FINAL TECHNICAL REPORT

Seventh International Workshop for Remote Sensing and Disaster Response

University of Texas at Austin
AT&T Conference Center
22-23 October 2009

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Prepared for the U.S. Geological Survey
By ImageCat, Inc.

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Grant Recipient: ImageCat, Inc.
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Group Photo of Workshop Participants

February 1, 2010

Acknowledgments

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Workshop Summary:

The following observations were recorded over the two-day period:

1) The 7th International Workshop on Remote Sensing and Disaster Response, held at the University of Texas at Austin, AT&T Conference Center, on October 22-23, 2009 was one of the most diverse workshops to date in this series. Over 30 participants from eight different countries delivered 24 presentations on a broad set of topics dealing with *rapid response; disaster preparedness and integration with modeling; hurricanes, windstorms, and tsunamis; earthquake effects; advances in analytical techniques,* and *disaster recovery*. In addition, two panel sessions were organized that dealt with *Data Issues: Rapid Access to Remote Sensing Datasets*; and *Perspectives of End Users: Emergency Managers and Decision Makers*. A special banquet dinner talk by Dr. Albert Lin from the University of California, San Diego introduced a National Geographic Society study to "Search for the Tomb of Genghis Kahn: Using Modern Tools to Hunt for an Ancient Past."

   A copy of the final workshop schedule is provided in Appendix A. In addition, a listing of workshop participants is given in Appendix B.

2) A brief review of last year's workshop in Pavia, Italy revealed that demonstrable progress has been made on almost all resolutions:

   - <u>Next workshop to be held in Austin, TX with a focus on Remote Sensing for Disaster Management Applications - Remote Sensing for the Disaster Cycle: Preparedness, Response and Recovery</u>. Over 30 experts from 8 different countries (Italy, Netherlands, Japan, UK, Germany, Peru, India and U.S.) discussed a variety of topics that encompass remote sensing and disaster management.
   - <u>A recommendation to extend invitations out to our research colleagues in South and Central America and Africa</u>. Our first participant from South America attended this year's workshop: Professor Miguel Estrada, National University of Engineering, Peru.

- The workshop topics need to include recent disasters in order to keep the application of remote sensing technologies current. Presentations on recent events were highlighted in several talks: 2009 American Samoa earthquake and tsunami; the 2009 L'Aquila, Italy earthquake; the 2008 Wenchuan, China earthquake; the 2008 hurricanes in the US Gulf; and the 2007 Pisco, Peru earthquake.
- Include members of the disaster management community in the next workshop – several members of the emergency response community in the Austin, TX area participated in a lively panel discussion on the second day of the workshop.

3) Several sessions, including the panel session on *Data Issues* emphasized the importance of international data initiatives - especially the one dealing with the International Charter - in promoting rapid and regular use of remotely-sensed data for large, global disasters.
4) Remotely-sensed data are now being used to characterize and quantify the built environment; great interest was expressed in methods that can be applied to large areas in a semi-automated way.
5) There were many examples of where remote sensing damage methodologies developed from one hazard were successfully applied to other hazards, e.g., storm surge to tsunami.
6) There were several studies that examined the use of remote sensing technologies for monitoring the recovery activities (and rates) after major disasters. A gap that currently exists is the lack of standardized metrics to measure the progress of recovery.
7) There was a question that suggested researchers are not working close enough with end-users to develop products that precisely meet the needs of these users. During this discussion, the notion of standard products (e.g., damage maps based on using remotely-sensed data of a certain resolution produced in a specific format, without field validation) or standard delivery timelines (e.g., immediate – within 2 days; early – within a week, etc.) Having such definitions and criteria would help drive the development of products and would also help in the communication of product details to end users.
8) A brief summary of each session is provided in Appendix C.

Workshop Resolutions:

The following resolutions have been discussed and agreed upon by all workshop participants:

1) The 8th International Workshop on Remote Sensing and Disaster Response will be held at the Tokyo Institute of Technology in Tokyo, Japan between 30 September 2010 and 1 October 2010.
2) The notion of community remote sensing (social networking) to improve situational awareness in moderate to large disasters is noteworthy and should be explored. Especially in situations where the public is involved and where the public feels there is a worthwhile return for their efforts. The 'community' can include remote sensing experts and local users.

3) The need for a standardized damage scale for buildings, lifelines and the environment based on post-event, remotely-sensed data is still considered a high-priority by the workshop participants. It was noted that by having such a scale, the consolidation and analysis of large remote sensing datasets can be more effectively accomplished. Damage scales should consider the output from different types of sensors, e.g., radar, optical, etc.

4) With a timeframe of 2 to 3 years as a target, publish a comprehensive textbook or handbook on the *Applied Use of Remote Sensing Technologies for Disaster Management.* The text or handbook would include the following topic areas:

   - Current state-of-the-art in damage detection methodologies
   - Current state-of-the-art in building inventory or exposure analysis
   - Current state-of-the-art in hazard identification and evaluation (all hazards)
   - Case studies in each of the above areas
   - Disaster management needs that can be addressed using remote sensing technologies or approaches
   - Implementation challenges in integrating remote sensing technologies into traditional disaster management studies
   - A database of events where remote sensing technologies have been used for disaster management
   - An immediate focus on characterizing the attributes of buildings; consider expanding to other infrastructure later.
   - Where possible, emphasize the impacts of disasters on communities, with particular attention to people impacts

5) A priority for the next workshop continues to be to reach out to regions that have not been actively engaged with this workshop, e.g., Latin America, Africa, and other Asian countries.

6) Within a two-day workshop platform, encourage more sessions/opportunities to interact with each to explore and perhaps collectively comment on possible research directions and practical solutions.

7) Since we still lack data (field data) to validate many of our damage detection methodologies, consider establishing a data format for post-event, damage data collection.

8) Consider establishing a set of protocols that will help the research community gauge progress in different areas (e.g., accuracy in damage detection, identifying attribution information for building inventory studies, measuring the rate of community recovery after large disasters, etc.

9) As a record of the Austin Workshop, copies of all papers and presentations will be put up on the MCEER website so that the general research community can have access to the products generated from this year's workshop.

APPENDIX A: Workshop Schedule

7th International Workshop on Remote Sensing and Disaster Response

22-23 October 2009
University of Texas at Austin
AT&T Conference Center (www.meetattexas.com)

Thursday 22 October (Classroom 102)			
8:00-8:45 am	**REGISTRATION AND CONTINENTAL BREAKFAST (outside Classroom 102)**		
8:45-9:00 am	**Introduction**	*Introductory Remarks*	Ellen Rathje
9:00-10:30 am	**Session A: Rapid Response**	*Remote Sensing in Response to Hurricane Ike*	Gordon Wells
		The International Charter in Action: A Project Manager's Perspective	Teresa Howard
		NASA Space Missions and Application to Disaster Response	Andrea Donnellan
		Virtual Disaster Viewer (VDV): The Story so far....	John Bevington, Paul Amyx, Beverley Adams, and Tiziana Rossetto
10:30-11:00 am	**BREAK**		
11:00-12:30 pm	**Session B: Disaster Preparedness and Integration with Modeling**	*Object-oriented and cognitive methods for urban structural and functional assessment as basis for disaster risk management*	Norman Kerle and Christoph Aubrecht
		Mitigation Project Information System	Cindy Menches, R Seekins, Craig Eissler, and Greg Pekar
		Hazards susceptibility mapping using Geoenvironmental approach and GIS in part of Garhwal Lesser Himalaya, India	Neetu Malik
		Tsunami hazard and structural damage inferred from the numerical model, aerial photos and SAR imageries	Shunichi KOSHIMURA, Masashi MATSUOKA and Shintaro KAYABA
12:30-1:45pm	**Lunch (Tejas Dining Room)**		
1:45-3:30 pm	**Session C: Hurricanes, Windstorms, and Tsunamis**	*Visual Rule-Based Classification of Combined Wind and Surge Hurricane Damage for Residential Buildings*	Carol J. Friedland, Beverley J. Adams, Marc L. Levitan
		Development of a Statistical Relationship between Ground-Based and Remotely-Sensed Damage in Windstorms	Tanya M. Brown, Daan Liang, J. Arn Womble
		A Comparison of Change Detection Algorithms for Windstorm Damage Estimation	Jim Thomas, Ahsan Kareem, Kevin Bowyer
		Image-Based Wind Damage Functions	J. Arn Womble, Douglas Smith, Daan Liang, John Schroeder, Tanya Brown, and Kishor Mehta
		Satellite image classification for detecting tsunami impact	Shintaro Kayaba and Shunichi Koshimura
3:30-4:00 pm	**BREAK**		
4:00-5:00 pm	**Panel Discussion 1**	**Data Issues: Rapid Access to Remote Sensing Datasets**	
		Moderator: Ron Eguchi	
6:30-9:00 pm	**BANQUET (The Mansion at Judge's Hill, 1900 Rio Grande, Austin, Texas 78705)**		
		Dinner Speaker: Dr. Albert Lin "The Search for Genghis Khan: Using Modern Tools to Hunt for an Ancient Past"	
Friday 23 October (Classroom 102)			
8:00-9:00 am	**CONTINENTAL BREAKFAST (outside Classroom 102)**		
9:00-10:45 am	**Session D: Earthquake Effects**	*The 2007 Pisco, Peru Earthquake*	Miguel Estrada
		Visual Damage Detection in Beichuan County Using Optical Images of the 2008 Wenchuan, China, Earthquake	Hiroyuki Miura and Saburo Midorikawa
		Estimation of Building Damage Ratio due to Earthquakes Using Satellite L-band SAR Imagery	Masashi MATSUOKA and Nobuoto Nojima
		Preliminary Analysis of High-resolution SAR Image for Detection of Landslide Area	Saburoh Midorikawa and Hiroyuki Miura
		Detection of Slope Failures due to the 2008 Iwate-Miyagi Earthquake using ALOS/AVNIR-2 Images	Fumio Yamazaki, Takahiro Ishide, Yoshihisa Maruyama
10:45-11:15 am	**BREAK**		
11:15-12:15 pm	**Session E: Advances in Analytical Techniques**	*Detection and Correction of Shadows in Remote Sensing Imagery*	Wen Liu and Fumio Yamazaki
		INTEGRATION OF CHANGES IN THE SURROUNDINGS OF REFERENCE BUILDINGS INTO A BUILDING DAMAGE ANALYSIS BASED ON AIRBORNE LIDAR DATA	Miriam Hommel
		FIRST EVALUATION OF BREC AS A TOOL FOR AUTOMATIC BUILDING EXTRACTION AND ANALYSIS FROM SATELLITE VHR IMAGES	Gianni Lisini, Fabio Dell'Acqua, Paolo Gamba, Beverley Adams, Ron Eguchi
12:15-1:30 pm	**Lunch (Tejas Dining Room)**		
1:30-2:30 pm	**Session F: Disaster Recovery**	*Measuring, monitoring and evaluating recovery: towards standardised indicators for post-disaster recovery*	Keiko Saito
		Community Remote Sensing: Part I	Arleen Hill
		Community Remote Sensing: Part II	Beverley Adams
2:30-3:30 pm	**Panel Discussion 2**	**Perspectives of End Users: Emergency Managers and Decision Makers**	
		Moderators: Arleen Hill and Gordon Wells	
3:30-4:00 pm	**BREAK**		
4:00 - 5:00 pm	**General Discussion and Closing**	Moderators: Ron Eguchi and Ellen Rathje	

APPENDIX B: Workshop Participants

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APPENDIX C

Summary/Notes of Individual Sessions

Session A: Rapid Response

Gordon Wells - Center for Space Research, UT at Austin: ***Remote Sensing in Response to Hurricane Ike***

- Discussed Hurricane Ike response
- They work with government agencies to define threat.
- Provided 7 days warning
- Provided day-by-day support on modeling events
- They have their own receiving stations from 17 different sensors
- Chinese data – FY-1 MVISR, Sept, 12, 2008 at 6:18 PM CDT
- Storm surge captured by spaceborne radar – Canadian RADARSAT 2 - 9/12/08 at 7:39:14 PM CDT – surge in progress – processed by the UT Center for Space Research
- Wished that they could have had continuous coverage, maybe using UAVs
- 634 total rescues/assisted evacuations by TTF1
- Military support (helicopters) in rescues
- ADCIRC Hindcast simulation – for Ike – for measuring water surface elevation
- Ike did not test the infrastructure that was built after the great Galveston hurricane.
- Hit between Houston and Lake Charles – 20 foot elevations max
- Sea wall at 16 ft that was topped in Ike
- UT collected lidar data before Ike
- Highest recorded surge height – 15 ½ ft
- In Galveston event, they built sea wall and raised land immediately behind wall; however, this left some other areas some distance away vulnerability to inundation.
- Great work by Air Civil Defense – preplanned flight lines – Sept 15, 2008
- Flight surveys over a week period. So, they get up early before the more detailed surveys are conducted. They provide guidelines on targets. They also use military aircraft to capture images.
- Damage assessment a week after event – now $30B; week after $28
- http://magic.csr.utexas.edu/Storm./08Ike.php

Teresa Howard: the University of Texas at Austin Center for Space Research – ***The International Charter in Action: A Project Manager***

- Discussed the International Charter

- Focus: disaster response; constellation of space agencies; emphasis on developing change detection products;
- Members (10) – ESA, CSA, DMC, NOAA, USGS, CONAE,ISRO, CNSA, JAXA, CNES
- Sensors are all listed in paper
- Events: flood and ocean waves
- Hurricanes in Texas and Louisiana 2008 plus others
- Teresa was trained by Brenda Jones – worked on Hurricane Dolly, Cat 2 July 23, 2008 – long-term funding, loss of power – pre- and post-event SAR radar data –ALOS – 7 frames. ENVISAT – 13 frames – RADARSAT – 2 frames. Their emphasis was on radar data.
- Archive data you can get right away – less than 24 hours
- Tasking before the event requires more time.
- Hurricane Gustav – there were problems in tasking
- Cat 2, Sept 1, 2008
- Wind damage and power loss
- Received many, many datasets
- Hurricane Ike complicated the response of Gustav
- Aug 9th, ESA caught the storm coming in.
- They have a SAR expert.
- Post-event (several days after) they requested optical data – Nigeriasat data, 9/24/08; UK-DMC scene. It took a long to get Nigerian and India data
- US data in public domain; non-US data are licensed and cannot be shared with non-emergency personnel. Not to shared for research or for mitigation
- Satellite asset tasking – charter requirement: disaster must be unfolding or recent occurrence
- Sometime funding is not available to provide the value-added products.
- She is working with an RS/GIS organizations to form a consortium
- Permit activation 24 hrs prior to tropical storm landfall for improved SAR tasksing
- www.disasterscharter.org
- 512 232-7514
- Brenda Jones – goal to train someone in each state of the US

Andrea Donnellan – *NASA Space Mission and Application to Disaster Response* – with Michael Goodman

- SDR link
- NASA working on natural disasters
- Effective use of airborne units
- Working on a post-fire airborne capabilities to focus on mudslides after fires
- Participated in simulated earthquake exercises – SHAKEOUT

- Decadal Survey Missions Application Workshop (Winter 2010) – NOAA, NASA, NESDIS
- If interested, let her know.
- Data latency
- SERVIR focusing on central, south American and Africa
- SPoRT – Short term Prediction Research and Transition
- Global Flooding and Landslide work – look up with Andrea's help
- Also looking at dispersion analysis for terrorism
- Cathleen Jones – JPL working levee analysis with DHS
- WIP on tsunami modeling
- Maggi Glasscoe at JPL earthquake disaster evaluation and response E-DECIDER
- Wildfire – Ikana – did not deploy this year because of maintenance issues
- NRC Workshop on Remote Sensing and Disaster Response – Michael Goodman will discuss next week
- Craig Dobson, Michael Goodman, and Andrea Donnellan would like to get more engaged with the International Charter

Beverley Adams – ImageCat Ltd.: *Virtual Disaster Viewer (VDV): The Story so far …" – with John Bevington, Paul Amyx and Tiziana Rossetto.*

A prototype community remote sensing tool was first announced at the Sixth International Workshop on Remote Sensing for Disaster Management, Pavia, Italy, in 2008. One year on, the Virtual Disaster Viewer (www.virtualdisasterviewer.com) is gathering momentum as a unique integrated visualization and participatory tool for past and future disasters. Its first foray into the disaster realm saw VDV used by a panel of international experts to provide remote damage assessment following the Wenchuan, China earthquake. VDV has since been used for pre-deployment planning and in-field support, allowing instant sharing of field information to a global audience. Used also as a repository for historical data, VDV is evolving to meet user needs in many areas of disaster management. This talk outlined the evolution of the system to date, and gave an insight into the future challenges and the many potential users of this exciting online system.

Session B – Disaster Preparedness and Integration with Modeling

Norman Kerle – International Institute for Geoinformation Science and Earth Observation: *Object-oriented (OA) and cognitive methods for urban structural and functional assessment as basis for disaster risk management* – with Christoph Aubrecht

Dr. Kerle's work emphasizes the use of object-oriented (OA) and cognitive methods instead of spectral- and pixel-based methods in extracting both *form* (buildings) and *function* (building use) for use in risk assessment and damage detection. OA methods for data-rich urban areas (e.g., Austria) center on the fusion of optical and lidar images as well as thematic and census data. OA

methods for data-poor urban areas (e.g., India) employ spatial metrics (homogeneous urban patches) and boundary network extractions to characterize the function of areas.

Cindy Menches – The University of Texas at Austin: *Mitigation Project Information System (MPIS)* – with R. Seekins, Craig Eissler and Greg Pekar

The Texas Hazard Mitigation Package (THMP) is a GIS/web-based resource designed to help communities analyze hazard risks and vulnerabilities and to identify areas which should be given priority to mitigation. Dr. Menches' present work maps mitigation projects that have already been implemented and that can serve as examples to other communities. The joint Technical Assistance Program of the Texas Geographic Society and the University of Texas – Austin has created a service-learning class to assist small communities by providing technical assistance and identifying potential projects (e.g., scope of work and cost estimates).

Chris Renschler – The University at Buffalo: *Information Products Laboratory for Emergency Response (IPLER)* – Heather Collins, Donald M McKeown, Jan van Aardt, Anthony Vodacek and Donald L. Boyd

Dr. Renschler's presentation discusses the NSF-sponsored partnership of the University at Buffalo and Rochester Institute of Technology, known as the Information Products Laboratory for Emergency Response (IPLER). The mission of IPLER is to create a technology, policy, and business development incubator to facilitate interaction and innovation among university researchers, private sector service and product providers, and public sector emergency response decision makers. The presentation focuses on recent integration of multispectral and lidar imaging with terrain and hydrologic modeling along the Cattaragus Creek watershed near Buffalo, New York.

Shunichi Koshimura – Tohoku University: *Tsunami hazard and structural damage inferred from the numerical model, aerial photos and SAR imageries* – with Masashi Matsuoka and Shintaro Kayaba.

Koshimura's presentation focuses on the monitoring of tsunami hazards by integrating seismic measurements, numerical modeling, near-real-time satellite imagery, and post-impact ground assessments (within 1 week). The integrated tool determines potential impacted areas by evaluating population sizes and probability for tsunami impact. A case study for American Samoa gives insight into quickly searching impacted areas based on tsunami model and exposed population, by suggesting areas for emergency satellite observations and developing fragility curves.

Session C: Hurricanes, Windstorms and Tsunamis

This session focuses on the capability to assess damage from hurricanes, windstorms and tsunamis using different types of remotely-sensed images. There were five presentations: one paper focusing on hurricane damage, three papers on wind storm damage, and one paper on tsunami damage. Various image analysis techniques including manual and automated approaches

are applied to identify the damage. And their findings are beneficial to damage inspection efforts in the affected area.

Carol Friedland – Louisiana State University: *Visual rule-based classification of combined wind and surge hurricane damage fore residential buildings* – with Beverley Adams and Marc L. Levitan

The authors integrate several types of remotely-sensed images to increase the accuracy of rapid damage assessment of structural damage caused by hurricanes. They accomplish this through the comparison of visual damage classifications from satellite images, ground observations and oblique aerial photographs. This research potentially contributes to increase credibility of damage interpretations using remotely-sensed data.

Tanya Brown – Texas Tech University: *Development of a statistical relationship between ground-based and remotely sensed damage in windstorms* – with Daan Liang and Arn Womble

Throughout the comparison between the ground-based observations and visual interpretation of satellite images with different sensors, the authors identify the relationship between DOD (Degrees of Damage) scale from the ground-based observations and RS (Remote-Sensing) damage scale to validate damage inspection results and to increase the accuracy of the methods. As a result, the authors propose a linear regression model to relate ground-based and remotely-sensed damage states.

Jim Thomas – University of Notre Dame: *A comparison of change detection algorithms for windstorm damage estimation* – with Ahsan Kareem and Kevin Bowyer

Towards a more accurate and automated assessment of windstorm damage, a systematic technique to evaluate the performance of modern change detection algorithms identifying the damage from pre- and post-storm image pairs. Some comparisons are made between several change detection algorithms and the authors suggest that determining the efficacy of existing change detection algorithms using algebraic and statistical treatment is required for more accurate automated assessment of windstorm damage.

Arn Womble – Texas Tech University and WindForce Associates: *Image-based wind damage functions* – with Douglas Smith, Daan Liang, John Schroeder, Tanya Brown and Kishor Mehta

This paper focuses on construction of wind damage functions to identify the relations between building damage interpreted by remotely- sensed images and known windspeed fields. The specific benefits of WDFs that are derived from remote sensing images plays an important role in unbiased determination of damages across an affected region.

Shintaro Kayaba – Tohoku University: *Satellite image classification for detecting tsunami impact* – with Shunichi Koshimura

An object-based analysis of post-tsunami satellite image was performed to identify the impact of tsunamis. The authors presented their preliminary results to classify the land cover in the affected area by the 2004 Indian Ocean tsunami including vegetation, inundated water, tsunami debris, soil and buildings.

Session D: Earthquake effects

Miguel Estrada – National University of Engineering, Peru: *The 2007 Pisco, Peru Earthquake*

Dr. Miguel Estrada discussed geospatial analysis conducted after the August 15, 2007 in Pisco, Peru. He demonstrated many examples of how his team used pre-and post-event optical remote sensing data for damage assessment, including dynamic side-by-side fly-by videos. Dr. Estrada also showed tsunami simulations and comparisons of risk maps with post-event damage maps.

Hiroyuki Miura – Tokyo Institute of Technology: *Visual Damage Detection in Beichuan County Using Optical Images of the 2008 Wenchuan, China, Earthquake* – with Saburoh Midorikawa

Dr. Hiroyuki Miura showed how his team conducted post-event visual damage detection after the 2008 Wenchuan, China earthquake. Since 1-m resolution optical sensor data were not available, they matched pre-event 3-m multispectral ALOS AVNIR-1 & PRISM data with 2 m FORMOSAT data collected two days post-event. The image resolution made visual inspection and interpretation challenging. Moderate damage was particularly difficult to identify. The damage inspection process took 2 minutes per building for a total of 150 hours. Their results indicated that the distribution of higher building damage was located on hanging wall sites.

Masashi Matsuoka – National Institute of Advanced Industrial Science and Technology (AIST): *Estimation of Building Damage Ratio due to Earthquakes Using Satellite L□band SAR Imagery* – with Nobuoto Nojima

Dr. Masashi Matsuoka compared building damage estimates using a methodology developed by Nojima and others for C-band SAR data with pre- and post-earthquake data collected by L-band SAR sensors. He demonstrated results for JERS-1 data of the Kobe, Japan earthquake and more recent ALOS PALSAR data of the Pisco, Peru and Sichuan, China earthquakes. Seven damage rankings based on signal measurements were calculated.

Saburoh Midorikawa – Tokyo Institute of Technology: *Preliminary Analysis of High-resolution SAR Image for Detection of Landslide Area* – with Hiroyuki Miura

Professor Midorikawa demonstrated a method for identifying landslides based on 1 m TerraSar-X data collected 2 days after the Aratozawa landslide in Japan, which was caused by the Iwate-Miyagi earthquake of June 14, 2008. Since no pre-event data were available, the analysis used texture measures as a surrogate for change detection. The study tested a series of window sizes and statistical measures including mean, variance and skewness. A Receiver Operating

Characteristic graph was used to determine the most effective measure – variance measured within 151x151 windows.

Fumio Yamazaki – Chiba University: *Detection of Slope Failures due to the 2008 Iwate-Miyagi Earthquake using ALOS/AVNIR-2 Images* – with Takahiro Ishide and Yoshihisa Maruyama

Professor Yamazaki analyzed landslides and slope failures caused by the Iwate-Miyagi earthquake. His team worked with pre- and post-event multispectral data collected by the ALOS AVNIR2 sensor. The analysis compared the results of two methods, one based on the Normalized Difference Vegetation Index and the other on supervised training set selection classification of land cover. Although neither method identified all of the landslides found using visual inspection, both performed relatively well, particularly in the case of larger landslides and slope failures.

Session E: Disaster Recovery

Wen Liu – Chiba University: *Detection and Correction of Shadows in Remote Sensing Imagery* – with Fumio Yamazaki

Shadows in remote sensing images often result in problems for many applications such as land-cover classification, change detection, and damage detection in disasters. Due to these reasons, it is very useful if the radiance of shadow areas is corrected to the same radiance as shadow-free areas. In this work, the measurement of radiance in sunlit and shadowed areas was carried out to investigate the spectral characteristics of the sunlight. Based on this observation, it is found that the radiance ratio (shadow/sunlit) increases as the sunlight gets weaker and that the ratio is dependent on the wavelength of the sunlight. The darkness of shadow is also found to vary depending on the surrounding condition. A Quickbird image and a digital aerial image were introduced and the spectral characteristics of the sunlit and shadowed areas were investigated. Based on these observations, a method to detect shadowed areas and restore the shadow-free radiance for the multi-spectral bands was proposed.

ZhiQiang Chen – University of California, San Diego: *Probabilistic Urban Structural Classification using Bi-temporal Satellite Images* – with Tara Hutchinson

Recent research endeavors in civil engineering have attempted to apply remote sensing technology to urban damage assessment as an aid for post-disaster reconnaissance and recovery. In these attempts, urban structural damage is usually identified based on pre- and post-disaster satellite images with the use of a pattern classification approach. The result is usually presented in a damage map wherein categorical damage levels, such as ‘fully collapsed,’ ‘partially collapsed,’ or ‘intact,’ are assigned to urban sub-regions or individual structures in images. However, a major limitation in past attempts is the use of deterministic approaches to classify damage levels. In general, these approaches are not able to capture the inherent uncertainties of structural damage and lack scalability when analyzing damage to built urban sub-regions of different sizes. In this talk, Chen presented a probabilistic classification framework for imaged-

based urban damage classification. By applying this probabilistic approach, classification of urban damage provides posterior probabilities, which can be used to quantify decision uncertainties and to obtain regional urban damage classification. Numerical experiments are conducted using satellite images acquired from a recent earthquake and a tsunami event, namely the 2003 Bam, Iran earthquake and the 2004 Indian Ocean tsunami.

Mariam Hommel – Karlsruhe University: ***Integration of changes in the surroundings of reference buildings into a building damage analysis based on airborne Lidar data***

The paper presents the extension of an existing building damage detection and classification method analyzing only changes inside reference building contours to the surroundings of these buildings. The method is based on airborne laser scanning data and distinguishes 11 different damage types. In order to include changes outside the reference building contours, buffers are generated around these building contours like the additionally covered area and the increased of volume area determined and integrated into the classification process. Besides, further features indicating the building as a whole are introduced. The results achieved with the extended classification method are presented and compared to the results obtained with the classification method only analyzing changes inside reference building contours.

Fabio Dell'Acqua – University of Pavia: ***First evaluation of BREC as a tool for automatic building extraction and analysis from satellite VHR images*** **– with Gianni Lisini, Paolo Gamba, Beverley Adams and Ron Eguchi**

The availability of very high resolution optical and SAR data creates big opportunities and challenges for the semi-automatic interpretation of these data in urban areas. Building detection is addressed in this work using the Building RECognition (BREC) software. Promising results are obtained using datasets with different spatial resolutions.

Session F: Disaster Recovery

Keiko Saito – Cambridge University: ***Measuring, Monitoring and Evaluating Recovery: Towards Standardization indicators for post-disaster recovery***

RECOVERY project needed because of a lack of standardized recovery monitoring methods. Goal is to produce a guideline to assist in monitoring and evaluating recovery after natural disasters. Identify recovery indicators with end user input, collected and analyzed data. Some details are provided below:

- 24 recovery indicators were identified, though prioritization was difficult because end user needs were extremely varied based on their area of interest. Used 5 tools to monitor recovery indicators: satellite images, official statistics, VIEWS, Key informant survey, household survey. Selected two case study sites in Thailand and Pakistan. Used Quickbird, IKONOS and WorldView-1 remote sensing imagery.

- Accessibility criteria – Remote sensing provides a wealth of data for monitoring transportation networks.
- Buildings criteria – Used to identify status of the built environment and describe the trend of recovery over time.
- Environment criteria – NDVI primarily used to monitor land cover and environmental change as a result of the events. Compared number of buildings against urban land covers over time. May be able to use urban land cover as a proxy for
- Resistance, Safety, Vulnerability criteria – Vulnerability maps were used to delineate danger zones and to monitor rebuilding within these areas.
- Local Services, Facilities criteria – Change in key facilities was completed using both remote sensing and local knowledge.
- Food Aid, Diet and Livelihood criteria – Surveys were complementary to remote sensing data, able to produce maps that display survey information.
- Effective tool for generation of data, compare phenomena from multiple time periods, most effective timing for imagery acquisition.

Arleen Hill (University of Memphis) and Beverley Adams (ImageCat Ltd) – *Community Remote Sensing: Parts I and II*

Community remote sensing from a social vulnerability perspective was discussed. Key questions: How do we explain the patterns that we see from remote sensing? How can we integrate RS observations with experiential data and information?

Surveys are effective but often not as effective for long-term recovery periods. Relationships and sense of community serve as foundations for experiences and decisions after an extreme event. Community remote sensing consists of a combination of remote sensing data, tools and techniques with citizen science where citizens participate directly in the observations. Community or Communities – community of remote sensing experts, community of residents (Local Knowledge Base)

Voting on commitment to community remote sensing:

23 attendees voted on their commitment to community remote sensing. How do we get people to participate? What kind of engagement do we need for the community? Earthquake in China was a great test bed because they couldn't get into China. EERI got some great experience of being virtual experts from. Arleen Hill (Arleen) – formalizing what already happens, exploring if tapping into process is possible. Bev – do we need to set up a blog to discuss data and get input? Teresa Howard (Teresa) – questions about whether it's better to get remote sensing community to collaborate or if it is a question of engaging others. Response may be predicated on the political environment of a particular event or situation. Some may choose to respond and some not. Arleen – this presents a new set of research questions. Ron Eguchi (Ron) – interested to look at public vs. researchers separately. Ron was at a conference with Arn where they discussed wind data collection and how to share data to affect better decision making – which is one solution that people are gravitation towards – how to have data accessed by researchers. This is the idea behind the VDV – it's easy to upload photos and view data, can we open this up

more to use the public as a sensor? There is good precedent in involving the public – USGS Did you feel it? - not scientific for ground motions, but does give information about areas that were affected. Opportunities may be here also – privacy, reliability, etc.

Gordon Wells (Gordon) – Informal sensor network already exists and is a chaos. Would need to engage Google for data mining and content analysis on publicly displayed and shared information – blogs, video, photos, etc. It already exists but we do not have web crawlers that can geo-locate and validate. Excellent examples recently from Iran, China. Need to extract, filter and make operational. Bev – could we do something like "What did you see?" Ellen Rathje (Ellen) – Publicize via Facebook – make it a quiz? Ron – damage to your house – take a picture and pop it in. Arleen – based on survey experience, people genuinely want to contribute to the body of knowledge. There is an intentional commitment to sharing. Chris – include that as long as the communication is both ways so there is a positive impact for both sides – gather, disseminate, add value. Needs to be a priority. Bev – two different hats – balance of feelings.

Teresa – has to be a willingness to provide something in return, even as simple as a map with images and annotation. Giving something value added like an image map is often much appreciated. Arleen – when you see an image of an entire community, residents become more aware of what is happening in other locations – community situational awareness. Chris Renschler (Chris) – if there was some information available out there; you can get a feel for the needs for communication on deployments. Andrea Donnellan (Andrea) said yesterday that she was in the situation of wearing the two hats. You can be a researcher or someone that is impacted or potentially impacted. We sign people up in advance and tell them the type of information that you would need.

Bev – if you were going to pilot something like this, how would you do it? Let people know in advance? What are operational considerations? Chris – there may not be an immediate impact to us, but there may be other impacts – e.g., a schoolteacher that wants to do a lesson, we don't need to be involved. Bev – people that are interested, they make a point to mention it when they are talking to people and we set up a common email where people send their information. Maybe start compiling names of people that are interested. Ron – this seems like a good starting point, especially if you are targeting the "low hanging fruit" people as they would have the same interests that we have. Longer term – contact USGS and ask them to add a visual component to Did you feel it? Also talk to Microsoft – they are a participant in VDV. Jeff Saunders – grassroots movement is citizens emergency response teams – sometimes retired, sometimes pillars of the community, have some training, all looking for something to do – may be a good avenue for them to be able to share experiential data. They are normally there during the event and could contribute.

Hampton Peele (Hampton) – in countries where you don't have this type of infrastructure in place, you can start developing. Infrastructure includes not only computer elements, but also NGO disaster response. Likes giving back idea – instead of giving back…give to them first. At least give them pre-event imagery to inspire them to take more initiative, which gives a way for you to start generating data. Bev – as good as the internet is, there is nothing like having a big map at a community center.

If you're interested in pursuing in giving feedback, participating or helping, let Arleen and Bev know.

1. In what ways would we like to contribute to community remote sensing activities?
2. What procedures/frameworks are needed?
3. What is a reasonable goal for 2010 workshop?

Panel Discussion 1: Data Issues – Rapid Access to Remote Sensing Dataset

Q1: What are the challenges in accessing datasets quickly?

- Training of people, so that they are familiar with what is out there
- Logistical restrictions on acquiring certain datasets within certain timeframes
- Effective use of resources
- Competition between scientists in different fields
- Training, communication, processing of data is important
- Thumbnail images should be displayed by aerospace companies,
- "We" should be part of the distribution framework
- AIST currently in negotiation with JAXA to become part of the network
- Network already exists that purchases satellite images collectively for research purposes - ImageCat has led in past events with commercial data providers
- EPA – can provide geo-rectified data in real-time for events in the US
- EPS tasks the data. Aircraft standing by.
- EPA Framework to distribute data exists, e.g., web-based.
- One airborne unit based in central Texas.
- 3 days lead time required by the satellite data providers
- Satellites sometimes doesn't go over the area required
- Space agencies are looking for events that cause trouble – the media reports can distract the companies from the real impact area
- Other priorities can be an obstruction to us getting images that we need.
- Difference exists in events in/outside the US
- Outside the US sensors become limited - more important to have images

Q2: When should the data be shared with government agencies, and when should it be shared with the public?

- Preliminary results to be shared with the government as quickly as possible
- Public should have access as well, however no control over how they would interpret data
- Should not over promise the capabilities of remote sensing – we have to share as much
- Validation is KEY!! Need funding structure to acquire validation data
- Access to raw data – access to expertise not been problem at UT
- Charter defines the level of processing that is done on the data provided
- Who the data is being delivered to decides what type of data you provide
- Analysis done (e.g. inundation map) – should it be released?

- Military organizations sometimes do similar analysis – for recon, or impact assessment – never gets into general public domain
- Seems like a waste to duplicate effort – military & research
- Client decides whether data is published or not

Q3: How soon can we get the analysis done – out into the public domain?

- Depends on the level of processing, sensor
- Between one day and months
- Info such as determining number of affected population should be put out asap
- Depends on the disaster
- Color composite should be the minimum to be delivered
- Info such as Damage ratios, Number of damaged buildings should be included.
- Southern California wildfires – evacuation, more and more information was getting out quicker as time went by. This helped calm the community
- Need to be cautious but also give information as well
- In LA last month, fire burn info was acquired through Facebook but, firefighters seemed to have good info.
- Time frame – one week after event is too late; should be few hours
- Level of detail included in the data is important too
- Coast inundation image really helps
- Working with the data providers – need pre- and post- for change detection
- If communicate with the data providers long before the event, and tell them the exact data requirements, will help in real events
- Some post-Katrina images were not geo-referenced – end users had to do this themselves
- Pre-event data is important – baseline data e.g. population data etc.
- Emergency managers have learnt a lot through the events in the past 5 years. Same people will be operating the aircrafts. NOAA
- NOAA is the only org that will fly just before the event
- NOAA will not fly inland. No one will currently fly pre-event for a river event

Q4: Remote Sensing - Gradual integration with the methods of response and recovery over the years -How?

- People who would evaluate the efficacy of remote sensing in disaster response
- Get more people involved in “the loop”. Google and Microsoft are pushing the agenda
- Get more students involved, funding for them, more research who would be on the receiving end, not just the technically side.
- The burden is more on the program managers in Washington DC
- Joint solicitations with other agencies (NASA)
- Training the new generation
- Form partnerships with different user groups
- Standardized index/methodology to create damage maps
- Many events occur in a short space of time – need a standardized framework for smooth implementation
- Limitations and accuracy should be defined by the academic

- Need to agree on the metrics, otherwise would be difficult to communicate with the public.
- Do we find it difficult to identify the most impacted area? – used LandSat to highlight the areas that needs to be focused on (China)
- 2004 tsunami covered a huge area as well
- Structured data – on the other hand, there are various other types of data through phone cameras, social networking sites. Outside the US, data will be difficult to obtain. Use of unstructured data.
- Use these unstructured data sources as data to validate the struct**ured data**

Panel Discussion 2: Perspectives of End Users: Emergency Managers and Decision Makers

Audie Nelson (Audie) – Texas Parks and Wildlife Department. Has the equipment to get to areas that most others don't get to. Responded to Hurricane Katrina. Deals primarily with rural areas. Heads up game warden GIS team – handle all the mapping and get data ready for field deployments and to generate maps for incident command. Contribute other data – flooded areas, debris lines. Sets up command centers, rescues people, and provides incident command support. Teams track with GPS where they are, set waypoints and include comments, downloads data daily to understand where they had been. Transfers data to new teams, turns over information to new teams – medical, information, etc.

Jeff Saunders (Jeff) – Operations Chief, Texas Engineering Extension Service – sponsoring agency for Texas Task force 1 – urban search and rescue, part of ESF-9. All agencies are essential for search and rescue – they continue to add agencies to be better and better. It is easy to get data off the internet, hard to print maps in the field. Portable HP plotters, etc. are used in the field. Centralized communications from the field to the emergency operations centers. After tropical storm Allison, significant doubling of effort. Joint air/ground coordination team works to avoid this. Coordination of resources, everything is a local event. TX-TF1 has 60 participating agencies with over 500 members. ~200 are just for structural collapse, other members of the team deal mainly with floodwaters. With the large influx of people moving towards the coasts, more rescue events are occurring and we are experiencing 100-year flood events every 10 years. During Hurricane Dolly, RC-26 provided bird's eye view of everything that was happening. All assets are pre-staged in the state of Texas based on risk. Remote sensing is particularly good to do this. CSR gives them a very good path for the storm, which puts the bulk of responders out of harm's way. Generally will have 1500 responders and need to get them into safe places or hardened facilities) away from the coast. Ground-truth and imagery helps with situational understanding. CSR provides reentry times in a 2-D map that provide waveform map with wind speeds for different times to be able to plan re-entry. Remote sensing can also get the true storm path, which can't be obtained from ground data. The true storm path may be the last place they get to, concentrating on the periphery where they can help people.

Building damage information – only way is to have structural engineers standing in the field, Pictometry also may be used. They use trackstars so they have satellite links, interoperability with other agencies in the state. Have to take everything that they have

with them. They have wide area networks and can blanket an area with a wide area net that covers ~ 2 football fields. Can push 3GB up and 3 GB down with trackstars. People want to do the same thing at the same time and it's eating up bandwidth.

Ellen Rathje (Ellen) – if you think remote sensing is not fast enough, what products are useful? Audie has hard drives full of the most recent data they could get. Current roads, satellite images, load everything that they can find. Jeff – Remote sensing is a lot of different things. They were alerted immediately about American Samoa – you go to Google and there are 30 videos on YouTube with live action cams about what is happening in American Samoa. Census data is very important in the valley with the number of colonias (special needs, low income housing where people often don't evacuate). Colonias were identified, especially in flood vulnerable zones to be able to rapidly respond if necessary. Audie does carry plotters with them, but it takes a lot of time to come back and get more maps. Specialized communications and internet-based cache of pdf products is the best so that everyone has the same information. Google maps or something with no extent makes for confusion – no extent limits and scale is different. USNG is standardized grid system that is established in the US, which has problems with implementation. Teresa has been working on this.

Hampton Peele (Hampton), Louisiana Geological Survey – is there a centralized data repository? TENRUS? Texas Water Development Board – they are supposed to have all the geospatial data, but status of updates is unknown.

Texas Natural Resources XX Board was supposed to update and make data accessible, but changes in government to have data offsite have made it very difficult to get data. Provided by private group that does not feel particularly rushed to provide data. A lot of data is distributed. UT probably has more information stored than any state agency but does not have interface to access or serve data.

What geospatial electronic capabilities does search and rescue have in the field – None – relies entirely on Gordon for imagery. Grant to be funded for 6 hand-launchable UAV's which will assist in collecting aerial information. Will provide digital real-time video. Playing with geocoded photography hooked into cell network with air cards – Nikon camera with GPS cards, automatically posting to a Flickr account, glean out information that is important and send to EOC. If successful, each search team will end up with some type of camera that can get data back to the EOC.

Audie – some technology exists where maps can be updated and pushed data back to the field with Toughbooks, which is a little cost prohibitive. Maybe in the future.

Gordon Wells (Gordon), University of Texas at Austin – remote telemetry to monitor filed teams and directing could be accomplished from more centralized location to provide guidance on areas to visit. Audie – this is currently done at the end of the day – they had assignments and were supposed to complete search areas and directions, but end of the day review reveals that a lot of time they are not following plan.

Arleen Hill (Arleen) – in an ideal situation, is there a wish list of products that you can share that are current challenges? Jeff - Water depth analysis –Driving component, transportation component, aquatic component. Parks and wildlife has airboats that go on very little water. Most other boats need some amount of draft. Vehicles are better with no water ☺ After Dolly, CSR provided water depth information and they could make decisions about if they should go through or go around water. Audie agrees – team took boats in (after driving there) and then hit dry spots. They have to jump the boats to the next inundated area. Something that is more real-time about the current situation of water depth would aid significantly.

Gordon – product from Katrina – used Ikonos imagery and pre-event ground elevation data to produce these types of products. You have to have very good pre-event data to be able to produce this type of information. Teresa Howard (Teresa) made some products using radar for Dolly because of cloud cover. Combining weather station information with radar is a possible application – Teresa. Jeff – contradictory reporting regarding flooding where ground water was popping up then disappearing.

Ellen – it seems that pre-event data is very important. Does the state put resources out there for collection of this type of data? Gordon – not satisfied with Texas response on this. Several years ago, Texas was a national leader, but there is a gap, even in utilization of existing resources.

Hampton – Louisiana has been doing a lot of flyovers, including DOQQ and flyovers for coastal change, including LIDAR. For Gustav and Ike, Hampton does the search and rescue maps for wildlife and fisheries in Louisiana, and puts the output results of the ADCIRC storm surge model to guide them. He feels that where they need to go is putting radar information that shows actually storm surge inundation. Can use this information to calculate depths and use to update ADCIRC model results. RadarSAT collected pre-event data to be able to produce multi-temporal products. Collaborating with satellite stakeholders – they will often take it upon themselves to collect the data.

Arleen – do you have any questions for our community? Audie would appreciate any help, but there is the question of where funding comes from. Jeff – interoperability is key. There is already an interoperability platform so you are mostly interoperable. For them, a common grid function is imperative (differences in LA because of UTM split in New Orleans). We do what we do but we need to understand needs for interoperability.

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