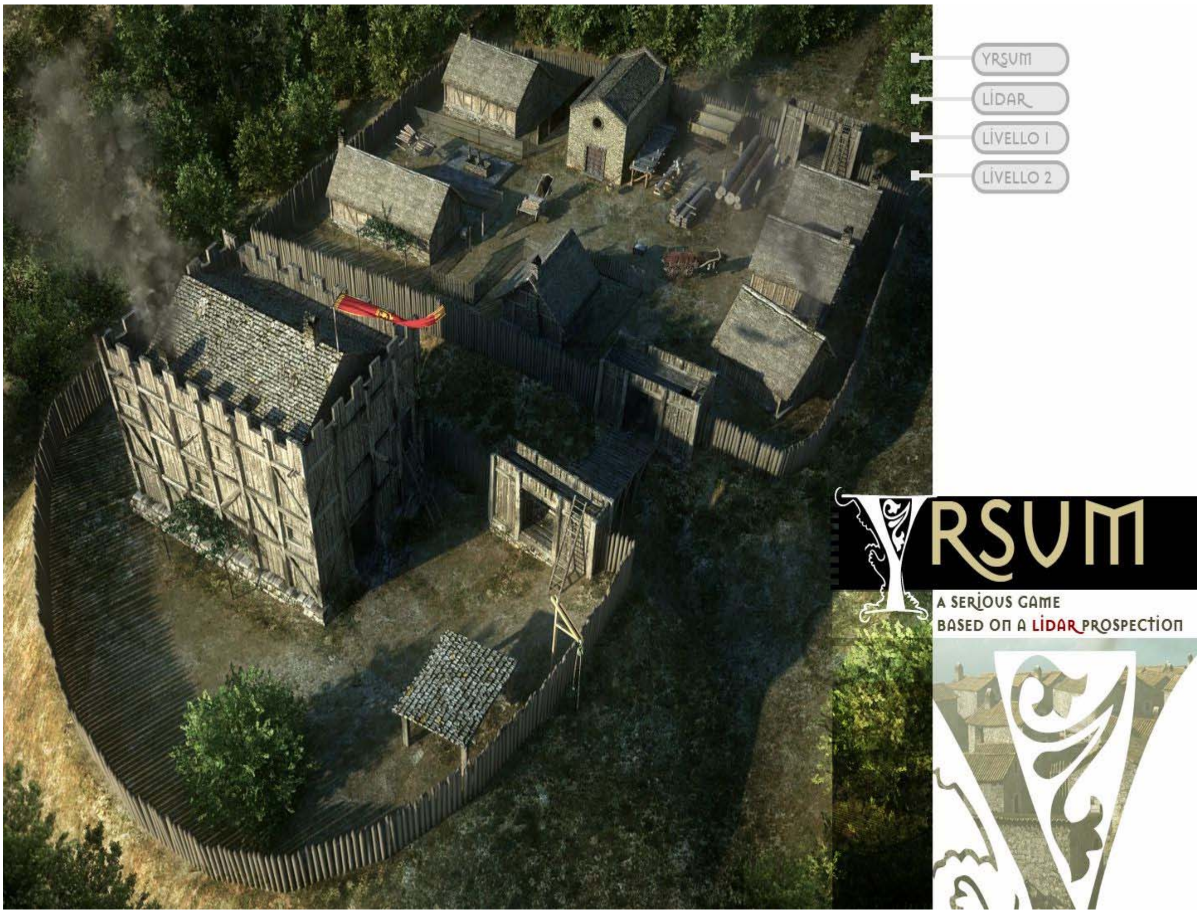

Figure 4: 3D Reconstruction based on LiDAR survey for educational activities.

1st Workshop on Temporal Analysis of Satellite Images Reprint

Multitemporal Very-High Resolution SAR Data for Urban Land Cover Mapping Using a Knowledge-Based SEM Algorithm

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Abstract. The objective of this research is to assess the multitemporal very-high resolution single polarization SAR data for urban land cover mapping using a novel knowledge-based SEM algorithm. Three-date RADARSAT-2 ultra-fine beam SAR data were collected over the rural-urban fringe of Greater Toronto Area. A modified Stochastic Expectation-Maximization (SEM) algorithm which employs an adaptive Markov Random Field (MRF) and the Finite Mixture Model (FMM) was proposed for the supervised classification. Several SAR intensity distribution models such as Gamma, K, G0 and Fisher were compared using the algorithm. A set of rules according to the diversity of the land cover texture patterns was further applied in the decision fusion to improve the urban land cover classification. Preliminary results show that the proposed algorithm which explores the spatio-temporal information with the knowledge about the ultra-high urban SAR textures could produce reasonable classification results. Homogeneous urban land cover maps could be obtained while the detailed shape features could be preserved. Although the overall classification accuracy of the single polarization data set is not as high as desired, more details could be identified in the very-high resolution SAR data. Using unique very-high resolution SAR textures, rules were designed to effectively improve the classifications of several land cover classes thus improve the overall classification accuracy.

Introduction

As one of the most important remote sensing applications, urban land cover mapping has gained increasing attentions in light of the accelerating worldwide urbanizations. Within many sensors, SAR is known as an excellent observation instrument as it is independent of solar illumination and weather conditions. With the launch of RADARSAT-2 and TerraSAR-X, SAR observations in high resolution have become routinely available. They present excellent opportunities for developing effective methods for urban land cover mapping.

Urban land cover mapping using higher resolution data is a challenge as higher resolution brings higher variance within each land cover category. To this end, object-based approaches (i.e. 1, 2) are often considered as a promising way for high resolution data. However, successful employment of such approach depends on proper segmentation results which are usually difficult to achieve using the SAR data in complex urban areas. On the other hand, several pixel-based contextual approaches (i.e. 3, 4, 5, 6) have been proposed to produce homogenous mapping results with high accuracy. In (3), for example, a modified SEM algorithm employing an adaptive MRF and the FMM has been identified as an efficient approach for supervised urban mapping.

Besides the contextual information, texture information has also been used to improve urban land cover classification. Particularly, grey level co-occurrence matrix (GLCM) have long been recognized as valuable for identifying various urban patterns (i.e. 7, 8, 9), especially when using the single polarization data.

Therefore, in this paper, a novel pixel-based contextual algorithm is proposed to evaluate the multitemporal very-high resolution single polarization HH data for urban mapping. Textures from the very-high resolution SAR images are explored by a rule-based approach for improving the classification results. The potential and the limit of using multitemporal single polarization very-high resolution SAR data for urban mapping are discussed.

Methods

Generally, the proposed algorithm is based on a modified SEM framework as illustrated in Figure 1. Brief descriptions about each component will be given in the following subsections. For detailed information about this algorithm one could refer to (3). In this paper, further improvement is made by introducing a rule-based decision fusion process through exploring the SAR textures.

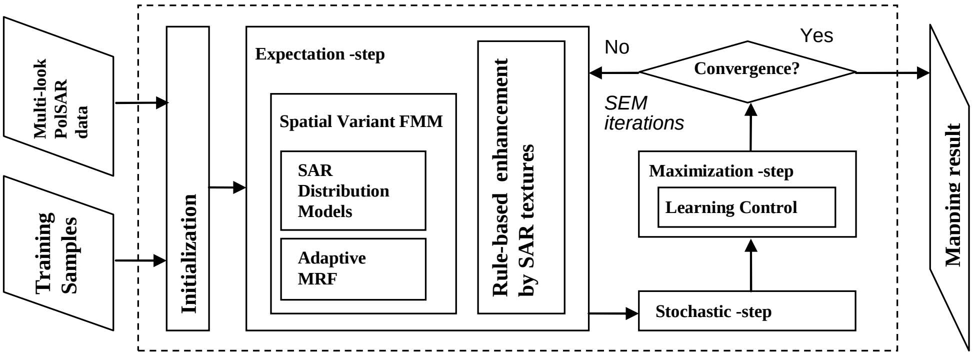

Figure 1: Flowchart of the proposed algorithm.

A. Adaptive MRF

As an effective way to explore the contextual information, MRF is often employed to model local constraints. With this assumption, the neighbourhood influence could be described by a Gibbs probability:

$$p(L_s \mid L_r, r \in \eta_s) = \frac{1}{Z_s} \exp\{-U(L_s \mid L_r, r \in \eta_s)\}. \quad [1]$$

This gives a measure of the prior probability that the pixel s is labelled as Ls when the neighbour r in the neighbourhood of s: η_s is marked as Lr. Z_s is a normalization factor. U(.) represents an energy function. Traditional MRF assumes a fixed neighbourhood structures and fixed energy function form. Such fixed configuration often leads to an “over-averaging” results and loses the structural details. To prevent such negative effects, an adaptive MRF based on an anisotropic Potts model is proposed by adaptively selected the neighbourhood shapes and the impact of the MRF analysis. The best neighbourhood shape which is assumed to have the lowest standard deviation will be selected from the five candidate templates as illustrated in Figure 2.

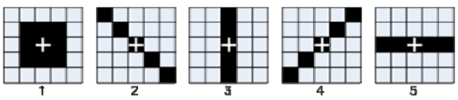

Figure 2: Candidate neighbourhoods for adaptive MRF.

Moreover, an adaptive energy function is given as:

$$U(L_s \mid L_r, r \in \eta_s) = -(\beta(1-b_s)\sum_{r\in\eta_s} \delta(L_s - L_r)). \quad [2]$$

where β is the Ising-Potts model impact. $\delta(\cdot)$ is the Kronecker delta function. bs measures the homogeneity of the neighbourhood η_s . The calculation of bs could be found in (10).

B. Spatial Variant FMM

FMM is commonly used to represent the heterogeneity of the observations. FMM assumes each datum is a mixture of a finite number of latent classes. The weight of each class is measured by the normalized probabilities. By FMM, the Probability Density Function (PDF) of an intensity observation I at location s is expressed as:

$$f(C_s) = \sum_{i=1}^{g} \rho_i f_i(I_s \mid \Theta) \quad [3]$$

where ρ_i is the prior probability of class i in g classes. According to the spatially variant FMM (11), it could also be represented by the MRF prior probability. $f_i(I_s \mid \Theta)$ is the likelihood of the intensity observation for class i with the model parameters denoted by Θ. For simplicity, the likelihood of multitemporal observations was modelled as the product of the PDFs from each date intensity data. Therefore, the mixture model density function could be rewritten as:

$$f(C_s) = \sum_{i=1}^{g} \rho_{si} f_i(I_s \mid \Theta) = \sum_{i=1}^{g} p(L_s = i \mid L_r, r \in \eta_s)(\prod_{t=1}^{m} f_{it}(I_{st} \mid \theta_{it})) \quad [4]$$

Where $f_{it}(I_{st} \mid \theta_{it})$ is the PDF of the intensity distribution of class i on date t. θ_{it} are the corresponding distribution parameters. I_{st} is the observation of the date t. m is the total dates.

C. Contextual SEM

To estimate the distribution models in the clustering process, SEM algorithm is often employed. Indicating the iteration index by the superscript k, the proposed contextual algorithm could be described as follow:

Initialization: estimating the initial intensity distribution parameter θ_{it}^{0} of each class in each date according to the training samples. The initial MRF prior probability is equally set with 1.

E (Expectation)-Step: for each pixel s, calculate the MRF probability $p^k(L_s \mid L_r, r \in \eta_s)$ based on the classification of the last iteration and update the posterior probabilities for each class i by

$$\tau_{si}^{k} = \frac{p^k(L_s = i \mid L_r, r \in \eta_s)(\prod_{t=1}^{m} f_{it}(C_{st} \mid \theta_{it}^{k}))}{\sum_{l=1}^{g} p^k(L_s = l \mid L_r, r \in \eta_s)(\prod_{t=1}^{m} f_{lt}(C_{st} \mid \theta_{lt}^{k}))} \quad [5]$$

S (Stochastic)-Step: according to the posterior probability τ_{si}^{k}, randomly label the current pixel. After all the pixels, a new map is generated with the pixels classified into g class $\{Q_1^k, \cdots, Q_g^k\}$.

M (Maximization)-Step: update the intensity distribution parameters θ_{it}^{k+1} with the pixels belonging to the class group Q_i^k for each date.

Such E-, S- and M- steps form an iteration cycle, and runs until the convergence point is met. To prevent the degenerate problems, a learning control scheme based on the similarity measure is further provided in the M-Step. Details about such algorithm could be found in (3).

D. Texture Enhancement Scheme

Through analysing the GLCM textures of the very-high resolution SAR data, we have found there is obvious difference between the urban and non-urban area by using the GLCM 2nd moment parameters. And the GLCM dissimilarity could be an efficient indicator for distinguishing the low-density (LD) and high-density (HD) areas. Such GLCM texture differences for identifying the urban patterns from the very-high resolution data are found even more significant than that from the high resolution data. Moreover, the temporal characteristics of the GLCM textures are noticed for classifying the forest and crops. For example, the GLCM 2nd moment of Jun. 25 SAR is better to differentiate the forest and crop2. And the GLCM Mean ratio of Sep. 02 to Jun. 25 SAR is useful to separate the forest and crop1. Based on such knowledge, a texture enhancement scheme is proposed as illustrated in Figure 3.

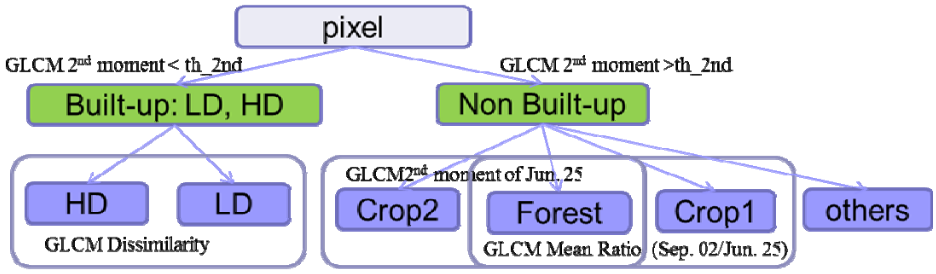

Figure 3: Texture enhancement scheme.

First, each pixel is assigned to the built-up and non-built-up areas. For the built-up area, the FMM only includes the LD, HD classes. For the non-built-up area, the other classes are counted in. Therefore, the latent finite class group is g={built-up classes} or {non built-up classes} in the above mentioned situations. The texture based decision is fused with the posterior probabilities [5]. For the two classes which could be further differentiated by certain texture information, i prefers the smaller texture value, but j prefers the higher texture value, the new posterior probabilities are given as:

$$\begin{cases} \tau_{si}^{k}\_with\_texture = \tau_{si}^{k} \cdot (th\_ij / val\_texture) \\ \tau_{sj}^{k}\_with\_texture = \tau_{sj}^{k} \cdot (val\_texture / th\_ij) \end{cases} \quad [6]$$

Data and Experiments

Three-dates RADARSAT-2 ultra-fine beam C-HH SAR data with the nominal pixel spacing about three meters were collected over the rural-urban fringe of Greater Toronto Area in Jun. 25, Aug. 12 and Sep. 05, 2008. They are all in ascending orbit with similar incident angles (30.6-32.0°). The images are first orthorectified and then followed by a multi-look process with a 4x4 window. The pixel spacing of the final prepared images is 8 x 8 meters. The major land cover classes were high-density built-up areas (HD), low-density built-up areas (LD), grass, golf course, forest, water and two types of crops. Training samples for each class is about 1600. Test samples were randomly selected. Four common intensity distribution models, namely Gamma, K, G0 and Fisher (12, 13) were compared in the proposed algorithm which is further optimized with parallel computing in C++.

Results and Discussion

The very-high resolution multitemporal data was evaluated first without the texture enhancement rules (Table 1). It was found that the overall classification accuracies for all models are rather poor. Over all, G0 and Fisher could produce better results than K and Gamma models with comparable time cost. K model cost considerable longer time. G0 and Fisher all had better performance for the built-up areas as LD and HD. Water, grass and crop 2 achieve good classification results for all models. However, for any model, the producer accuracy of LD is near 0, which could also be observed in the selected result samples by the G0 model in Figure 4.

By applying the texture enhancement rules, significant improvement could be observed as summarized in Table 1 and compared in Figure 4. Such enhancement is more evident for the LD class, Forest and crops, as the rules were designed for. Using the texture rules, almost all the LD area could be correctly identified, which also improved the user accuracy of the Forest. By the rules for distinguishing forest and crops, the producer accuracy of forest and user accuracy of crops also increased significantly. The texture strategy also improves the HD class as well. The overall accuracy and Kappa were improved significantly. Moreover, such improvement only cost very little extra time considering the total time is from 15.7 min without rules to 17.1 min with rules.

Table 1: Results using various intensity distribution models and improvement by the rules. "P" and "U" are respectively the producer and user accuracy. OA is overall accuracy.

	Gamma		K		G0		Fisher		G0+rules	
	P	U	P	U	P	U	P	U	P	U
Water	0.87	0.81	0.88	0.82	0.87	0.85	0.87	0.84	0.87	0.85
Golf course	0.52	0.55	0.54	0.56	0.63	0.57	0.62	0.55	0.63	0.57
Grass	0.78	0.69	0.76	0.68	0.75	0.69	0.74	0.68	0.65	0.72
LD	0.01	0.31	0.01	0.32	0.07	0.49	0.05	0.46	0.92	0.72
Crop1	0.72	0.48	0.71	0.47	0.69	0.46	0.71	0.47	0.68	0.66
Crop2	0.88	0.53	0.87	0.53	0.87	0.62	0.86	0.60	0.89	0.90
Forest	0.50	0.27	0.51	0.27	0.52	0.33	0.52	0.31	0.78	0.63
HD	0.47	0.83	0.48	0.83	0.62	0.76	0.60	0.78	0.67	0.94
OA	0.54		0.54		0.59		0.58		0.77	
Kappa	0.46		0.46		0.51		0.50		0.73	
Average Iteration time	2.1 min		3.3 min		2.2 min		2.2 min		2.4 min	
Total time	14.5 min		23.3 min		15.7 min		15.8 min		17.1 min	

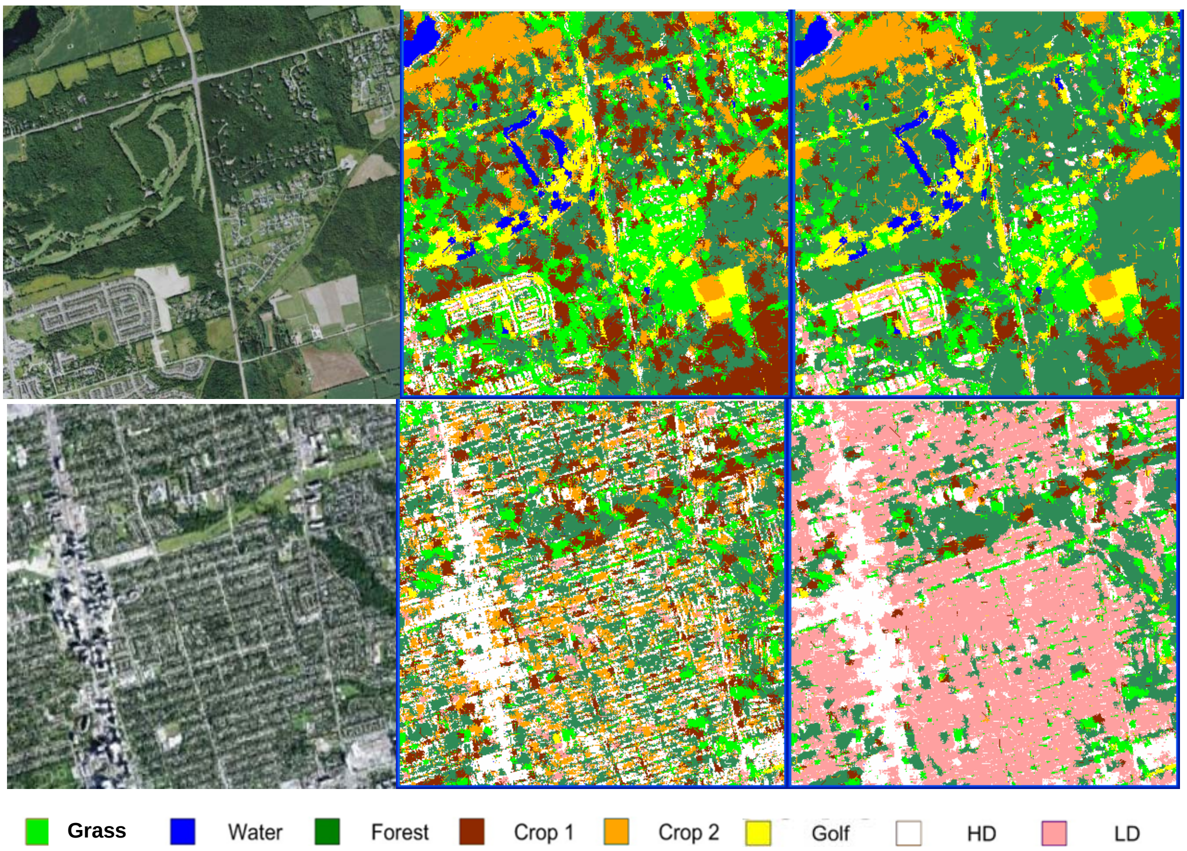

Figure 4: Selected samples of the classification results. Left column: ground truth; Middle column: using G0 model without texture rules; Right column: using G0 model with texture rules.

Conclusions

The proposed Knowledge-Based SEM Algorithm could integrate the spatio-temporal information to produce homogenous mapping results with reasonable accuracy. Texture information could be effectively explored by the rules to significantly enhance the results with small time cost. Although very-high resolution single polarization HH SAR data has limited ability for urban mapping, the unique very-high resolution textures have the great potential to improve urban land cover classification.

Acknowledgements

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References

1 Ban Y, H Hu and I M Rangel, 2010, Fusion of QuickBird MS and RADARSAT SAR data for urban land-cover mapping: object-based and knowledge-based approach. International Journal Remote Sensing, 31: 1391-1410.

2 Niu X and Y Ban, 2012, Multitemporal RADARSAT-2 Polarimetric SAR Data for Urban Land Cover Classification using an Object-based Support Vector Machine and a Rule-based Approach. International Journal of Remote Sensing, accepted for publication.

3 Niu X and Y Ban, 2012, An adaptive contextual SEM algorithm for urban land cover mapping using multitemporal high-resolution polarimetric SAR data. IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, accepted for publication.

4 Zhong P and R Wang, 2009, Image segmentation based on Markov random fields with adaptive neighborhood systems. Optical Engineering, 45: 462-465.

5 Garzelli A, 1999, Classification of polarimetric SAR images using adaptive neighborhood structures. International Journal of Remote Sensing, 20: 1669-1675.

6 Wu Y, K. Ji, W. Yu and Y. Su, 2008, Region-based classification of polarimetric SAR images using Wishart MRF. IEEE Geoscience and Remote Sensing Letters, 5: 668-672.

7 Ban. Y. and Q. Wu. 2005. “RADARSAT fine-beam SAR and GIS data for urban Landuse and land-cover mapping“, In: Proceedings, 8th AGILE Conference on GIScience, Estoril, Portugal.

8 Gamba P, M Aldrighi and M Stasolla, 2011, Robust Extraction of Urban Area Extents in HR and VHR SAR Images. IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, 4: 27-34.

9 Dell'Acqua F and P Gamba, 2003, Texture-based characterization of urban environments on satellite SAR images. IEEE Transactions on Geoscience and Remote Sensing, 41: 153-159.

10 Lee Jong-Sen, MR Grunes and G de Grandi, 1999, Polarimetric SAR speckle filtering and its implication for classification. IEEE Transactions on Geoscience and Remote Sensing, 37: 2363-2373.

11 Celeux G, F Forbes, and N Peyrard, 2003, EM procedures using mean field-like approximations for Markov model-based image segmentation. Pattern Recognition, 36: 131–144.

12 Tison C, J-M Nicolas, F Tupin, and H Maître, 2004, A new statistical model for Markovian classification of urban areas in high-resolution SAR images. IEEE Transactions on Geoscience and Remote Sensing, 42: 2046–2057.

13 Frery A C, H-J Muller, C C F Yanasse, and S J S Sant'Anna, 1997, A model for extremely heterogeneous clutter. IEEE Transactions on Geoscience and Remote Sensing, 35: 648-659.

EARSeL eProceedings

New Publications in Vol. 11(2), 2012

Effect of variations in salinity and nitrogen concentration on photophysical parameters of phytoplankton obtained with fluorescence spectroscopy

Timofey Gostev, Fedor Kouzminov, Maxim Gorbunov, Elena Voronova, and Victor Fadeev

Abstract Read full paper online: http://www.eproceedings.org

Variations in salinity and nitrogen concentration in the aquatic environment are among the observed effects of global climate change. They affect the structure of phytoplankton communities and the physiological state of algae and cyanobacteria. Results of laboratory studies of these effects are presented. A combination of Nonlinear Laser Fluorimetry (NLF) and Fluorescence Induction and Relaxation (FIRe) fluorimetry is used to evaluate the photophysical parameters of photosystem II and Chlorophyll a in native samples of the diatom algae *Thalassiosira weissflogii*, the zooxanthellae *Symbiodium sp. CCMP 2467*, and the cyanobacteria *Synechococcus sp. CCMP 1379*, grown under different salinity (40, 18, and 5 psu) and nitrogen concentration (normal, ×0.5, ×2).

Cyanobacteria are shown to be most resistant to these variations, while zooxanthellae are the most sensitive species. This suggests that an effect of global climate change on the phytoplankton community might be the transformation of its structure towards an increasing role of cyanobacteria. Another alarming outlook is the negative impact of climate change on the physiological state of corals, which live in symbiotic relationship with zooxanthellae. This suggests that the reasons for the degradation of coral reefs are not entirely anthropogenic. It is suggested that coral reef monitoring of variations in the photophysical characteristics of zooxanthellae might be one of the most effective ways for detecting the influence of global climate change on marine biota in early stages. It is advisable to monitor coral reefs in the oceanic areas with lowest anthropogenic impact as "background stations" for climate change monitoring.

Recent Books

Statistics for Imaging, Optics, and Photonics is available from Wiley Publishing written by Peter Bajorski.

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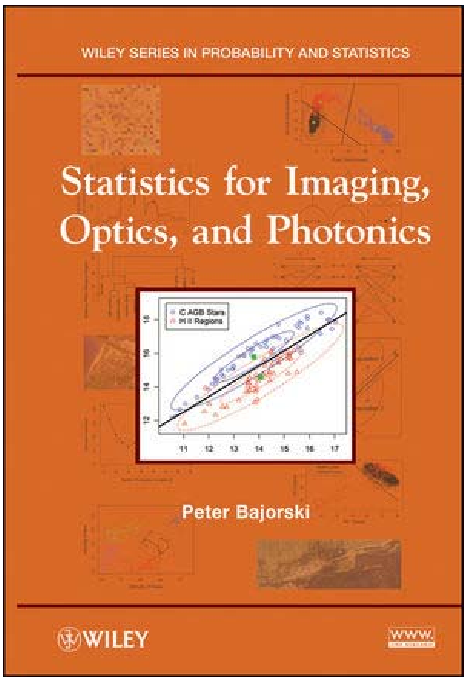

- Linear regression models, vector and matrix algebra, and random vectors and matrices
- Multivariate statistical inference, including inferences about both mean vectors and covariance matrices
- Principal components analysis
- Canonical correlation analysis
- Discrimination and classification analysis for two or more populations and spatial smoothing
- Cluster analysis, including similarity and dissimilarity measures and hierarchical and non hierarchical clustering methods

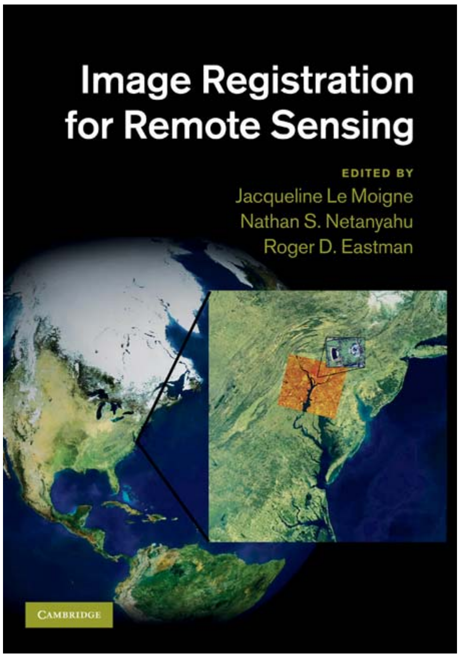

Image Registration for Remote Sensing is available from Cambridge University Press, edited by: Jacqueline Le Moigne, NASA-Goddard Space Flight Center, Nathan S. Netanyahu, Bar-Ilan University, Israel and University of Maryland, College Park and Roger D. Eastman, Loyola University Maryland.

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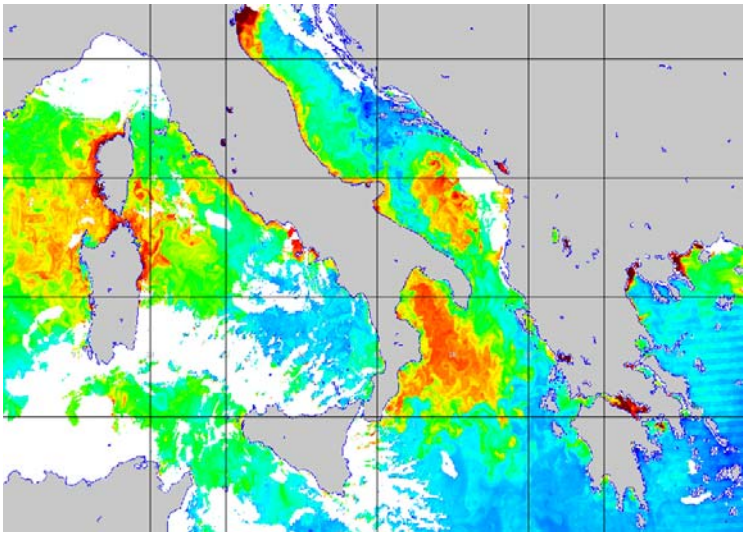

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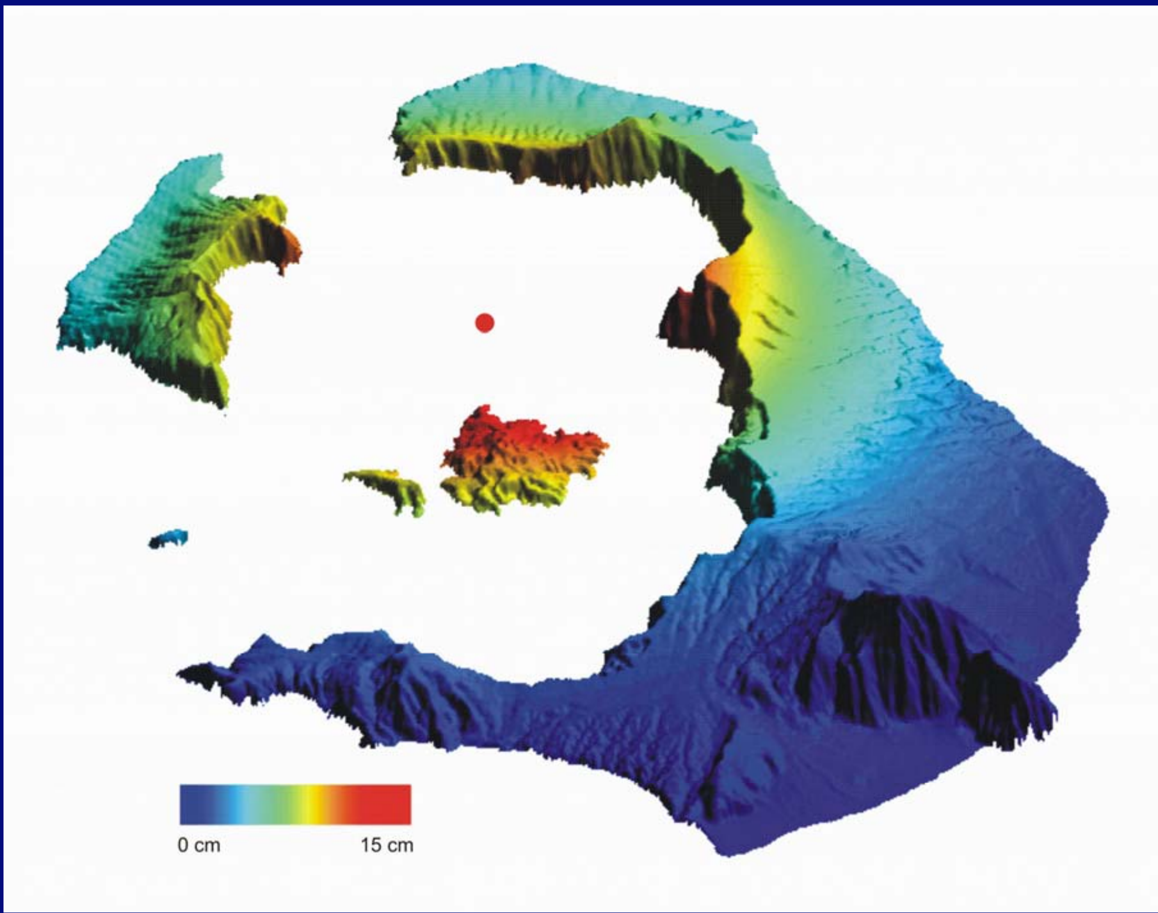

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