

ESSC Remote Sensing workshop

Time: 25th November 2010 (13:30-18:00)

Place: D.3.04

1<sup>st</sup> Session (13:30)

1. Tracing human activities with DEM - Joyce Paesen, Sara Adriaenssens, Marc De Bie, Dries Tys, Erwin Meylemans and Guido Creemers
2. Monitoring activity and constraining eruptive history of African volcanoes using multispectral satellite data - Matthieu Kervyn
3. Detection of aerosols and other climatological effects by remote sensing using GERB/SEVIRI - Stijn Nevens

Coffee break

2<sup>nd</sup> Session (14:45)

4. Remote sensing based calibration of the MOLAND land-use change model - Tim Van de Voorde
5. Impact assessment of urbanisation on hydrology for the River Tolka in Dublin, Ireland - Boud Verbeiren, Tim Van de Voorde, Frank Canters and Okke Batelaan
6. Region-based and pixel-based classification techniques for urban impervious surface mapping and the impact on simulated runoff - Eva Ampe
7. Multiple endmember spectral unmixing of impervious surface in Brussels region using CHRIS/Proba - Luca Demarchi, Frank Canters, Tim van de Voorde, Jianglin Ma and Jonathan C-W Chan

Coffee break

3<sup>rd</sup> Session (16:20)

8. Assessment of mangrove vegetation based on remote sensing and ground-truth measurements at Tumpat, Kelantan Delta, East coast of Peninsular Malaysia - Behara Satyanarayana, Mohamad Khairul Azwan, Indra Farid Idris, Husain Mohd-Lokman, Farid Dahdouh-Guebas
9. Mapping *Posidonia Oceanica* meadows using Quickbird and Worldview images: western part of Alexandroupolis Gulf (N.E. Greece) - Maria-Venetia Apostolopoulou, Parcharidis Isaak, Pavlopoulos Kosmas, Dehairs Frank
10. Superresolution image reconstruction of hyperspectral remote sensing images for Natura2000 habitat mapping - Jianglin Ma, Jonathan C-W Chan and Frank Canters
11. Measurements of volcanic SO<sub>2</sub> with ASTER, a comparison with automated scanning DOAS measurements - Robin Champion, Giuseppe Giovanni Salerno, Alain Bernard, Pierre-François Coheur, Michael Burton and Tommaso Caltabiano

Reception

1. Tracing human activities with DEM - Joyce Paesen, Sara Adriaenssens, Marc De Bie, Dries Tys, Erwin Meylemans and Guido Creemers

*This presentation focuses on the use of the Digital Elevation Model (DEM) within archaeology. The use of these data in geographical information systems has enhanced archaeological research in many ways. It can help in facilitating the analysis and interpretation of spatial data, surveying sites, spatial modelling, etc. To illustrate this, two case studies in woodland areas will be discussed, i.e. "Burial mounds, historic roads and a defensive wall in the Meerdaal Forest of Central Belgium" and "Celtic Field systems in the Kempen region of Limburg". Furthermore there will be a brief discussion on the influence the DEM in relation to GIS will have on the future of archaeological research.*

2. Monitoring activity and constraining eruptive history of African volcanoes using multispectral satellite data - Matthieu Kervyn

*Most volcanoes in developing countries are poorly known and not regularly monitored with field techniques. Remote sensing provide unique capabilities to constrain eruptive behaviour of these volcanoes. Case studies for Oldoinyo Lengai (Tanzania) and Nyamulagira (DRC), the most active volcanoes in Africa, illustrate how high and low spatial resolution multispectral imageries (i.e. MODIS, ASTER) can be combined to detect eruption onset, record variations in eruption intensity, constrain eruptive behaviour and characterize eruption products' composition. These data provide essential constraints on the dynamics of these poorly studied volcanic systems and on short and longer term hazards related to volcanic activity.*

3. Detection of aerosols and other climatological effects by remote sensing using GERB/SEVIRI - Stijn Nevens

*The GERB (Geostationary Earth Radiation Budget) and SEVIRI (Spinning Enhanced Visible and Infrared Imager) instruments onboard the Meteosat Second Generation satellite allow for a wealth of remote sensing applications. GERB makes broad-band measurements of the earth radiation budget. From this one can provide information on important basic physical processes in the climate. SEVIRI has 12 different narrow-band channels sensitive to different parts of the electromagnetic spectrum. These are chosen for specific detection purposes. We will discuss applications in the detection of aerosols (aerosol optical depth, radiative forcing,...) and other climatological effects using both instruments.*

4. Remote sensing based calibration of the MOLAND land-use change model - Tim Van de Voorde

*Land-use change models are useful tools for assessing and comparing the environmental impact of alternative policy scenarios. Their increasing popularity as spatial planning instruments also poses new scientific challenges, such as correctly calibrating a model. The challenge in model calibration is twofold: obtaining a reliable and consistent time series of land-use information and finding suitable measures to compare model output to reality. Both these issues are currently being investigated by CGIS together with VITO in the frame of a Belspo funded project called MAMUD (<http://www.mamud.be>). We propose a model calibration framework that is supported by information on urban form and function derived from a time-series of medium-resolution remote sensing data through newly developed spatial metrics. The remote sensing derived maps are compared to model output of the same date for two model scenarios using well-known spatial metrics. Results demonstrate a good resemblance between the simulation output and the remote sensing derived maps.*

5. Impact assessment of urbanisation on hydrology for the River Tolka in Dublin, Ireland - Boud Verbeiren, Tim Van de Voorde, Frank Canters and Okke Batelaan

*Sealed surfaces play an important role in the hydrology of urbanised catchments. Sealed surfaces prevent water from infiltrating into the soil and water runs off faster than naturally expected. An increase of these surfaces due to urbanisation will most likely have a considerable effect on the generated surface runoff. Fully distributed hydrological models need spatially distributed input data. Remote sensing potentially offers a relatively easy and cheap way of collecting spatially distributed information of the earth surface. One of the aims of the MAMUD project (Measuring and Modelling*

*Urban Dynamics*) is to integrate remote sensing information into the hydrological modelling process for the Tolka River (Dublin).

#### 6. Region-based and pixel-based classification techniques for urban impervious surface mapping and the impact on simulated runoff - Eva Ampe

*Objective and detailed mapping of impervious land-cover types over large areas is important in hydrological modelling, as these determine the amount and intensity of runoff on catchment scale. Moreover, those impervious surfaces are the predominant type in urbanized areas and can lead to increased surface runoff, which increases the risk for water pollution and floods in the watershed, hampers the recharge of aquifers and boosts erosion. Classification of these man-made objects in urbanized areas is not straightforward due to similarity in spectral properties. This study examines using hyper-spectral imagery, i.e. CHRIS-Proba images, for the extraction these man-made objects. A wide range of classification techniques exists for estimating impervious surface cover, ranging from region-, pixel- to sub-pixel based methods, each with their own advantages and disadvantages. This work studies the influence of two such methods when using their outcome in calculating of yearly discharge, which are determined by a GIS-based distributed model for Water and Energy Transfer between Soil, Plants and Atmosphere under quasi-Steady State (WetSpass), applied to the Woluwe River catchment in the southeastern part of Brussels. The two methods are (1) Multiscale region-based classification, based on a causal Markovian model, defined on a multiscale region adjacency tree and a set of nonparametric dissimilarity measures that express the data likelihoods; (2) Mahalanobis distance, a pixel based classifier. For Multiscale region-based classification two sets with different amount of segments are used: one with 20000 segments and a simplified set with 14000 segments. Multiscale region-based classification results in a Kappa value of 0.5 while Mahalanobis distance has a slightly lower Kappa value of 0.92. The fractions estimated with each method are different. A main observation is the large forest fraction estimated with Mahalanobis pixel-based classification. With the WetSpass model the highest yearly recharge is predicted with Multiscale region-based classification. This due to the lower forest fraction compared to the map produced with Mahalanobis distance.*

#### 7. Multiple endmember spectral unmixing of impervious surface in Brussels region using CHRIS/Proba - Luca Demarchi, Frank Canters, Tim van de Voorde, Jianglin Ma and Jonathan C-W Chan

*Mapping land cover in urban environments with multispectral data is a challenging task due to the confusion between spectrally similar land-cover types, such as sealed surfaces and bare soil. Hyperspectral remote sensing opens up new opportunities for improved mapping of urban areas. In this paper we test the potential of multiple endmember unmixing of CHRIS/Proba data for sealed surface mapping in the Brussels Capital Region. The impact of the criterion used for choosing the appropriate model for unmixing each pixel on the accuracies of the estimated class fractions is analysed, based on a reference dataset derived from 25 cm resolution aerial photographs. Results show that the use of a model selection criterion that favours models with less endmembers performs better compared to models with more endmembers, both in terms of fractional error and in terms of selecting the right model for unmixing.*

#### 8. Assessment of mangrove vegetation based on remote sensing and ground-truth measurements at Tumpat, Kelantan Delta, East coast of Peninsular Malaysia - Behara Satyanarayana, Mohamad Khairul Azwan, Indra Farid Idris, Husain Mohd-Lokman, Farid Dahdouh-Guebas

*The lower reaches of River Kelantan formed a vast delta (1200 ha) consisting of bay, mangrove and estuary on the north-east coast of peninsular Malaysia. Present study was conducted to assess the mangrove vegetation at Tumpat based on ground-truth and remote sensing measurements. The mangroves were composed of several true species such as *Nypa fruticans*, *Sonneratia caseolaris*, *Avicennia alba*, *Rhizophora apiculata*, *R. mucronata* and *Bruguiera gymnorrhiza* in order of dominance. The Point-Centred Quarter Method (PCQM) was employed to estimate stem density (no. of stems/0.1 ha) and basal area ( $m^2/0.1$  ha) at select sites on the ground. A recent high resolution multispectral satellite data (QuickBird 2006, 2.4 m spatial resolution of the multispectral image) was used to produce land-use/cover classification and NDVI (Normalised Differential Vegetation Index) mapping*

for the delta. The area statistics revealed that mangroves occupy 339.6 ha, while coconut plantation dominated the vegetation (715.2 ha) followed by settlements (621.6 ha), sandbar (148.4 ha), agriculture (89 ha), and aquaculture (42.7 ha). Although the relationship between spectral indices and dendrometric parameters was rather weak, we found very high significance between (mean) NDVI and stem density ( $P = 1.3 \times 10^{-8}$ ). The sites having young/growing and also mature trees with lush green cover reflected greater NDVI (0.40-0.68) implying healthy vegetation, while mature forest under the environmental stress due to sand deposition and/or poor tidal inundation indicated low NDVI (0.38-0.47) and unhealthy situation. Overall, a combination of ground survey and remote sensing provided valuable information for the assessment of mangrove vegetation types (i.e. young/growing or mature forest) and their health in Tumpat, Kelantan Delta.

9. Mapping *Posidonia Oceanica* meadows using Quickbird and Worldview images: western part of Alexandroupolis Gulf (N.E. Greece) - Maria-Venetia Apostolopoulou, Parcharidis Isaak, Pavlopoulos Kosmas, Dehairs Frank

Since March 2007 the construction of an oil pipeline is under deliberation by the governments of Russia, Greece and Bulgaria. The aim of this development is to transport Russian oil through the Black Sea, Bulgaria, Greece and the Aegean Sea to the worldwide market. A possible result of this construction will be annoyance and decline of marine flora. *Posidonia oceanica* is the dominant endemic seagrass in the Mediterranean Sea and its meadows are considered as one of the most important and productive ecosystems in coastal waters. On the other hand, increasing human pressure as a result of industrial (including oil spills) and domestic waste disposal in the coastal ecosystem is a threat to benthic communities. In this research, sensing approaches have been used to map seagrass extent before the construction of the pipeline, using multispectral data from Aster (2007), Quickbird (2007) and WorldView-2 (2010) imagery for bottom classification in a shallow coastal area west of Gulf of Alexandroupolis (Evros and Rodopi Prefecture, Greece). After applying a supervised classification, pixels are automatically classified in four classes: sand, unvegetated area, dense *P.oceanica* and *Cymodocea nodosa* beds. The change detection between different dates is examined. The method is evaluated using ground truth data.

10. Superresolution image reconstruction of hyperspectral remote sensing images for Natura2000 habitat mapping - Jianglin Ma, Jonathan C-W Chan and Frank Canters

In the frame of Belspo project HABISTAT which aims to map Natura 2000 priority heathland, we explore the possibility of using superresolution enhanced hyperspectral data. In this presentation, we present a novel superresolution algorithm based on a MAP estimation technique by minimizing a multi-term cost function. The L1 norm is used for measuring the difference between the simulated low resolution images from potential high resolution image and observed low resolution images. The correlation between bands is explored by enforcing simultaneous sparsity on their wavelet representations. Total variation regularization is employed to keep sharp edges of reconstructed high resolution image. Experimental results on synthetic and real data sets confirm the effectiveness of our method.

11. Measurements of volcanic SO<sub>2</sub> with ASTER, a comparison with automated scanning DOAS measurements - Robin Campion, Giuseppe Giovanni Salerno, Alain Bernard, Pierre-François Coheur, Michael Burton and Tommaso Caltabiano

Volcanoes emit each year an estimated 20 10<sup>6</sup> Tons of Sulfur Dioxide (SO<sub>2</sub>). This gas has an important impact over environment and climate. SO<sub>2</sub> flux measurements are also a widely used and valuable method for volcano monitoring. A number of satellites operating in the Ultra Violet (OMI, GOME-2 and SCIAMACHY) or in the Thermal Infrared (ASTER MODIS, AIRS, IASI) can measure SO<sub>2</sub>, with a more global perspective, but lower precision than ground measurements. However a lot of work has still to be done towards a rigorous validation of SO<sub>2</sub> measurements from space.

ASTER (Advanced Spaceborne Thermal Emission Reflection radiometer) acquires images in the thermal infrared (TIR) with a resolution of 90m/pixel, which enables to quantify the SO<sub>2</sub> fluxes emitted in small-scale tropospheric plumes. These images are processed with radiative transfer simulations and a band ratio algorithm to produce maps of SO<sub>2</sub> column amounts. The band ratios (B10+B12)/B11 and B14/B11 are used for their insensitivity to variations in ground altitude and atmospheric humidity, two

variables that often complicate SO<sub>2</sub> retrievals in the TIR. Their sensitivity to surface emissivity is also reduced.

So far, the ground validation of satellite SO<sub>2</sub> measurements has been complex due to logistics difficulties and the lack of strictly simultaneous measurements. Recently the development of permanent networks of scanning DOAS on several active volcanoes has provide a wealth of ground based SO<sub>2</sub> measurements that can be exploited for validating satellite-based measurements.

We will present the results of comparisons between SO<sub>2</sub> Column Amount (CA) and fluxes measured by ASTER and by the FLAME network of Mt. Etna. The two independent measurements sets are in good agreement in magnitude. Fluxes range from 2000 to 5000 T/days and column amounts from 0 to 4 g/m<sup>2</sup>. CAs measured by ASTER present a 0.5g/m<sup>2</sup> random dispersion and no systematic bias compared to DOAS measurements. However the CAs measured by DOAS are subject to increase at low-scanning angles. These results represent constitute a rigorous ground validation of ASTER SO<sub>2</sub>, and provides interesting insights into accuracy and precision on both methodologies.

Recently we also got interested in comparing SO<sub>2</sub> measurements from ASTER to those produced by OMI (Ozone Monitoring Instrument, operating in the UV), which are widely used among the volcanologists and remote sensing communities. We will present the first results of this comparison.