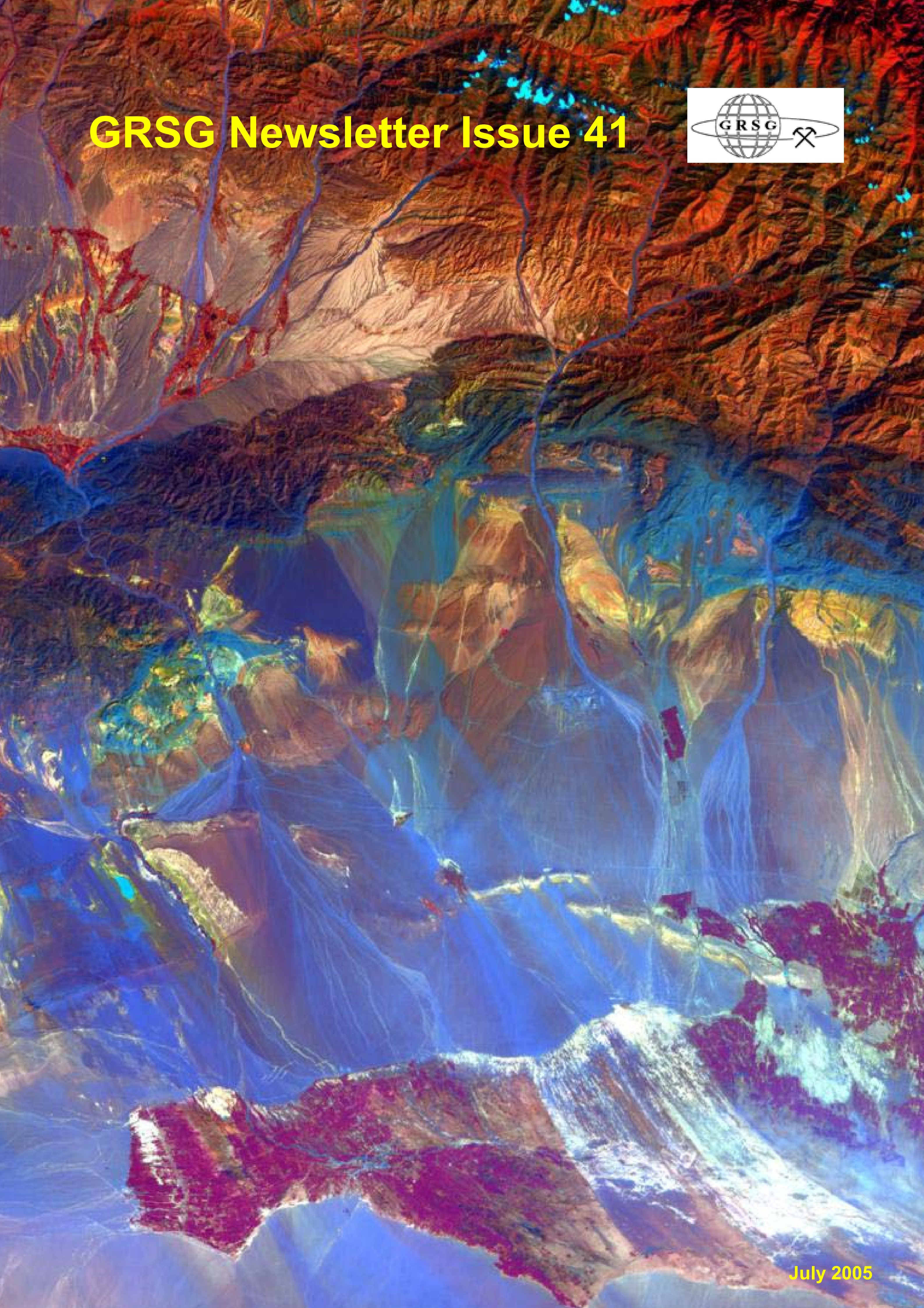
GRSG Newsletter Issue 41



July 2005

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If you would like to know more of our aims or would like to join, and receive the Newsletter regularly, please contact one of the Committee Members:

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Aims of the GRSG

This specialist Group, affiliated jointly to the Geological Society of London and the Remote Sensing Society, was founded in 1989 to foster and raise awareness of the use of remote sensing and related techniques within the geological and geophysical communities.

We feature a good working relationship between industry, government and academic organisations resulting in a balanced scientific, technological and commercial viewpoint.

Membership is £10/$20US personal, £6.00 Student or £100/$200 corporate. Advertising is welcomed (contact Newsletter Editor) - Charges are £40 per full page per issue or £110 for the year, £25/£75 per half page and £12.50/£30 per quarter page.

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Give them a call. These members are keen to co-ordinate the effort to build a wider geological remote sensing forum around the world. We also hope that the many "international" remote sensing scientists that meet up will use the opportunity to think "GRSG" and sound out new possibilities to work together.

Contents

Chairman's Message

We're turning over a new page in this edition of the GRSG Newsletter, the first to be distributed digitally. Tradition is a fine thing, and there's much to be said for the paper version. However, shifting to an e-Newsletter will allow easier, cheaper and better quality colour graphics – a fundamental aspect of geological remote sensing. Going digital should also help to increase the number of articles submitted to the Newsletter, as authors can be guaranteed high-quality graphics, rather the limited quality of cheap colour printing. Special thanks to Alex Davis for taking on the task of re-vamping the Newsletter, especially as he's also been working flat-out (a common state of many students) to finish his PhD thesis. In addition to our gratitude, though, Alex would greatly appreciate any news material, case studies, viewpoints or hot gossip that could be broadcast in the Newsletter without fear of ensuing libel action.

The e-Newsletter will also produce some significant savings in printing and postage costs – revenue that will now be directed towards improving the quality of the GRSG website. GRSG's Student Rep, Rachel Holley, has already been reviewing possible new formats for the website (http:www.grsg.org) and a new-look version is there for you to peruse – please email Rachel with any comments.

The GRSG-sponsored day on "Volcanoes and associated hazards" at this year's RSPSoc Annual Conference ("Measuring, mapping & Managing a Hazardous World", Portsmouth, 6-9 Sept – details below) has attracted a bumper set of oral and poster presentations, so much so that some of the volcanic papers have had to be squeezed into the Slope Instability and Disaster Management sessions. GRSG's volcanic day will include presentations on applications of ASTER, MODIS, SRTM, ERS InSAR, thermal sensors and a new portable ground-based radar sensor.

The decision to organise the volcanic remote sensing day for RSPSoc2005 was taken for a number of reasons. As far as I know, GRSG have not held a meeting on a volcanic theme before, even though it is a sector that involves a lot of geological remote sensing practitioners. Encouragement and organisational support from Gerald Ernst and his research team at Ghent University helped to guarantee a full compliment of presentations. But crucially, given the international distribution of volcanoes and their researchers, the meeting should help to increase and broaden the GRSG membership base.

Another sector where GRSG looks set to see an increase in its membership is mineral exploration, particularly in the Americas. GRSG's USA rep, Richard Beddell, recently helped to organise a very successful mineral exploration conference for the Geological Society of Nevada. 1,400 participants attended the conference, which included two geological remote sensing sessions, with 40 participants on a linked fieldtrip to the Comstock Lode. Alvaro Crosta, the GRSG rep for Brazil, and Vern Singhroy, GRSG rep for Canada, both attended and there are now plans for a "GRSG Americas" workshop at the 2007 Exploration Technology Conference in Toronto. A key aspect of the 2007 workshop would be that GRSG membership would be included in the registration fee, which could well provide a boost to GRSG numbers. The GRSG committee has welcomed this exciting initiative. Discussions about the practicalities are ongoing: if you have any comments, I would appreciate hearing from you.

Back to the present: preparations are now being made for this year's GRSG annual conference, "New developments in geological remote sensing", which will be held at the Geological Society of London on Friday Dec 16th. If you would like to make an oral or poster presentation, please email a 300-400 word abstract to Tim Wright (tim.wright@earth.ox.ac.uk), before Sept 19th.

Looking ahead to the 2006 annual conference, a two-day "ASTER revisited" conference is planned…

Editors Message

This is the first issue of the new digital format of the GRSG Newsletter which will be sent out to the membership as an e-mail pdf attachment. Following numerous debates by the committee over the last 5 years, certainly since I've been on the committee, it was finally decided to go digital.

This issue is very much a transitionary issue bridging the gap between the old format and the new. It is hoped that the newsletter will be linked to the website in the future. Let us know what you think and what you would like to see in future editions of the newsletter. The pdf copy is formatted as an A4 page. A number of hardcopy tests have been carried to assess the print quality. When printing out please print 2 pages per landscape A4 for the usual A6 size newsletter (and to save the rainforest!).

During the last AGM, much criticism was given to the fact that hardcopy newsletter colour prints were very poor and that this possibly deterred people from writing articles. The new digital format resolves this poor reproduction problem. To make images e-mail friendly please send article images resampled to 150 dpi print resolution. We hope to setup a gallery on the website possibly using images from the newsletter (with the author's permission of course).

Apologies for an error that occurred in the previous newsletter. The wrong template for the industrial sponsors listing was inadvertently used. A full apology has been sent out to all affected Industrial sponsors following a complaint. You will see on page 9 that the alphabetic listing of the industrial sponsors list has been restored.

Also, as we are all remote sensers working in different parts of the world it would be nice to have a different image on the front cover. To start the ball rolling, the front cover image on this inaugural digital issue is a subscene showing the tectonic geomorphology of the Turpan foreland basin, Xinjiang, NW China. The image is a Landsat 531 rgb and shows blind thrust folds interacting with the Bajada fan drainage on the northern regional slope of the basin. Please send in your images from around the world, the most interesting being selected for the front cover. This may be a good way for students to get involved in the GRSG and to promote their research.

Now that the newsletter is digital and that images are in a digital format, I reiterate my requests for articles, news and gossip. Even though the format is going more professional looking it is hoped that the "community feel" of the newsletter is not lost. Please feel free to print out relevant parts of the newsletter to read on the train, bus or plane.

I look forward to receiving many articles, news, images and stories from around the world.

Student Rep

First of all let me introduce myself - I'm Rachel Holley, the new GRSG student representative. I have been a GRSG member for just over a year, and I took over from my predecessor Alex Davis as student rep. in September. I am in my first year of a PhD at Reading University, working on InSAR atmospheric errors over Etna, Sicily, and comparing traditional correction methods with direct forward modelling of the atmospheric water vapor field.

I joined the GRSG committee at the busiest time of year, in the run-up to the December 2004 AGM meeting. It was a hectic introduction to the GRSG, but an excellent way to meet everyone. It was fantastic to see so many students getting involved - presenting talks, bringing posters, chatting over coffee and suggesting ideas for the future. Being relatively new to the GRSG, one of the things I like most is it's inclusiveness and diversity, both in terms of subject breadth and experience. Geological remote sensing is a fairly wide brief, as the diverse range of presentations at the conference demonstrated, and there can't be many places where students are encouraged to mingle with professors and industry leaders over a pint after the meeting!

One of the things that impressed me most about the GRSG when I first joined was the extent to which students are encouraged to participate as active and valued members, rather than an under-class who are tolerated because they might start paying the full membership fee eventually! Students are welcome to contribute to the newsletter, have the opportunity to present their work at meetings, are listened to at AGMs, and are generally encouraged to get involved. And as student rep, it's now my job to help continue that reputation.

I had a chance to talk to quite a few of the students at the meeting about how they found the GRSG and what else we could do to welcome students, and I came away with several suggestions. The first was improving the website content - several people thought it would be more encouraging for students if there was a specific page on the website emphasising the fact that students were very welcome to become members and to get involved. People also felt that the website as a whole was important to the GRSG, and that we should work at getting more content up. This was something that Tim Wright (GRSG publicity officer) and myself had already been planning; and Armen Asryan, a student from Kingston University, has offered his help with the technical side of the web development.

Another point that was raised was the GRSG's publicity to students. Someone mentioned the fact that quite a lot of student members discovered the GRSG through their supervisors, and that people whose supervisors were not involved perhaps didn't hear about us. So maybe we need to look at ways of advertising our presence better to students.

Something else that struck me was how few of the student members I spoke to were aware of the GRSG student stipends, now sponsored by NPA. They provide a great opportunity for students to present their work to an international audience, and are awarded annually, providing up to £250 towards the travel and subsistence costs of presenting a paper at an international conference. Applications are considered in the autumn, and full details are published in the newsletter beforehand. This is also something

I would like to advertise more prominently on the new student pages on the website, to make sure all GRSG student members are aware they can apply.

So the question I would like to ask the student members - what would you like to see GRSG doing? What ideas do you have for the future? It would be really great to have some feedback on what you would like me to do as student rep, what you would like to see on the student web pages and any other ideas you have for encouraging more students to get involved in the group.

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Article

Remote sensing and the Indian Ocean tsunami

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The Indian Ocean tsunami of 26 December 2004 was one of the biggest natural disasters in recorded history. A magnitude 9 earthquake caused up to 15m of vertical displacement in the seafloor along 1,500 km of tectonic boundary and displaced a trillion tonnes of water. The tsunami travelled at the speed of a jet airliner, reaching northern Sumatra (Banda Aceh) in half an hour and the coasts of Thailand, Sri Lanka and India in about two hours.

Space satellites are available that can map and possibly monitor tsunamis and associated hazardous terrain. “Real time” satellite observations of tsunami activity are extremely rare. However, the Indian Ocean tsunami was observed by a handful of satellite systems. Both the TOPEX-Poseidon and Jason-1 radar satellites were collecting altimetry readings of the Indian Ocean surface as the tsunami waves propagated out from the epicentre zone, allowing the tsunami dimensions to be measured (Figure 1). The tsunami wave heights in the deep ocean zone showed changes of +/- 40cm-50cm: it was only in shallow coastal zones that the waves built up to catastrophic heights.

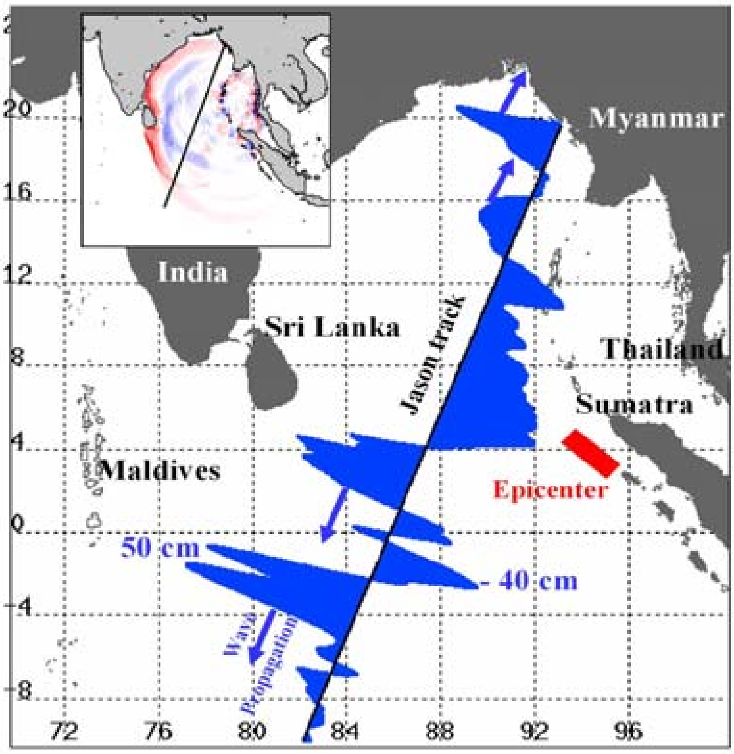

Figure 1. Measurements of the Indian Ocean tsunami wave heights, collected by

the Franco-American Topex-Poseidon and Jason-1 satellite radar altimetry projects.
Inset box shows a computer simulation of sea surface height in the region, which is in good agreement with the satellite observations (sources: NASA & JPL, USA; CNES, France; National Institute of Advanced Industrial Science & Technology, Japan)
Fortuitously, two Earth observation satellites – Quickbird and MISR - were collecting imagery over coastal zones of the Indian Ocean region at the time of the tsunami activity. The Multi-angle Imaging Spectro-Radiometer (MISR) satellite observed the tsunami along the coasts of India and Sri Lanka from seven different look-angles, viewing various phases of inundation (viz. Figure 2: note the varying degrees of submergence along the arrowed near-shore sandbars).

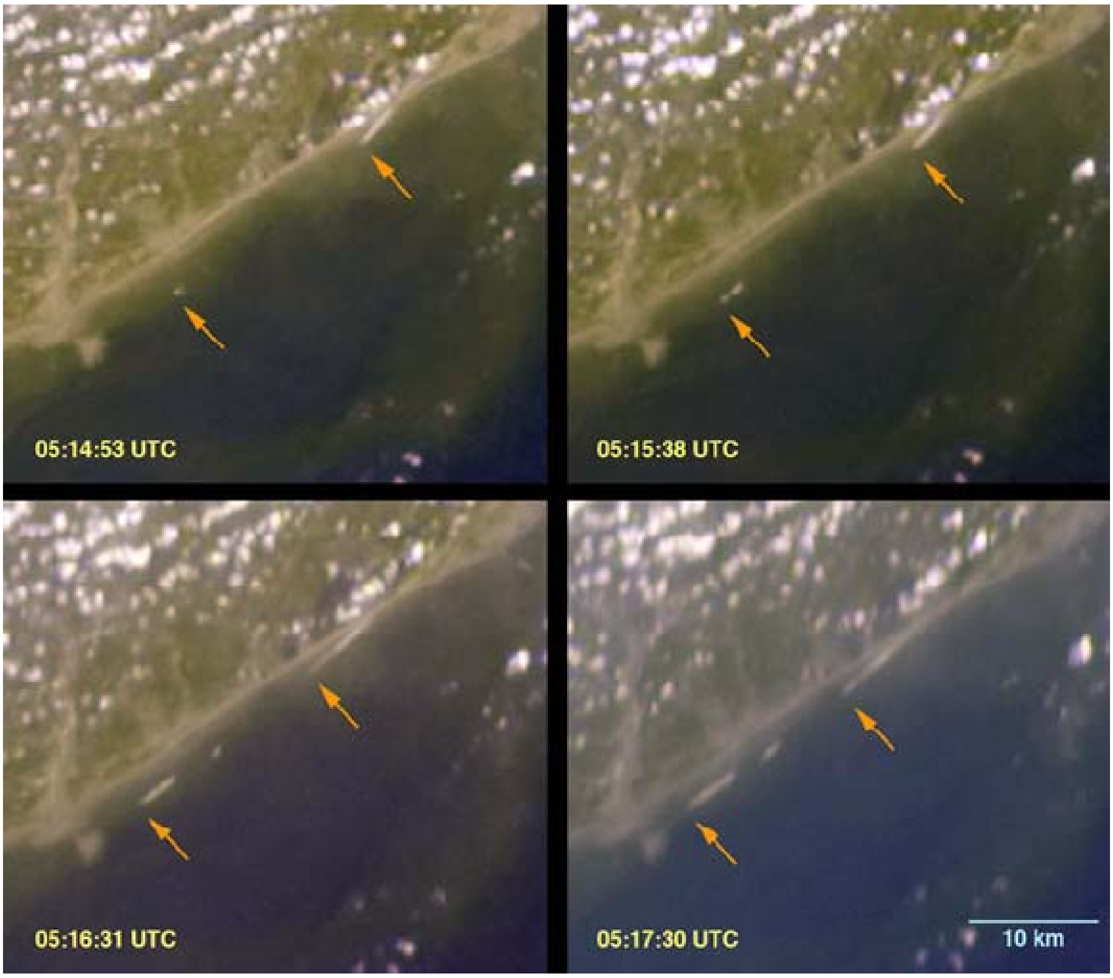

Figure 2. Three minutes of devatation: phases in the tsunami inundation of the Andhra Pradesh coast, India, observed by the MISR satellite system (source: NASA)

The Quickbird micro-satellite was orbitting over SW Sri Lanka during the tsunami event and yielded very detailed images of various phases of tsunami inundation and wave diffraction (Figure 2). Quickbird can view features as small as 60 cm: this was very useful for the detailed mapping of tsunami-affected areas – particularly urban zones - and greatly assisted the disaster relief efforts.

Figure 3. Quickbird image showing tsunami water retreating from the inundated SW coast of Sri Lanka (source: DigitalGlobe Inc., USA)

Other Earth observation satellites, notably the MODIS, Landsat ETM+, SPOT 5 and IRS multi-spectral sensors - and to a lesser extent the RadarSat and ENVISAT radar systems - have provided extensive coverage of tsunami affected areas (Figures 4, 5 and 6). Within a few days of the disaster, images provided by these satellites were being used to produce maps of land cover types, coastal geomorphology and estimates of population density. Such maps, coupled with 20m-contour digital elevation data from the Shuttle Radar Topographic Mission (SRTM), enabled the production of coastal inundation severity maps.

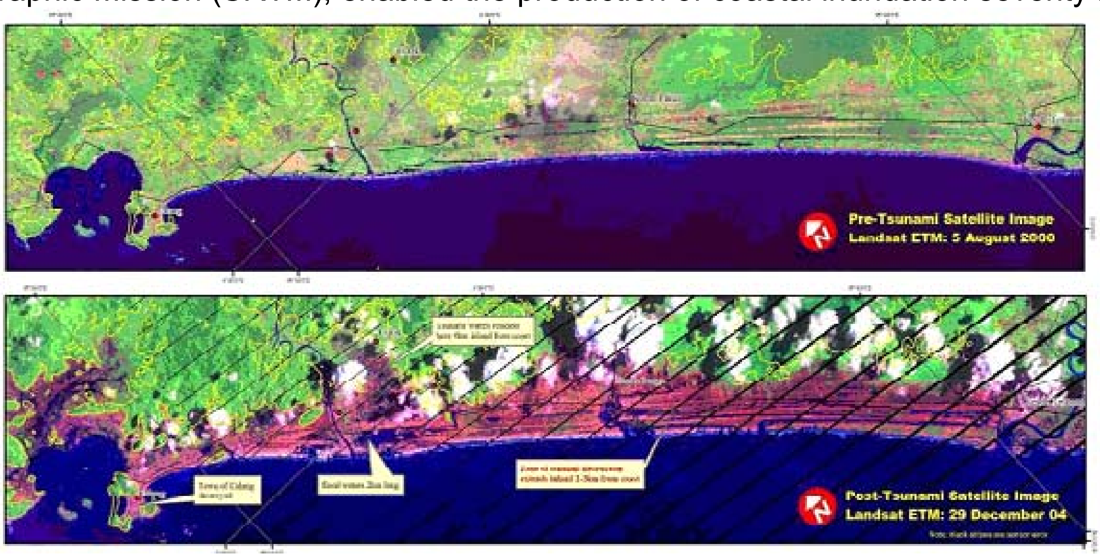

Figure 4. Landsat ETM+ “true colour” imagery showing the extent of tsunami damage on the Sumatra coast (source: UNOSAT)

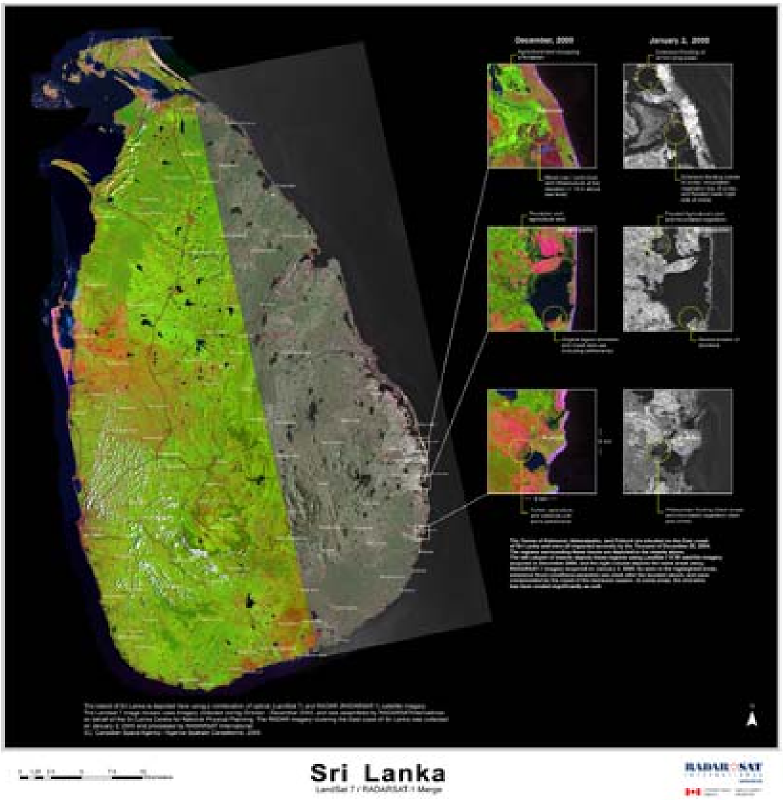

Figure 5. Radasat image of Sri Lanka. The island sits between two orbit-paths of the satellite. The colour imagery of the western part is a pre-tsunami multi-temporal image that highlights land cover types. The geyscale eastern part is from a single post-tsunami image: areas of water are black. Inset images illustrate the amounts of inundation caused by the tsunami (source: Radasat International, Canada).

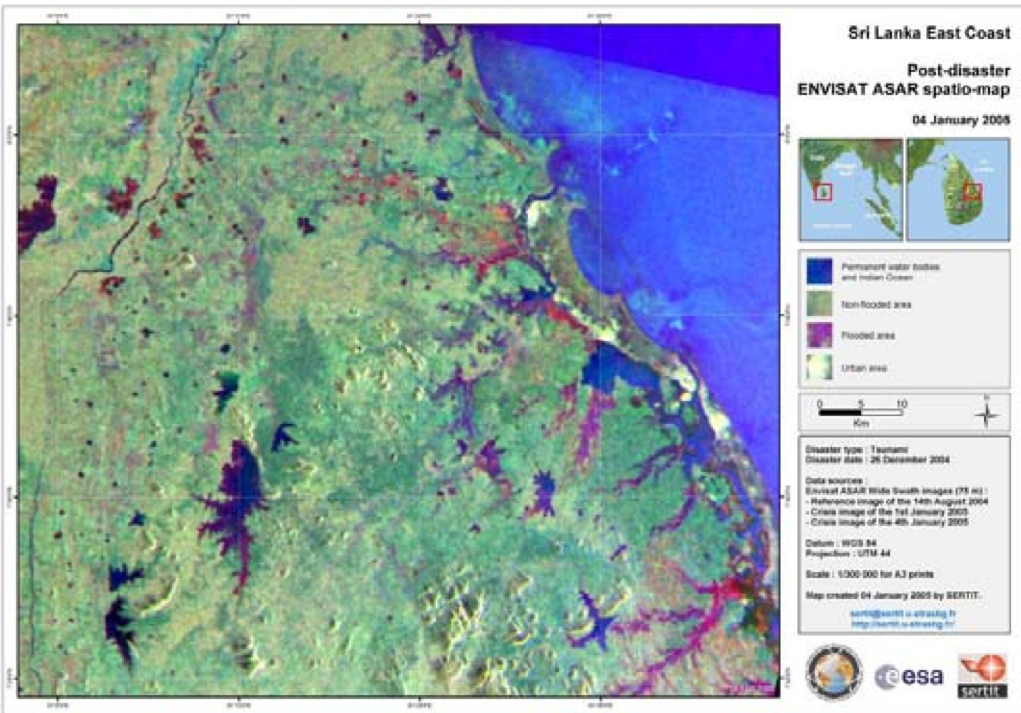

Figure 6. Multi-temporal ENVISAT radar image of eastern Sri Lanka, with tsunami-inundated areas showing as red-purple (source: ESA and UNOSAT)

Looking to the future, real-time monitoring of the world's oceans for tsunami waves may be possible using geostationary radar satellites. Data-mining of real-time regional satellite imagery, as well as web-based GIS-derived hazard maps, should also help to give early warnings of areas at risk of tsunami inundation. Daily coverage of affected areas was rapidly provided by the Disaster Monitoring Constellation (DMC), a recently-launched UK-based system of micro-satellites (Figure 7). The post-tsunami daily coverage of affected areas was of use to disaster relief organisations assessing the severity of the tsunami and targetting areas requiring priority relief

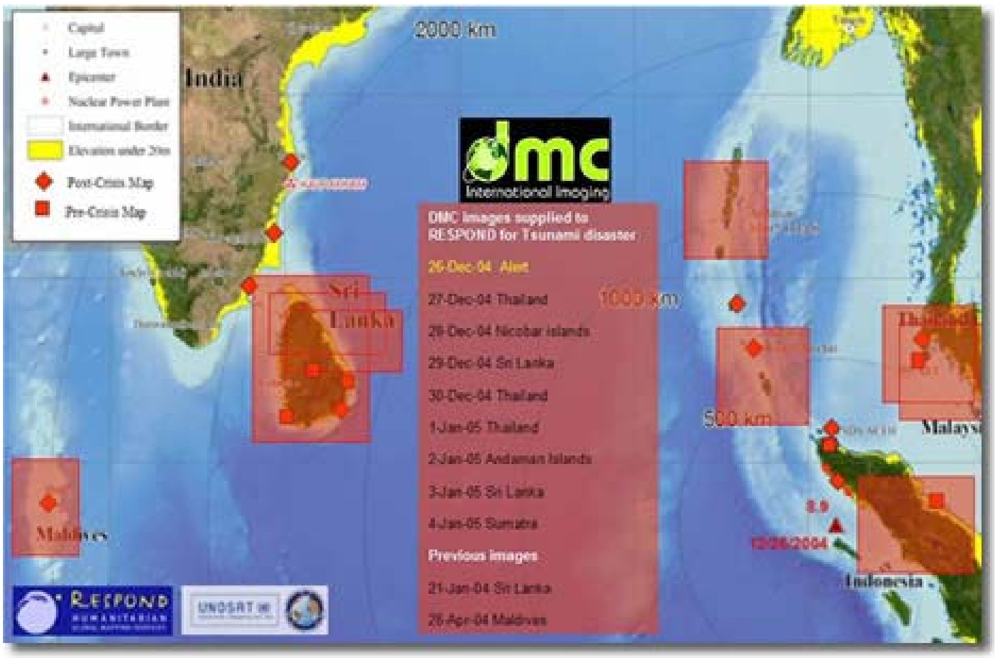

Figure 7. Areas with daily coverage from the Disaster Monitoring Constellation, between 27 Dec 2004 and 4 Jan 2005. The yellow areas are less than 20m above sea level and were obtained from SRTM data (sources: DMC, NASA and UNOSAT).

It is clear that remote sensing could play a key role in the production of tsunami inundation hazard maps. Satellite remote sensing can detect a number of key features that influence the behaviour of tsunami waves as they flood an area, notably near-shore gradients, seafloor morphology; the presence of reefs or sand bars; sand dune or mangrove coverage; land-surface morphology, surface roughness, soil moisture and permeability. Features that can influence the potential loss of life during a tsunami flood can also be detected, such as variations in coastal land cover types, particularly high-density coastal population zones and major transport infrastructure (roads, railways, bridges); areas of high ground and other potential 'refuges' such as large reinforced concrete buildings.

Satellite remote sensing can greatly assist tsunami hazard mapping, as well as helping to raise public awareness of the risk and leading to better local preparedness. However, satellite imagery can be very expensive, limiting its use in developing countries. Fortunately, the recent United Nations Charter on 'Space and Major Disasters' provides for the free supply of satellite imagery to relevant relief organisations. Furthermore, the USA's Global Land Cover Facility provides a free Internet supply of archive Landsat imagery and Space Shuttle (SRTM) digital elevation data: this makes inundation hazard mapping and the raising of public awareness a relatively easy and cheap process. Figure 8 illustrates some of the tsunami and coastal flooding hazard maps produced by Dr Steve Drury of the Open University soon after the disaster: these were generated using SRTM data.

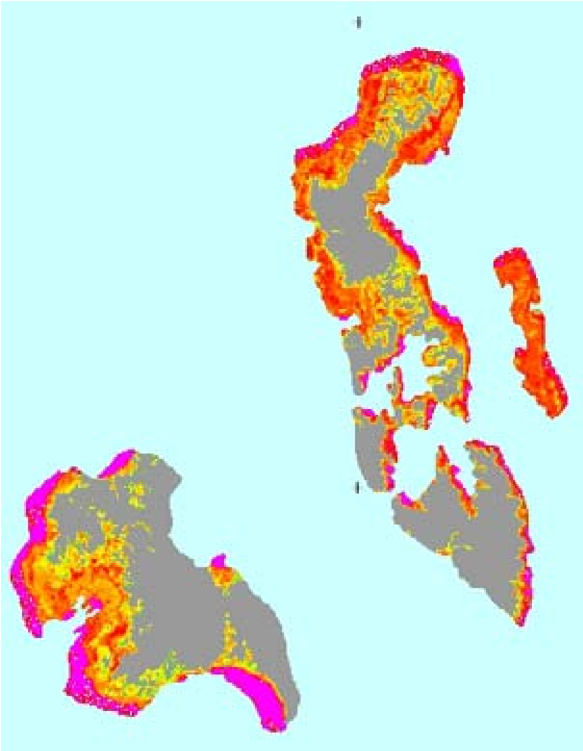

Figure 8. Tsunami and coastal flooding map for some of the Nicobar Islands. Colours correspond to elevations above sea level: 0-8 m magenta-red; 9-16 m red-orange; 17-24 m orange-yellow; 25-32 m yellow-green (produced by Steve Drury and available on the geodata.gov website).

The growing awareness of remote sensing's value in disaster relief has led the European Community to establish the Global Monitoring for Environment and Security system (GMES), which assists with satellite data provision for disaster relief. A related EC initiative is RESPOND: a 5-year project that aims to use GIS to integrate remote sensing imagery with data from field workers in disaster affected areas.

Although we cannot stop severe geohazards such as the Indian Ocean tsunami, remote sensing offers ways of mapping areas at risk, identifying "refuge" areas, raising local people's awareness, providing some degree of early warning, assessing post-disaster damage and monitoring aspects of relief operations.

Tsunami remote\sensing weblinks:

- British National Space Centre: UK remote sensing of the tsunami http://www.bnsc.gov.uk/default.aspx?nid=4897
- Disaster Monitoring Constellation: http://www.sstl.co.uk/index.php?loc=6&id=782
- European Community RESPOND & GMES initiatives: http://www.respond.eu.com/public/html/whatIsGMES.html#
- European Space Agency tsunami coverage: http://earth.esa.int/ew/earthquakes/Asia_earthquake_dec04/
- GEsource: http://www.gesource.ac.uk/hazards/tsunami2004_full.html
- Global Land Cover Facility: http://glcf.umiacs.umd.edu/
- Jet Propulsion Laboratory: details on MISR and Topex-Poseidon-Jason http://www.jpl.nasa.gov/news/news.cfm?release=2005-019

- MapAction - a UK charity using GIS, GPS and remote sensing for disaster management: http://www.mapaction.org/
- NASA remote sensing and natural hazards http://earthobservatory.nasa.gov/NaturalHazards/
- NOAA tsunami information: http://www.prh.noaa.gov/itic/
- Quickbird image gallery: http://www.digitalglobe.com/
- Radarsat International (Canada) – 'before and after' radar imagery: http://www.rsi.ca/news/press/2005/current_event_tsunami_jan05.asp
- UNOSAT: UN International Charter: Space & Major Disasters – regional tsunami impact maps: http://unosat.web.cern.ch/unosat/asp/charter.asp?id=55
- US government Geospatial One-stop e-GovInitiative - select the Indian Ocean tsunami link: http://www.geodata.gov/gos

Acknowledgements

Thanks to Jan-Peter Muller and Steve Drury for helpful discussions about various aspects of RS and the Sumatra tsunami; also to Stuart Marsh for details on IGOS, GMES and RESPOND. Finally, many thanks to the various space agencies and data suppliers who gave permission to publish the images used in this article.

Note:
A version of this article has been published in the August 2005 edition of *Geoscientist,* the magazine of the Geological Society of London.

Meeting Report

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A post-graduate training school dedicated to the study of hydro-geomorphological risks took place at Strasbourg, France, from 14 to 19 September 2004. The training school, entitled “Living with hydro-geomorphological risks: from theory to practice”, was proposed within the framework of FORM-OSE (European training programme on risk sciences) that sets out to provide training in risk sciences at the European level. The graduate school was organized by the European Centre on Geomorphological Hazards, with the support of the School and Observatory of Earth Sciences of Strasbourg, the Faculty of Geographical Sciences of Strasbourg, and the International Association of Geomorphologists.

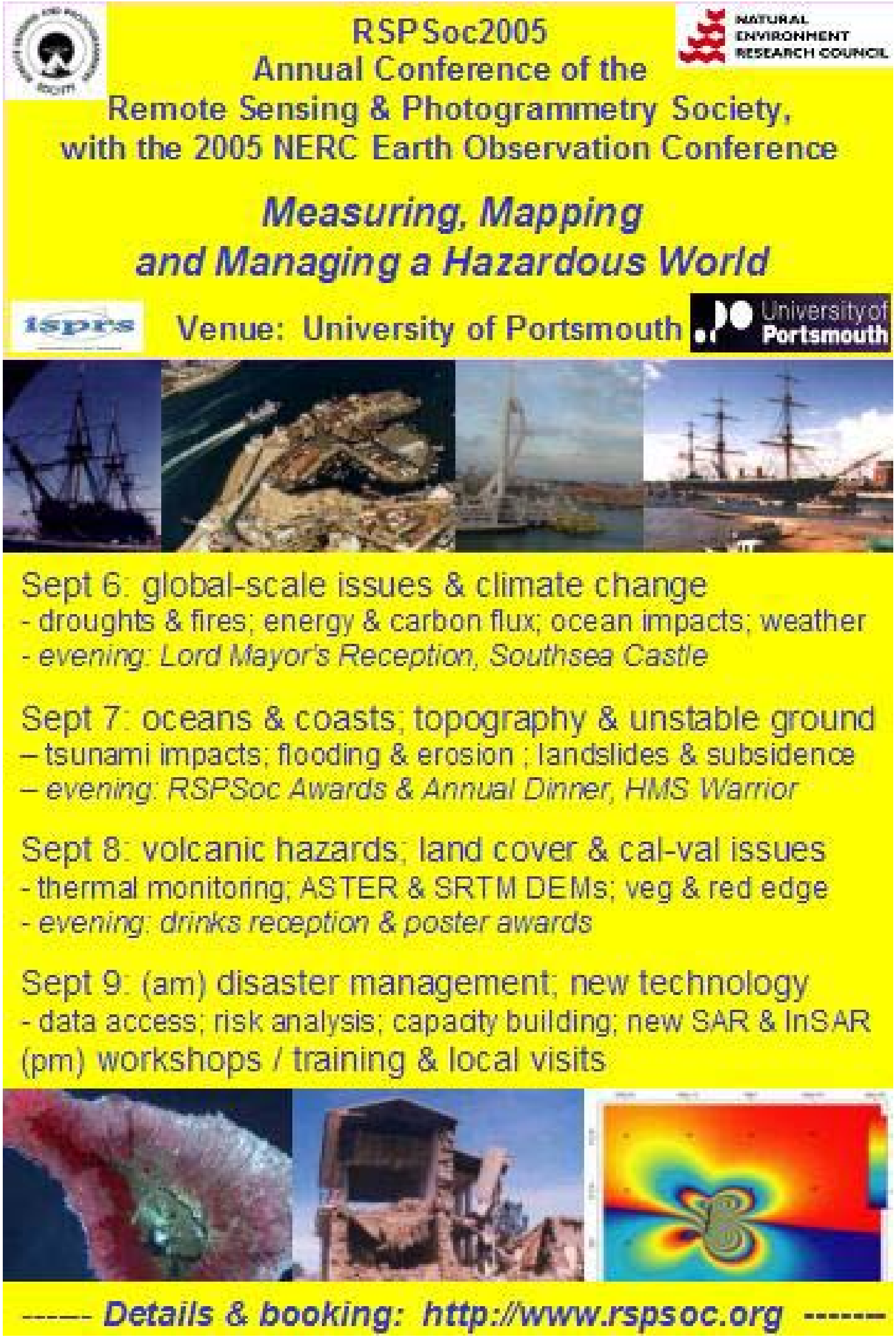
The objectives of the training school were (1) to exchange ideas on coping with hydro-geomorphological hazards. Particular emphasis was placed on the utilization of state-of-the-art methodologies, involving earth observation data and novel technologies of communicating and integrating that information, (2) to practically delineate and analyze various kinds of prevention and mitigation strategies employed in living with these hazards, and (3) to enable interdisciplinary discussions and facilitate the forging of scientific cooperation regarding the aforementioned subjects.

The objective of the training school was to present the participants with an applied knowledge relating to hydro-geomorphological risks (subsidence, sinking, slides, and flows) through a number of theoretical classes, practical workshops and field trips; the latter included case studies on hazard and risk assessment, remote sensing-aided mapping, survey and mapping systems and risk mitigation. The courses were delivered by internationally renowned experts in the fields of geomorphology, remote sensing, engineering geology and geophysics. A brief review of some of the lectures more strongly pertaining to geological remote sensing is given below:

A practical workshop on earth observation data and image processing for landslide delineation and hazard assessment focused on an analysis of the “La Valette” landslide (French Alps) by aerial image correlation technique, and was presented by Christophe DeLacourt from the University of Lyon. The initial data included multi-temporal aerial images of the landslide mass, maps of displacement values along North-South and West-East directions between selected dates, as well as a digital elevation model of the area. After having estimated the geometrical properties of the landslide (length, width and surface extent), the landslide’s spatial extension evolution was calculated, alongside a quantitative study of the mass’s motion. The motion’s amplitude (absolute planimetric motion) was first calculated, followed by the displacement’s orientation. Finally, using the displacement maps, the correlation coefficient maps and the aerial images, a tentative evolution of “La Valette” landslide was offered by the workshop’s participants.

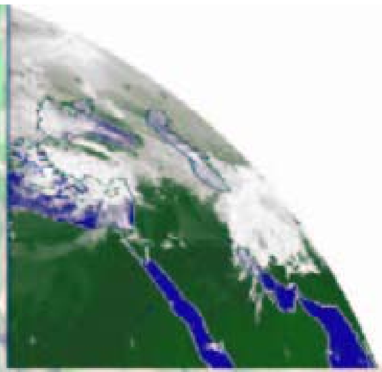
Work regarding spatial models for the definition of landslide susceptibility and landslide hazard that is being carried out at the Centre of Geographical Studies at the University of Lisbon was presented by Dr J.L. Zezere. Utilizing DEM data, digital orthophoto maps, as well as geologic and rainfall data, a general methodology for the probabilistic evaluation of landslide hazard was investigated, taking into account both the landslide susceptibility and instability triggering factors, mainly rainfall. With the study area being in the north of Lisbon and having experienced numerous shallow translational slides, susceptibility to landsliding was evaluated using algorithms based on statistical/probabilistic analysis over unique condition terrain units. Rainfall triggering information was integrated in the hazard assessment model by firstly defining rainfall thresholds responsible for past landsliding incidents and then calculating the relevant return periods. The presentation clearly laid out methodologies whereby different landslide scenarios can be assessed, corresponding to unique susceptibility conditions and rainfall events with various intensities and return periods.

Overall, the training school succeeded in offering an excellent overview of the state-of-the-art research methodologies concerning the study, prediction and mitigation of hydro-geomorphological hazards with the help of new technologies, particularly earth observation ones. It also proved highly successful in offering ample opportunities for scientific exchange of ideas between renowned practitioners and younger research students from a large number of European and Mediterranean countries (including, but not limited to, France, Germany, Croatia, Italy, Morocco, and Greece). The welcoming city of Strasbourg also provided an ideal backdrop for the hosting of the school, being equally rich in student and other life.



For more information on the latest details, meeting programme and booking goto:

http://www.rspsoc.org



Tarbiat Modarres University
Water Engineering Research Center
Workshop on

Remote sensing applications in water management

Workshop Objective

The workshop is designed to bring together decision makers, researchers, students, and users in the area of remote sensing applications in water sector. Its goal is to showcase examples of programs and projects which bridge the gap between applied remote sensing research efforts and user communities, and to stimulate the development of new projects. It is considered to review the current trends in Earth observation techniques in hydrology, agro-meteorology, land and water management, and environmental aspects of water ecosystems
To professionals, this conference provides: 1) an opportunity to learn about new available data and images, 2) an opportunity to present their research results, 3) a forum of exchange of ideas and information, and 4) the use of remote sensing data in the study of land surface hydrological processes.

Topics

Application of remote sensing in water management and hydrology including the following subjects:

- **Snow survey;**
- **Evapotranspiration**
- **Salinization and water logging**
- **Floods**
- **Environment**

Tentative time

December 2005

Place

Tehran, Iran

Language

Farsi and English

Contact

Dr. Kourosh Mohammadi, P.O. Box 14115-336, Tehran, Iran,
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GRSG2004 - Mapping hazardous terrain using remote sensing
Burlington House, London, 13-14 December

Juliet Biggs, University of Oxford
Rachel Holley, University of Reading

The GRSG 2004 AGM was held over 2 days, and had a truly international theme with presenters from seven different countries and studies involving work in at least ten. The opening session focused on the applications of InSAR with the first two talks, from Rachel Holley from the University of Reading and Juliet Biggs from Oxford University, focussing on measuring interseismic strain accumulation across faults with examples from the North Anatolian Fault in Turkey and the Denali Fault in Alaska. Next, Micheal Riedman from the NPA Group demonstrated that the some of the problems inherent in classical radar interferometry can be overcome using Persistent Scatterer Interferometry (PSI), and showed some promising results from tests using Corner Reflectors (CR's) and Compact Active Transponders (CATS) for use in areas with few natural scatterers.

This was followed by Friedrich Kuehn from the Federal Institute for Geosciences and Natural Resources (BGR) in Germany, who advocated an integrated approach to detecting unstable ground by using a combination of aerial photography, airborne laser scanning (lidar) and satellite imagery to detect diagnostic features such as lineaments, scarps and altered vegetation. His study focussed on collapse sinkholes caused by salt dissolution in Eiseben, Germany. Particularly impressive was the use of lidar to detect some extremely small changes in terrain. After lunch Richerd Eyers from Newcastle University spoke on subsidence detection in North-East England, combining innovative photogrammetric methods to create and orientate DEMs from photographic data over the last forty years with hyperspectral analysis of vegetation changes and surface disturbance.

Next up was a very interesting discussion of the recent floods in Boscastle, Cornwall by Alastair Duncan from the Environment Agency, highlighting the impressive dataset including LIDAR, CASI imagery, thermal video and digital photography which is now available for a range of studies. Premalatha Balan from University College London discussed problems associated with the mosaicing and orientation of DEMs.derived from spaceborne sensors (ASTER, SPOT, SRTM). Premalatha's example was in the Zagros Mountains in Iran, for which a study of geomorphology and drainage had been difficult with previous uncorrected DEMS.

A rapid change of scene then led us to a study of major landslides in and around the city of Bukavu in the Democratic Republic of Congo by Philippe Trefois from the Musee Royal de l'Afrique Centrale in Belgium, who used GIS and IKONOS imagery to demonstrate the increased settlement of unstable land during the rapid growth of the city. The final talk of the afternoon, from Saied Pirasteh, used remote sensing and GIS to relate geomorphological and lithological factors to active faulting in the Zagros of Iran. The afternoon was rounded off by a drinks reception which included the presentation of the NPA Student Award to Richard Eyres and GRSG Lifetime Achievement awards to John Berry and Geoff Lawerence. The day finished pleasantly with a trip to the local haunt of the GRSG, the Captain's Cabin pub.

Tuesday began with a session themed around volcanic hazards. Matthieu Kervyn De Meerendre from the University of Ghent in Belgium kicked off with a case study on Mauna Kea, Hawaii; comparing Landsat ETM and stereoscopic ASTER imagery with more traditional topographic maps and aerial photos for characterising small pyroclastic features and volcanic deposits. Sukina Stewart from Lancaster University then discussed the challenges of a combined remote sensing and fieldwork based approach to studying volcanic and geomorphological changes at Grimsvotn volcano in Iceland. The spectacular pictures and anecdotes of fieldwork on the glacier-bound volcano were particularly topical as the volcano erupted shortly before the conference: 'before and after' pictures provided an impressive illustration of the dynamic nature of that environment. The problems of observing the volcano in cloudy conditions linked neatly to the next talk by Geoff Wadge from the University of Reading, describing an innovative new instrument for all-weather terrain mapping on volcanoes. The field-portable instrument uses millimetre-wave radar to build up raster images of lava dome growth, and achieves results through cloud and at night. The dual-mode design will also allow passive radiometric sensing of temperature at the same time as radar imaging.

Paul Goldsmith from Kingston University started the next session with an account of field radiometry work in Belarus, aimed at establishing a technique to estimate radionuclide contamination levels in vegetation from spectral data. Stuart Marsh from the British Geological Survey then followed with a wider overview of the field, with a UK perspective on European and International initiatives for remote sensing and Earth observation. During lunch, the GRSG Annual General Meeting provided a forum for discussion of a wide variety of issues, including initiatives underway to boost the finances of the organisation, some lively discussion on a suggestion for optional electronic distribution of the newsletter, and a few bold ideas for the future.

The afternoon sessions had a landslide and debris flow theme. The furthest travelled delegate at the conference, Andy Hansen from Curtin University in Western Australia, gave a very informative comparison of stereo and multi-image photogrammetry with hand measurements and laser scanning. He was followed by Graham Hunter from Halcrow Group, who discussed the issues involved in monitoring the Blaencwm Landslide site in the Rhondda Valley. Ian Anderson from 3D Laser Mapping Ltd then took over to explain the terrestrial laser monitoring project undertaken at the landslip, and the advances in image grid alignment and distance correction achieved during the project. Malcolm Whitworth from the University of Portsmouth then gave a talk on semi-automated landslide detection in the Cotswolds, using a combination of airborne multi-spectral data and high-resolution digital elevation data, developing a technique incorporating textural and principal component analysis.

Francois Kervyn from the University of Ghent started the second afternoon session with a presentation on active faulting in the Rukwa Basin, Tanzania, using and ERS SAR DEM and ASTER spectral data. Lineaments seen in the basin from the DEM were also located in moisture and vegetation data, and although little was visible on the surface in some places, a trench revealed a normal fault with a 1.6m offset. Andy Gibson from the British Geological Survey then returned to more familiar territory with a talk on the Black Ven landslide in Dorset, looking at spectral characteristics of the different debris deposits. One interesting result was the surprising sensitivity of the spectroscopy to the clay mineralogy of samples, possibly comparable to conventional XRD techniques. The day was rounded off by Delioma Oramas Dorta from the University of Coventry, who presented a study on re-callibration of the LAHARZ model for volcanic debris flows using data from Sarno, Italy.

The presentations were also complimented by a variety of posters and exhibitors, which mirrored the international scope of the talks providing case studies from countries as varied as Norway, Ethiopia, Kyrgyzstan and Jamaica. Overall the two days proved very exciting, with lots of new approaches to hazard investigation showing promise, and the standard of presentation was generally excellent. The event provided a fantastic opportunity to meet the wider community involved in many different aspects of geological remote sensing, and it would be great to see everyone back again in a years time for the next GRSG annual conference.

Interseismic deformation from InSAR: the North Anatolian Fault, Turkey

Rachel Holley[1], Tim Wright[2] and Barry Parsons[2]

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(2) Centre for the Observation and Modelling of Earthquakes and Tectonics, Department of Earth Sciences, Oxford University.

The North Anatolian Fault (NAF) is a major right-lateral strike slip fault, which extends for more than 1000 km across Northern Turkey, one of the most seismically active areas in the world. Nine large earthquakes have occurred along the fault during the twentieth century, and as recently as 1999 the Izmit earthquake ruptured the western NAF killing at least 18,000 people. We present an analysis of Interferometric Synthetic Aperture Radar (InSAR) data acquired by the ERS satellites, of a section of the eastern NAF that last ruptured in 1939. The data image the slow accumulation of interseismic strain, building up to the next earthquake.

InSAR is a well-established technique for the study of co-seismic deformation during earthquakes, but its use for measurement of interseismic strain accumulation is more challenging. Interseismic deformation signals are small (a few centimetres per year at most) and may be distributed over tens of kilometres. It is therefore difficult to separate the deformation signal from noise caused by atmospheric differences and orbital errors. Multiple interferograms can be used to improve the signal to noise ratio by a process known as stacking, which enables small deformation signals to be measured. In this study we stacked seven interferograms, with time intervals between one and three years. The final interferogram is equivalent to a single image spanning 12.7 years - a time interval over which coherent interferograms cannot be formed.

A best-fit inversion for the slip rate and elastic locking depth of the fault agrees well with the results from previous work on an adjacent track. A joint inversion of the two datasets yielded slip rates of 18-29 mm/yr under a 7-18 km elastic lid, comparable with existing estimates of slip from GPS data and geology.

Satellite Radar Interferometry observations of fault motion between earthquakes - Alaskan examples

Juliet Biggs[1], Tim Wright[1], Zhong Lu[2] and Barry Parsons[1].

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A significant proportion of earthquakes occur on faults which have no surface expression and are therefore passed over by traditional mapping techniques. Recent examples include the M6.7 1994 Northridge, California earthquake and the M6.6 2003 Bam, Iran earthquake. Observations of the ground deformation occurring on faults between earthquakes could identify even those active faults which are blind or newly-formed.

Interferometric Synthetic Aperture Radar (InSAR) is a satellite-based geodetic technique which is capable of producing spatially dense maps of ground deformation crossing entire tectonic zones. InSAR is routinely used to study a range of natural hazards including earthquake and volcanoes, but extending the technique to study the earthquake cycle as whole requires a much larger archive of data.

Situated at the boundary between the Pacific and North American Plates, Alaska is the most tectonically active of the United States. South-central Alaska is a region of continental collision - a transition zone between the Aleutian Trench to the west and the Queen Charlotte Transform to the southeast. The second largest earthquake ever recorded, the M9.2 Great Alaskan Earthquake of 1964 occurred in the Prince William Sound and postseismic deformation from this earthquake continues today. The M7.9 3rd November 2002 Denali Fault Earthquake was the largest strike slip earthquake in North American for more than 150 years, rupturing 340km of the Denali, Susitna and Totshcunda Faults with offsets of up to 9m. A large archive of InSAR data is available over Alaska from the ESA satellites ERS-1 and ERS-2 during the period 1992-2002, providing a rare opportunity to study the strain accumulation on a fault in the decade preceding a major earthquake. We analyse data from the Denali Fault and the Cook Inlet regions and compare the results to both geological and GPS observations.

Mapping hazardous terrain using SAR Interferometry

Michael Riedmann

NPA Group

In 1992 conventional, 2-pass differential SAR interferometry (InSAR) was introduced to the remote sensing community with the publication of Massonnet's interferogram, depicting the ground deformation caused by the Landers earthquake. Although the power of interferometry was demonstrated, application of the conventional technique in operational scenarios has proved to be more challenging. Over the last few years, however, a number of technical developments have emerged that allow for higher precision of motion rates, the extraction of specific motion histories, and precise targeting.

This presentation will illustrate the benefits of differential SAR interferometry (DiffInSAR) for earthquakes and landslides. Some of the classic limitations of DiffInSAR will be discussed: lack of coherence, atmospheric refraction and targeting. It will be shown how some of these limitations can be overcome with Persistent Scatterer Interferometry (PSI), which allows detecting slow ground motion with annual rates of as little as a few millimetres along the line of sight, reconstructing a motion history based on ESA's ERS archive. The technique permits the estimation and removal of the atmospheric phase achieving higher accuracies than DiffInSAR. PSI relies on the availability of pre-existing ground features which happen to strongly and persistently reflect back the signal from the satellite. However, in highly vegetated regions, PSI may not be applicable due to the lack of natural scatterers. To ensure motion measurement of the ground or structures at targeted locations, NPA are developing InSAR using artificial radar reflectors, such as Corner Reflectors (CRs) or Compact Active Transponders (CATs). Both reflectors are still undergoing validation tests, but first results show a high phase stability in both cases.

Orientation problems of mapping from images in hazardous and remote areas.

Ian Dowman and Premalatha Balan

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It is frequently necessary, for geological applications, to require mapping from images which cover rugged, mountainous areas in remote parts of the world. In order to produce accurate maps of such areas it is necessary to reference the images to the ground and make corrections for the orientation of the images. This is the process of exterior orientation. Exterior orientation may be achieved by using information acquired from GPS and attitude sensors on the platform with the sensors, but this is frequently not accurate enough for the desired purpose; in that case ground control points are required. These are often difficult to acquire *ab initio* with sufficient accuracy because of cost or not being able to go into the area of interest, and existing maps are not accurate or complete enough. These problems can be solved by using orientation data and by using digital terrain models (DEMs) as reference data. This paper will look at the requirements for exterior orientation and the method which can be used to achieve this, including a study of the accuracy achievable for different sensors. Results of generating a DEM and orthoimages from SPOT HRS data without ground control will be described. The paper will also describe novel techniques for constructing mosaics from ASTER data in the Zagros region of Iran as part of the COMET project (Centre for Observation and Modelling of Earthquakes and Tectonics). Orientation of models with SRTM data will also be discussed.

Detecting Instable Ground by Satellite and Airborne Remote Sensing

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Underground mass movement can cause subsidence, collapse sinkholes, and landslides at the earth's surface. We have used satellite and airborne remote sensing to detect subsidence and collapse-prone ground caused by the dissolving of salt. The study area is near Eisleben in the German federal state of Saxony-Anhalt, where subsidence and collapse-prone ground are widely distributed. Instable ground is caused by the dissolving of salt from rock salt strata of the Zechstein Formation, which is at depth of about 250 meters and deeper. Fresh water reaches the rock salt through fractures, and abandoned galleries of former copper mines. Cavities are formed at the top of the rock salt. Subsequent collapse of these cavities triggers mass movement in the cover rock, leading to subsidence and collapse sinkholes.

We have used satellite images and airborne geophysical survey data to detect hazards caused by underground mass movement. Because the electromagnetic radiation utilized by remote sensing cannot penetrate the ground, early detection of hazardous ground by remote sensing will require "diagnostic features" which can serve as surface expressions of subsurface situations, and which can be recorded by satellite and airborne sensors. Such diagnostic features are lineaments, fractures, fissures, small scarps, hummocky terrain, moisture anomalies, depressions, altered vegetation, and those best seen with low-angle illumination.

We have tested the extent to which surface features can indicate subsurface mass movement. Reliability is improved and ambiguity is reduced when data recorded by the different types of sensors are used. Integrated processing and interpretation of high-resolution aerial photography, airborne laser scanning and satellite imagery reveal surface features that are associated with fracturing, subsidence and weakened rocks. We have demonstrated that airborne laser scanning (Lidar) can improve the reliability of remote sensing for early detection and characterization of subsidence and collapse-prone ground. A major advantage of laser scanning is its ability to detect extremely small changes in the terrain.

Subsidence detection from multi temporal airborne imagery

Richard Eyers and Jon Mills

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Multi temporal aerial photography and airborne hyperspectral imagery have been integrated for the detection and monitoring of subsidence hazards in the former coal mining region of the North East of England. Digital elevation models derived from successive epochs of aerial photography produce estimates of topographic change which may be indicative of collapse above abandoned underground mine workings. These results are combined with spectral anomalies indicating surface disturbance using multi criteria analysis in a geographic information system.

Photography originally acquired for topographic mapping during the last forty years has been scanned and processed in a Digital Photogrammetric Workstation. A DEM was created for each epoch of photography using automated stereocorrelation. Since uncertainties in surface stability preclude the use of conventional ground control points for controlling archive photogrammetric models, each DEM was processed with only relative orientation. A surface matching algorithm and a contemporary surface, created from a photogrammetric model with ground control surveyed using phase processed GPS control, then provides the exterior orientation. Areas of topographic change, including subsidence features are then identified by subtraction of the archive DEMs from the control surface model.

Coast Line Change Detection on the North Coast of Istanbul (Turkey) by Using GIS and RS Technology.

H. Volkan ORAL, Hasan OZDEMIR, Barış MATER, Orhan YENIGUN,

Effects of human activities on coasts have been in the forefront of environmental challenges of today. Land use change can be classified under those effects and more specifically coal mining is the function which causes land use change.

The aim of this study is to detection of coast line change of coal mining on the north coast of Istanbul by using Geographic Information Systems and Remote Sensing Technology. Geographic Information Systems and Remote Sensing Technology are computer based systems that can be used as tools to figure out large scale environmental problems. Remote Sensing and GIS technology are both used to collect, analyze, and report information about the earth's resources and the infrastructure that is developed to use them. The two technologies provide complementary capabilities. In this scope, topographic maps in 1:25.000 and 1:100.000 scales in different date, and Landsat ETM, TM and MSS images were used in this study.

In the north of Istanbul-Catalca peninsula, along the coast of the Black Sea, coast line is taking place due to coal mining. Also in the north of the peninsula, a large forestry area is diminishing under expansion of coal mining activity. At the same time coast line is changing from this activity. All of these effects cause some environmental problems for the future. In this study, coast line change were exposed in last 25-30 years.

Applications of IRS-1D data for electricity power-grid line routing, Himachal Pradesh, India

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Laying the powerline grid in difficult terrain of Nalagarh ,Himachal Pradesh was a challenge with the local authority. This area is seismically active and changing terrain was noticed since decades. Using Geo-image and ERDAS software some vital landform features were extracted from geo-coded IRS-1D satellite data of the area.

Palaeochannels were identified, shifting lineaments were inferred and floodplains were traced. All these informations were plotted in the map after a field confirmation. Alternate alignments of power gridlines were suggested for immediate implementation. Palaeochannels, lineaments (possible faults and fractures) and floodplains were individually studied by the specific pixel correlation.

In the mixed terrain of Limestone, Sandstone, Shale, Slate and Quartzite this type of study is a pioneering and proves the potential of remote sensing applications academically and its usefulness in difficult terrain for addressing societal issues in large.

Mapping the aftermath of the Boscastle flash flooding using airborne remote sensing.

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To provide environmental remotely sensed data at a range of scales the Environment Agency operates an aircraft platform equipped with a variety of sensors including an Optech ALTM 2033 LIDAR, an ITRES Compact Airborne Spectrographic Imager (CASI), digital camera, thermal imager and a variety of video cameras. These instruments are integrated into the platform using common GPS position and orientation systems ensuring data is produced to a common reference. Since 1998 there has been an on ongoing program to produce high quality elevation data using the LIDAR instrument - approximately 60,000sq km of high resolution LIDAR elevation data has been collected, mainly for flood defense applications. In addition to this provision of data for the Agency's mandatory tasks, the airborne remote sensing capability enables the Agency to respond to environmental emergencies.

In the past few years the Agency has been able to rapidly deploy its survey aircraft to such emergencies as the Sea Empress disaster, the floods of 2003 and most recently the devastating flash flooding at Boscastle, Cornwall.

Working in partnership with other government departments and the emergency services, the Agency's survey plane deployed to the area to capture a definitive record of the post flood event landscape. LIDAR data at a spatial resolution of 50cm was collected for the whole of the catchments of the River Valency and River Jordon that converge at Boscastle, along with the adjacent catchment of Crackington Haven which was also badly hit by the flooding.

As well as LIDAR data, CASI imagery, thermal, video and digital photography were collected, these have been automatically geo-rectified using the LIDAR data.

This data will enable the Agency, plus other interested bodies, to test and model the catchments assessing factors such as landuse, farming practice and development and how they contributed to this event. Comparisons with historic Agency LIDAR data will allow change detection to be measured. Meteorological data will also be integrated.

This virtual environment will help to inform future decisions within this catchment and similar landscapes that may also be at risk from flash floods.

Satellite Data and GIS Techniques to Interpret Influence Of Lithology & Geomorphology For Development Of Faults & Lineaments and Tectonic Processes In The Tang-e-Bostank Area Southwest Iran, Zagros Mountains

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Lithology and geomorphology are two main factors for development of the faults and lineaments in tectonic processes. The Zagros Mountains is parts of Alpine-Himalayan orogenic system. The orogen can be divided into three structural zones as, 1-An inner crystalline Zone of over thrusting, 2-An Imbricated Belt, and 3-Zone of Folding often referred to the Simply Folded Belt (SFB). The Tang-e-Bostank in SFB is selected for the present study. The lithogical and geomorphological analyses using remotely sensed data and GIS techniques were carried out. The lineament density was calculated and correlate with lithology, erosion, drainage density and other geomorphic parameters. The study shows that the development of lineaments and faults are depended in lithology and geomorphic parameters. This study also reveals that the most of the tectonic processes and development of the lineaments are caused erosion and influenced by lithology. Thereby Bangestan formation develops maximum lineament density and erosion with tectonic activity in the Tang-e-Bostanak area.

Capabılıtıes of fıne resolutıon remote sensıng to map hazardous volcanıc terraıns: a case study from Mauna Kea, Hawaı‘ı

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Due to dramatic improvements in spatial resolution, remote sensing data have been increasingly used to map and study potential hazards in volcanic terrains by identifying volcanic deposits related to contrasting eruptive activities. The stereoscopic capabilities of ASTER images allow accurate numerical terrain modelling. The acquisition of multispectral data combined with the georeferencing, low cost, availability, homogeneous and repeated coverage of extended volcanic terrains are key advantages of these new sources of spatial data. This is in contrast to the past, when topographic maps and aerial photos were extensively exploited where available, but were usually not readily available for remote areas or in developing countries. We assess to what extent satellite imagery can be used as a substitute for topographical maps and air photos when these are lacking or too difficult to obtain. Here we illustrate the use of satellite data to map small hazardous features through a case study. We focus on the numerous pyroclastic constructs of relative small size on Mauna Kea volcano, Hawai’i. We also explore to what extent spectral information can be used to retrieve information on surface characteristics and used in automated classification of volcanic regions as an automated geological mapping tool. For example, we assess the ability to discriminate between lava flows and pyroclastic deposits. Here, Landsat ETM+, a stereoscopic pair of ASTER images, topographic maps and aerial photo of Mauna Kea volcano were comparatively analysed to assess their respective capabilities. These include retrieving accurate quantitative and descriptive morphological parameters and mapping and characterising distinct volcanic deposits. Satellite imagery proved invaluable to map a diversity of features larger than 150 m (e.g., vent location; size, height and shape of pyroclastic constructs; breached flank), relating to eruptions of small and high intensity. Analyses of surface spectral responses allowed for recognition of a specific spectral signature (i.e. high mid-IR reflectance) of hydrothermally oxidised iron in scoria deposits. Cloud and vegetation coverage as well as the finite spatial resolution and the shadow effect due to the illumination angle appear to be the chief limitations. Discrimination of distinct volcanic deposits such as lava flows and scoria deposits based on reflectance value alone is not yet straight forward. Combining these approaches with radar data and the new global SRTM dataset should soon help to overcome some of these limitations. Implications for future data collection and analyses and volcanic terrain hazard assessment are considered.

Airborne Remote Sensing of the Thermal Activity of Grímsvötn, Iceland

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Grímsvötn is Iceland's most active volcano. This sub-glacial volcano, which erupted in 1996 and again in 1998, has a partially exposed geothermal system, and ground-based measurements have been used to make calorimetric estimates of the relationship between volcanic eruption rate and heat flux. However, increased melting in Grímsvötn during and after the 1998 eruption resulted in major leakage of a sub-glacial dam. This significantly increased the problems of calculating heat flux calorimetrically. Due to the inaccessibility and difficult terrain surrounding the volcano the NERC ARSF carried out a combined infrared and photogrammetric aerial survey of Grímsvötn in 2001 to overcome this.

The aims of the project are to learn more about the processes in operation within this particular subglacial volcano, such as heat flux, morphological changes and volcanic processes. We are also using the ARSF data to assess its usefulness in understanding hazards posed by other subglacial edifices. Aerial photographs collected during the ARSF survey are used to produce geomorphological maps of the instabilities on the caldera wall, together with deep geothermal cauldrons that cannot be safely mapped from the ground. The photographs are scanned and the resultant images orthorectified and mosaiced using ERDAS Imagine. The combined data sets will be analysed both visually and quantitatively using a combination of ERDAS Imagine and ArcGIS environments.

The June 2001 thermal images of the Grímsvötn subglacial caldera reveal distinct areas of geothermal activity. These images allow previously unknown areas of high heat flow to be identified, and they provide a reliable estimate of the present heat output.

A new instrument for terrain mapping on cloudy volcanoes

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Cloud cover often inhibits the monitoring of dynamic processes on volcanoes. The new AVTIS instrument (All -weather Volcano Topography Imaging Sensor) has been designed to overcome this. It uses millimetre-wave (94 GHz) radar energy beamed from a 50 cm antenna to illuminate the surface of the volcano and measure the range distance from the returned signals, and hence can be used through cloud and during both the day and the night. The range resolution is of the order of 1 m and the angular resolution is about 0.2 degrees. An automated pan-and-tilt gimbal enables raster images to be built up. The instrument is field portable, runs off two car batteries and can be used at distances from about one to six kilometres. The first volcano testing of the instrument took place on Soufriere Hills Volcano, Montserrat in May/June 2004. The instrument was designed with the monitoring of active lava dome growth in mind. Although no dome was growing during the fieldwork we were able to test AVTIS's ability to map the "static" topography, including the huge amphitheatre produced as a result of the July 2003 collapse event. Multiple viewpoints enable the volcano surface to be reconstructed in 3D. AVTIS has a dual mode design allowing passive radiometric sensing of temperature at the same time as radar ranging. This functionality will be enabled at the next stage of development of the instrument, together with design improvements based on our Montserrat field experience.

Remote Sensing the Radionuclide Contaminated Belarusian Landscape

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The 1986 Chernobyl accident resulted in radionuclide contamination (dominated by 137Cs) across large areas of Belarus. Consequences continue to affect Belarus long after initial contamination, which in turn has placed strain upon social, economic and political infrastructures. One method to reduce this strain and remediate contamination is to return areas of land which no longer pose a hazard, back to an appropriate use. As a method of remediation, this requires regular and accurate monitoring of the landscape at which existing ground based techniques have not been entirely well-suited. Remote sensing, specifically the use of imaging spectrometry offers potential to monitor the Belarusian landscape at opportune spatial and temporal resolutions, with the possible end product being up-to-date digital maps, distinguishing between contaminated, and non-contaminated land. Vegetation has been shown as an important agent in the cycling of radioactive isotopes through the environment, and therefore a useful indicator of radionuclide contamination. This research has focused on applying field radiometry to assess spectral response from Pinus sylvestris (dominant on the Belarusian landscape) at differing ages and with varying levels of 137Cs contamination. A number of analysis techniques have been applied to spectra collected during summer 2003, including derivative spectroscopy and continuum removal. These have shown that statistically significant differences exist between relatively high, and low contaminated trees, at wavelengths which have been causally related to key foliar biochemicals. The results signify potential to infer contamination levels from spectra, thus indicating the possibility of using airborne or spaceborne imaging spectrometry to monitor radionuclide contamination. A recent field campaign to Belarus during summer 2004 focused on expanding the existing data set and enhancing understanding between spectra, key foliar biochemicals, and 137Cs levels. Preliminary results show differences in spectra similar to those seen in the 2003 data, and indicate that further analysis will move a step closer towards the overall goal of the project; namely the use of imaging spectrometry to regularly and accurately monitor the radionuclide contaminated Belarusian landscape.

International initiatives on the remote sensing of hazardous terrain

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2) British National Space Centre

3) Nigel Press Associates

The UK is currently playing a leading role within a number of international initiatives aimed at mitigating the impacts of geological hazards using remote sensing. These operate from the strategic and intergovernmental levels, through the responsive mode, down to more operational projects. This presentation will provide a briefing for the UK community.

The Integrated Global Observing Strategy (IGOS) is a strategic planning process that links research, long-term monitoring, operational programmes, data providers and users to help identify gaps in environmental observations and the resources to fill them. Partners include the Committee on Earth Observation Satellites (CEOS), currently chaired by the British National Space Centre, the Global Observing Systems and the International Agencies that sponsor them, the International Group of Funding Agencies for Global Change Research, and various international global change research programmes. Following on from extensive work on hazards undertaken by the CEOS Disaster Management Support Group, the British Geological Survey now chairs the IGOS Geohazard Theme. Its goal is to integrate disparate, multidisciplinary, applied geohazard research into global, operational systems by filling gaps in organisation, observations and knowledge. The Theme was approved in November 2003 and it will be implemented over the next decade. It is hoped that the Earth Observation summit process will significantly boost the strategy's impact. Supported by the intergovernmental Group on Earth Observation, GEO, this process comes to a climax in early 2005 when the UK is in the chair of the G8 Countries that helped launch the initiative.

As well as supporting the development of the IGOS for geohazards, the British National Space Centre has been involved in more responsive, disaster management initiatives. They are one of the key players in the UN (UNISPACE III) Action Team 7 on Disaster Management, which will publish its final report in 2004. They have also supported the development of the Disaster Monitoring Constellation (DMC). In September 2003, Surrey Satellite Technology Limited (SSTL) successfully launched the latest three DMC satellites. SSTL and its partners propose a network of affordable, micro-satellites providing imaging on a daily basis as an affordable solution to the problem of disaster assessment and monitoring from space. The satellites, for Nigeria, Turkey and the UK, join AlSAT-1, another Surrey-built satellite launched for Algeria last November. Together, they will transform the ability of international disaster relief organisations to monitor and provide emergency assistance to disaster zones whenever and wherever they occur. The DMC may be activated by organisations such as Reuters Foundation AlertNet and disaster management projects, such as RESPOND within the EC/ European Space Agency (ESA) Global Monitoring for Environment and Security (GMES) programme. It may form the basis for the UK to join the International Charter on Space and Major Disasters. Constellation growth will fuel operational use.

A third UK player behind the IGOS for geohazards is Nigel Press Associates, who also lead a key European project that aims to put in place a pre-operational system for mitigating geohazards. The Terrafirma Project, one of several services being supported by the ESA's Service Element within the GMES Programme, aims to provide a Pan-European ground motion hazard information service through the national geological surveys. Initially the focus is on urban subsidence but, once the project has demonstrated a successful service, it may be widened to include other types of ground motion hazard. As well as this over-arching service, NPA have been involved in three, more focused geohazard projects with the BGS and other partners. PRESENSE was an EC Framework 5 research project on pipeline monitoring, within which NPA and the BGS addressed the issue of ground instability. This has been followed by PIPEMON, an ESA-funded market development project on a similar theme. Finally, NPA and BGS have worked with various international partners on the application of INSAR to earthquakes, in the project PSIGN.

This paper will describe all these initiatives and present a forward look, in anticipation of the BNSC chairing CEOS and co-chairing IGOS in 2005. This will occur in conjunction with the UK Presidency of the European Community, as GMES moves to its operational phase, and the UK Chairmanship of the G8, as the GEO and EO Summit process comes to a conclusion. The UK has a unique opportunity to influence these international developments during 2005 and should organise itself to take advantage.

Applying stereo and multi-image photogrammetry to geomorphological measurement and mapping of rock slopes and landslides

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Measurements of hillsides and rock surfaces for landslide and slope stability investigations are often constrained by problems related to difficulty of access and personal safety. Options for measurement of surfaces and daylighting planes of weakness include direct measurement by hand (e.g. compass and clinometer) and indirect remote sensing methods such as reflectorless total station, laser scanning and photogrammetry. Investigations into the mapping and measurement of landslides and complex rock surfaces using stereo and multi-image photogrammetry produced results comparable to hand measurement and laser scanning. The results further demonstrate that these techniques can be used to obtain geomorphometric information adequate for geotechnical investigation and design using equipment and procedures that are cost-effective for small geotechnical projects.
Using automated and semi-automated photogrammetric measurement, 3D morphological maps have been generated for a quarry face as well as relict and recent debris flow landslide scars, and the resulting models developed into 3D geomorphological visualisations. Constraints of the techniques are evaluated, including recommendations to facilitate use of consumer grade cameras for precision measurement in geomorphological fieldwork.

Landslide Monitoring in the Rhondda Valley, South Wales

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Since 1989, when a landslide occurred on the Coal Authority owned Blaencwm Landslide site, conventional movement monitoring has been conducted of some 60 points on the 100ha site. This revealed movements of nearly 100m. This system was augmented by the use of terrestrial laser monitoring, conducted in February and June of 2003 and February 2004.

Terrestrial laser monitoring obtains the coordinates of numerous points (63,000 in this case) on pre-set grids, which for this site places the points some 3m apart. The long sight lengths of between about 750 and 1500m required the use of a Riegl LPM-2K scanner which has a range of up to 2000m and measures points to an accuracy of 25-50mm using non-reflective technology.

Terrestrial laser surveys have the following particularly useful benefits, they:

- include areas that are generally too dangerous or difficult to monitor, such as potentially unstable cliff faces;
- monitor all of the site, so would reveal any movement occurring where it would not be expected;
- provide 3 dimensional models of the site that can be used for modelling;
- provide information on adjacent areas that could be affected by landslides without having the need to physically enter those areas.

They also validate the results from movement marker monitoring;

However, owing to the long sight lengths and irregular ground surface the laser surveys revealed some drawbacks:

- even if the same grid could be recreated on subsequent surveys, the very small differences in setting up the instrument can cause the actual points surveyed to differ in position.
- The laser instrument cannot be mounted on a tripod because each survey takes several hours and fluctuating wind pressures can affect the results.
- Pressure/temperature corrections based on observations at the instrument location could be inaccurate as most of the laser path is mid-valley where conditions may differ.
- Recreating the same survey grids to compare surveys on a point to point basis was difficult owing to the relatively inaccurate means of sighting the equipment.
- It is necessary to interpret the results cautiously; the surveys detect all surface movement and some of this may not be landside movement.

The effects of all but the last of these drawbacks were minimised by:

- using a concrete survey plinth;
- surveying GPS positioned targets on the landslide to both ensure accurate distance correction and alignment of subsequent surveys;
- evaluating previous survey grids by sophisticated computer programming and setting subsequent grids by electronic means;
- sophisticated data processing that eliminates inconsistent results;
- defining movement using the average data for areas within the landslide, rather than that for individual points.

The potential for incorrect interpretation can only be overcome by having knowledge of the site, which is much improved by having good historic photographic records, and must be verified by site inspection conducted by competent individuals. In this case the apparent slope movement was mostly due to the effects of an extensive grass fire.

The use of terrestrial laser monitoring at this site has further developed the use of this equipment. Such surveys can now be made repeatable, which is essential when surveying points on irregular ground surfaces at large distances, as is the case for many landslides.

It should be noted that the opinions expressed here are those of the authors and not necessarily those of the Coal Authority.

Airborne remote sensing, terrestrial LiDAR and landslide mapping

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The Cotswold Jurassic escarpment of central United Kingdom is associated with extensive landslide activity including rotational failures, shallow translational landslides and mudslides. These landslides can pose a particular hazard related to the presence of relict failure surfaces at depth, which can be subject to reactivation if these features are disturbed by engineering works or excavations.

This research project has sought to develop robust methods for the identification and delineation of landslides using airborne remotely sensed imagery and digital topographic data. The project employed high-resolution Airborne Thematic Mapper (ATM) multispectral imagery acquired by the UK NERC Airborne Remote Sensing Facility (ARSF) and high-resolution digital elevation data derived from GPS surveys and digital photogrammetry. The research has shown that landslides can be identified successfully within imagery using this type of semi-automated method, and that such techniques can provide a rapid means for terrain evaluation and landslide hazard assessments.

This presentation will describe the landslides and geomorphology of the chosen study area in Worcestershire, UK, and detail the methodology adopted for the identification of landslides using a combination of textural analysis, principal component analysis and image classification and describe how digital image processing can be used for the discrimination of landslides in airborne remotely sensed data.

Geomorphology and urban geology of Bukavu (R.D. Congo): interaction between soil instability and human settlement.

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The city of Bukavu, on the south coast of Lake Kivu in the Democratic Republic of Congo, suffers from frequent landsliding, leading to continuous degradation and destruction of houses, buildings and roads, waterworks and sewerage infrastructure.

Thirty one landslides identified on aerial photographs of 1955 and 1973 are located outside the Bukavu micro-rift and are related to actively incising river basins. Their origin is due to an increase of hydrostatic pressure. Four from the six landslides within the micro-rift are bigger and wider than the others. They are adjacent to or crossed by active faults, and they fall far below the envelope of topographic threshold, a combination of slope at the head of the slide and surface drained to it, as defined for North America and verified in Rwanda. This indicates seismic or anthropic triggering. All these landslides still reactivate occasionally. An important deforestation followed by a large development of the population lies at the base of the continuation of the mass wasting processes up to today.

The present situation is shown by an IKONOS satellite image of 2001 (fusion of panchromatic image at 1 m resolution and multispectral data at 4 m resolution). The density of newly built houses is important on the steep slopes in the south of the city. Water infiltration is modified, and water runoff is an additional cause of landslides and mud flows.

The recent satellite imagery at very high spatial resolution is used as a base map for updating the city situation in a Geographic Information System on the basis of field survey, including the roads and tracks, the river network, the water distribution and the sewerage infrastructure, the soil instabilities and all the ongoing degradations. This GIS is intended as a powerful tool for urban planning.

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Spectral Properties of Debris from the Black Ven Landslide

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Landslide debris is a significant geohazard in temperate environments. Debris is often unstable, variable and exhibits engineering behaviour that is difficult to predict. Conventional monitoring techniques are rarely suitable for monitoring debris deposits. This study assessed to what extent reflective spectroscopy could be used to perform semi-quantitative analysis of the engineering character and condition of debris deposits under laboratory, field and remote sensing conditions.

The study area chosen for this research was the Black Ven landslide complex on the West Dorset coast, a landslide with two broad geomorphological terrains. Conventional geotechnical indices were used to classify samples from each terrain in terms of geological provenance and geotechnical characteristics. The spectral characteristics of each material under different controlled conditions were determined using an ASD Fieldspec spectroradiometer at wavelengths 0.35-2.5 µm.

It was possible to classify debris type according to geomorphological terrain using a simple soil line equation. Bulk mineral analyses of the spectral data using recognition algorithms provided results remarkably similar to those published from more conventional methodologies, and indicated that reflective spectroscopy may demonstrate greater sensitivity to the clay mineralogy of bulk samples than XRD. Variation of reflectance with moisture content was consistent for each debris type and could be described by a mathematically defined functional relationship. This relationship can be represented by an index measurement- the Soil Moisture Index (SMI). It has been demonstrated that similar results can be achieved using bandwidths available on an airborne remote-sensing platform. It is proposed that this relationship be represented by a new spectral measure, the Airborne Thematic Mapper Soil Moisture Index (ATMSMI).

Remote sensing and GIS-based empirical modeling of small debris flows in Sarno, Italy

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Debris flows are fully saturated mixtures of water and sediments that can be triggered by heavy rainfall within mountainous areas mantled by volcanic deposits, representing a permanent hazard for nearby people and infrastructures. This was tragically demonstrated by the events of May 1998 in the area of Sarno, Southern Italy; when persistent rains made collapse the upper slopes of local hills that evolved into debris flows affecting Sarno and the neighboring towns, and killing more than 150 people.

The identification and characterization of debris flow endangered areas has thus become a critical issue for the scientific community worldwide. Within this context, Iverson et al. (1988) and Schilling (1988) developed LAHARZ, a computer program embedded in a GIS that allows simulation of the inundation area of large volcanic debris flows or lahars. LAHARZ is calibrated by regressions between flow volume and inundated area for a set of known events. This paper presents a recalibration of LAHARZ designed to simulate smaller debris flows than are currently covered in the original regression model, by considering the specific events occurred in May 1998 in Sarno.

The approach followed was the use of remotely-acquired images (aerial photographs) of the affected area after the event, in order to carry out geomorphological interpretation. This allowed deriving information on flow morphology and estimating flow volumes and inundation areas for the set of debris flows that took place in Sarno. We developed two regression models (i) a “local model” with data from Sarno only, and (ii) a “global model” combining data from both Sarno and the original LAHARZ calibration. For small debris flows, these two models predict inundation areas that are a factor of ten less than those predicted by the original LAHARZ equation. This suggests that the Sarno events were less mobile than typical lahars. This may reflect several factors, including (i) the bulking of the flows by carbonate rocks removed from the source areas and the flow channels, (ii) the built environment reached by the distal parts of the flows, and (iii) possible overestimation of flow volumes.

These two models predicted the inundation areas of the Sarno events with similar levels of uncertainty. Uncertainty in flow volumes and statistical errors in the model suggest that hazard maps need not attempt a higher horizontal resolution than around 10 hectares (ha). The new models offer a valuable extension to the original LAHARZ dataset, especially for modeling smaller non-volcanic debris flows, which may nevertheless be destructive.

Landslide Risk in the Mailuu-Suu valley, Kyrgyzstan

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Mailuu-Suu is a former Uranium-mining area in Kyrgyzstan (Central Asia), at the northern border of the Fergana Basin. This region is particularly prone to landslide hazard and, during the last 50 years, has experienced severe disasters related to landslide activation and the presence of numerous nuclear waste tailings. Major impacts had landslide activation and related river damming in the early 90' as well as the continuous destruction of the infrastructure protecting the tailings (by missing maintenance after the collapse of the Soviet Union). Due to its critical situation, the Mailuu-Suu region was and still is the target area for several risk assessment projects. This paper first provides a brief review of previous studies, past events and a discussion on possible future risk scenarios. In addition, various aspects of landslide hazard and related impacts in the Mailuu-Suu valley will be analyzed in detail: landslide susceptibility, historical evolution of landslide activity, size-frequency relationship, river damming and flooding as well as impacts on inhabited areas and the nuclear waste storage zones. The study was carried out with standard remote sensing tools for the processing of satellite image data (ASTER and SPOT4,5) and the construction of digital elevation models. CORONA images and aerial photographs were used to complete the analyses at higher resolution. The processed inputs were combined on a GIS platform with digital landslide distribution maps of 1962, 1977 and 2003, digitized geological and geographic maps and information from landslide monitoring and geophysical investigation. As result, various types of landslide susceptibility maps are computed on the basis of two statistical methods, the landslide factor method and the conditional analysis. We also present predictions of future landslide activity and the related landslide damming and flooding potential. For some cases of risk scenarios, existing remediation and prevention measures are reviewed but also new ones are suggested.

Keywords: landslides, susceptibility mapping, risk analysis, GIS, Kyrgyzstan

Mapping morphological changes at Arenal volcano, Costa Rica: Remote Sensing and GIS techniques for integration and generation of topographic information

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Arenal is a small stratovolcano 1633 m high and approximately 33 km^2 of area situated in the North of Costa Rica. Its last period of volcanic activity, which began in July 1968 as a series of explosions followed by deadly pyroclastic flows, has continued to the present date. Activity currently includes small vulcanian explosions, sporadic pyroclastic density currents, lava flows and avalanches. The increasing tourist development in the area has raised serious concerns related to these volcano hazards.

These eruptive processes have generated considerable morphological changes in the volcanic edifice. Characterising and quantifying these changes for the last thirty years is one of the main goals of ongoing research. In this context, the proposed approach consists on 3-dimensional mapping of morphological changes at Arenal, using a range of cartographic and remotely-sensed data within a Geographical Information System.

A major challenge faced in implementing this approach consisted in acquiring data spanning the considered period and dealing with the numerous problems derived from their heterogeneous nature; especially regarding their origin, data format, geographic reference frames and accuracy. Consequently, processing of available data is being carried out in order to achieve their homogenisation and integration into a database. Several topographic paper maps and digital maps from years 1961, 1971, 1979, 1986 and 1988 have served as the bases of 30 meters resolution Digital Elevation Models; a photogrammetric DEM is currently being developed from aerial photographs of 1988 with 5 meters accuracy; and several radar-derived DEMs with accuracy ranging from 5 to 30 meters are also been used, including SRTM and AirSAR DEMs from years 2000 and 2004 respectively. Landsat TM and ETM images of Arenal are also part of developed database.

At this moment, further analysis regarding the accuracy and validity of available data is being made. Interpretation of morphological changes as recorded by acquired topographic data is being carried out, with an aim of linking observed variations to morphological processes of volcanic and non-volcanic nature that act at Arenal, and to eventually quantify their influence in overall geomorphological development of the volcano. This will provide valuable information regarding specific sources of topographic variation and rates and patterns of morphological change, as well as giving insights into the magma budget and behaviour of topography-controlled volcanic hazards.

Comparative analysis of GIS techniques used for carrying out landslide susceptibility assessment for St. Thomas, Jamaica.

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Landslides are a major natural hazard in Jamaica, and have resulted in loss of life, major economic losses, social disruption and damage to public and private properties. The parish of St. Thomas has the highest incident of slope instability on the island and is extremely prone to catastrophic landslides. The Judgement Cliff landslide in the parish is arguably the most infamous landslide on the island, and in 1692, killed 19 people and moved a settlement half a mile from its original location. St Thomas is particularly prone to slope instability due to its geology, steep and partially bare slopes, deeply weathered soils, improper land-use and high rainfall intensity. There is a need to delineate the areas that are prone to landslippage in order to mitigate their effects. One way of achieving this is to create landslide susceptibility maps in a Geographical Information System (GIS).

The first and most important stage for the creation of the susceptibility map is the collection of accurate landslide data in a timely manner. Due to the size of the study area and the rugged terrain, aerial photographs were used to map the landslides for huge tracts of the area. Temporal series of aerial photographs were using dating from 1950 to 1991. These proved quite effected in correlating landslide temporal distribution to years of high rainfall intensity, confirming that rainfall is the major trigger of landslide within the study area. Optical Satellite Imageries (IKONOS 1m spatial resolution) were tested for a small area, unfortunately this proved less effective than the use of aerial photo for mapping of the landslides. While the imageries are quite detailed, the spectral resolution and the lack of temporal imagery made it very ineffective for this purpose. The misclassification using this imagery was high (24%), particularly for the older and smaller landslides. However, the Imageries are proving to be quite effective for mapping new landslides quickly and efficiently after landslide disaster, as they are much cheaper and quicker to acquire. In the future it is envisage that SAR, RADAR and/or LIDAR will be used, which may prove much more effective that the use of optical sensors imageries particularly for the mapping of older landslides which are partially overgrown and or their surface have been reworked.

The second phase of the project was to create a susceptibility map in a GIS. There are a number of GIS methodologies that may be employed to create susceptibility maps but care must be taken to choose the best method that is suitable for the terrain and the contributing factors to slope instability unique to Jamaica. Five methods were examined, these were; Simple overlay, Index overlay, Fuzzy logics, Multiple logistic regression and Bayesian conditional probability. Of these five methodologies, the Bayesian, Fuzzy Logics and Multiple logistic regression method has the highest rate of success in classifying the existing and 'future' landslides into the high and very high susceptibility zones and may be useful in creating models for other areas of Jamaica

Landslide hazard mapping in North-East Wales

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Slope instability has come to be recognised as a significant hazard in its own right in the UK. The problem of landsliding in North Wales was brought to the fore in 2000 when severe rainfall led to over £2 million of damage through large- and small-scale slope failure. In one incident a car with its passenger was swept over a cliff at Nefyn (North coast of the Lleyn Peninsula) by a landslide, killing one of its occupants. There is clearly a need to map relict and active landslides in the region, to better understand and characterise their spatial distribution in order to produce zonations of existing and potential slope instability. A recent (2002) volume on landslide impact and remediation in North Wales, published by the National Museums & Galleries of Wales, emphasises the need for research into landslide hazard zonation in North Wales akin to that carried out in the South Wales Coalfield during the late 1980s and early1990s.

The current project (undertaken in association with Reynolds Geo-Sciences, Mold) seeks to characterise the nature of the landslide processes in North-East Wales using Geographical Information Systems (GIS), and to model the processes within GIS to produce the first landslide susceptibility maps for the area. Existing landslides are currently being mapped using 1:10000 scale aerial photographs dating between 1980 and 1998. This has proved effective in augmenting the existing (BGS) landslide database for the area; for example, an additional 79 landslides have been added to the database for the county of Flintshire alone.

Work to date suggests two main families of landslide activity in the area: shallow failures, most extensive where glacial till overlies Silurian bedrock; and deep-seated failures in rocks of (predominantly Middle) Carboniferous age. The precise nature of these and other relationships (e.g. with slope and structural geology) are currently under investigation, as are the characteristic mechanisms of shallow and deep-seated failure.

This paper reviews progress in the research in its first year, focusing on the methodology used to map the existing landslides and the assimilation of data from these landslides within GIS to derive preliminary slope susceptibility models.

Use of space technology for disaster management: data access and its place in the community.

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The ways in which remotely sensed data can be used to manage and so alleviate the consequences of natural hazards and disasters have never been fully exploited. If prediction of impending disaster is to be useful, those affected by catastrophes and those who come to their aid must work together. A global strategy based on a vision for disaster management that does not involve those affected in their own disaster preparation, mitigation, avoidance, rehabilitation, and relief efforts, is doomed to failure.

Local people are experts in ground truth: all that is needed therefore, is the means for those with expertise in remote sensing to pass on their skills, relevant knowledge and highly informative data in a way that can be understood and valued. To do this, those threatened by catastrophe must understand how disaster relates to their lives and homes, how to use information that can help them lessen the affects of catastrophe, and how satellite data is one of the best means of reducing the hazards that effect them.

This can be achieved by making available remotely sensed images (colour lithographic printing is cheap and an excellent source of educational aid) that enhance natural features - vegetation, water, rock differences and their effects, natural hazards, volcanoes, landslides, active faults and topography. Appropriate data would include perspective views, SRTM DEM data and stereo anaglyphs that mirror natural landscape, together with Landsat TM 742 images and ASTER 631 images that simulate natural-looking vegetation, all of which are free or low cost.

With timely, reliable information preventative measures can be taken. Surface structures, clearly enhanced on satellite images, can guide refugee placement organised and managed to ameliorate disasters rather than exacerbate them. Hazards can be anticipated and contained by planning and local people can take charge of their own lives.

The International Charter of Space and Major Disasters: the Nyiragongo Emergency, city of Goma, North Kivu

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The Nyiragongo volcano in D. R. Congo erupted on January 17, 2002, and sent lava streams into the city of Goma on the northern shore of Lake Kivu. More than 100 people were killed, more than 12,000 houses were destroyed, and hundreds of thousands were forced to escape to safe areas. As the population fled the city, there was no immediate danger for human lives in the hours following the eruption.

After a few days, most of the inhabitants of Goma started to come back to their homes, even while the volcano still threatened the city. It was then necessary to start a rapid mapping of the area on the basis of remote sensing imagery. The Belgian Civil Protection authorities asked for the activation of the *International Charter for Space and Major Disasters*. Urban land use information was extracted from a recent SPOT archive data and post eruption spacemaps of the area were produced within 3 days. They show the extent of the lava on the different urban developments of the city and the airport, the main roads and the possible locations for the setup of refugee’s camps. Due to the persisting cloud cover, it was not possible to acquire scenes in the optical range in this time period. A 10 m resolution Radarsat image was used to see through the clouds, and interpreted to delineate the main lava flows.

The results were presented to the humanitarian organizations acting in Goma: ECHO and OCHA, in order to optimize their use and gather the feedback of the end users in the field. They were validated by cross-checking with a map obtained by topographic GPS survey in the field ordered by OCHA and a thermal image from the ASTER sensor. The time delays for production were considered adequate in the local situation, dealing with first rehabilitation rather than extreme urgency rescue. The maps were seen as useful for planning purposes, though their spatial resolution was not optimal to be used in the field for this kind of event.

Reference: http://www.disasterscharter.org/charter_e.html

MapAction's use of GIS and remote sensing in humanitarian relief operations

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MapAction is a UK-based charity, staffed by volunteers, that supports humanitarian operations through *in situ* information collection and mapping.
The group has been operational for just over a year and has completed several projects in very varying humanitarian contexts. Here we show the range of GIS methodologies and technologies that have been used.

In emergencies, accurate route maps are typically the first priority, to plan assessment missions and coordinate immediate interventions. These are extended to show where help is needed, where resources are located (water supplies, medical facilities, food distribution points, fuel depots), and security and safety features (border crossings, contamination, military installations, evacuation routes). This information is based on GPS field survey, while existing sources such as Landsat ETM imagery are used to provide contextual mapping. A high-bandwidth satellite phone is used to download high resolution imagery (Ikonos, QuickBird), made available by the UK team; these products are specially useful in urban emergencies such as earthquakes.

MapAction also uses GIS in slow-onset crises, disaster preparedness and long-term development projects. A project in Lesotho in 2003 mapped potential food distribution points in areas of high food insecurity for the UN World Food Program, while an on-going collaboration with the Delhi-based Centre for Urban and Regional Excellence is providing a GIS-based framework for surveying water and sanitation provision in poor settlements. MapAction is working with another Indian NGO, SEEDS, to using neighbourhood mapping as part of villages' own response and recovery following disasters.

The widespread use of GPS units and the usefulness of sharing information between agencies are leading to greater calls for training. MapAction has recently provided training in GPS and data collection techniques in Ethiopia, India, Norway and the UK. Such an initiative is becoming realistic and affordable on account of the portability of field equipment (computers, GPS units, communications), accessibility to free and low-cost basemap data (raster and vector), and increasingly favourable conditions for information sharing among relief agencies, helped by the existence of UN coordinating offices. Notable constraints still exist: technical (cost of software for image-processing and GI-aware data collection, availability of high-resolution satellite imagery); procedural (rapid data integration, inter-agency information management); and institutional (standardised information requirements are just emerging, relatively low awareness of GI-based approaches). These are some of the challenges for MapAction in making effective use of GIS and remote sensing to benefit the humanitarian community.

Newly acquired and existing data available from the NERC Earth Observation Data Centre (NEODC)

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The NEODC (NERC Earth Observation Data Centre) is one of the 8 NERC designated data centres, and is located at the CCLRC Rutherford Appleton Laboratory in Oxfordshire. The NEODC obtains and archives a variety of remote sensing data and supplies this data to the user community via an increasingly sophisticated web portal. We currently hold the archive of all data released by the NERC Airborne Remote Sensing Facility (ARSF) from 1982 to present. We also hold data from recent experimental instrument deployments such as campaigns using LiDAR, CASI-2 and CASI-SWIR instruments.

Of particular interest to users of current ARSF data is the recently-acquired NextMap digital elevation dataset for England, Wales and most of Scotland, at a horizontal resolution of between 2.5 and 10 m. The NEODC also holds extensive, global coverage from many satellite missions such as the Landsat series, SPOT, Radarsat as well as ERS-1 and 2 SAR data, as well as many high resolution aerial photographs. Much of this data can be located via the online searchable catalogue at http://www.neodc.rl.ac.uk, which also provides “quick-looks” and associated metadata.

The NEODC obtains, creates and maintains the NERC archive of Earth observation data, and endeavours to provide assistance to it’s customers in their application of the data it supplies. The NEODC is actively involved in projects to improve the delivery of remote sensing data via the web and is keen to remain at the forefront of developing and providing such capabilities to the UK science community.

Quantifying Landslide Evolution Using Historical Aerial Photographs and Modern Photogrammetric Methods

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A sequence of historical aerial photographs captures morphological change, which can only be unlocked by using appropriate photogrammetric methods. There are several challenges: initially it is necessary to trace and acquire suitable imagery in an appropriate format; typically there is a lack of precise photo-control available at the time of photography and similarly, it is rare to have access to the original camera calibration certificate. Furthermore, it is essential to assess the quality of the extracted morphological data. Once these challenges have been overcome, quantitative data can be extracted, used to assess landslide mechanisms and develop evolutionary models.

Initial results from a case study at Mam Tor (Derbyshire, UK) show the potential of the methods to quantify past landslide movements. Photographs from four different epochs (1953, 1971, 1973 and 1990), of varying scale and quality, were processed. Difficulties caused by limited ground control and limited camera calibration data were solved by differential GPS and self-calibrating bundle adjustment methods. The quality of the data is at an adequate level to extract ground movements that are consistent with observations by other authors. Currently, the sequence is being extended by processing three more epochs (1984, 1995, 1999), hence improving the temporal resolution.

Further research will focus on automatic extraction of three-dimensional displacement vectors. Analysis of the movement patterns, both spatially and temporally, is expected to aid a better understanding of the mechanisms involved. Knowledge of the landslide mechanisms might eventually lead to the capability of predicting future movements, considering climatic (changing) parameters.

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