CERS Observer

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Brigham Young University

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Remote Sensing at BYU

David G. Long, Center Director

Welcome to the first issue of the *CERS Observer*, the newsletter of the **BYU Center for Remote Sensing** (CERS). In this newsletter we hope to let you know about the activities of the new center and present research results from students and faculty. Futher information is available on the Center for Remote Sensing website (see left).

The dawn of the space age has helped mankind view the Earth as a global, connected system. Developments in the technology of remote sensing have enabled us to better understand the global atmosphere, ocean and biosphere and our effects on the climate and the environment. The term *remote sensing* is used to describe methods for studying an environment from a distance. That distance may be from a few inches (or even less), to billions of light years. The interdisciplinary field of remote sensing is thus very broad, encompassing a variety of science and engineering disciplines.

The expanding applications for remote sensing and the need for close, interdisciplinary collaboration prompted the formation of the new BYU Center for Remote Sensing. Hosted jointly by the College of Engineering and the College of Family, Home, and Social Science, the Center is designed to coordinate research and academic activities across multiple colleges and departments. Its primary goals are: 1) to enhance the academic experience for BYU students, 2) to enhance the reputation of BYU and to expand the number of businesses, industries and agencies which are friends of BYU, 3) to foster and expand research opportunities, experiences, and funding for faculty and students, 4) to attract to and retain world-class faculty at BYU, and 5) to strengthen and increase the stature of existing BYU programs. The Center will coordinate with participating departments and laboratories in promoting related research programs and thereby foster and support interdisciplinary research. The Center has plans to develop a Remote Sensing Certificate Program.

Faculty in various departments at BYU, including the Electrical and Computer Engineering (ECEn), Geography, and Civil and Environmental Engineering (CEE) departments have been engaged in remote sensing and GIS research. As a result of this research, they initiated the Center. The Center is a confederation of laboratories and research groups including the Archometry research group, the Environmental Modeling Research Laboratory (EMRL), the Laboratory for Geographic Information Analysis (LGIA) and the Microwave Earth Remote Sensing (MERS) Laboratory. We hope to involve additional laboratories and research groups in the future

An Interview with Perry J. Hardin

We hope to highlight a different faculty in each issue. Our first target is Associate Director Perry Hardin of the Geography Department.

Reporter: Dr. Hardin, you're a faculty member within the Department of Geography. What does geography have to do with remote sensing?

Dr. Hardin: Geography is the study of the earth's physical environment, its human inhabitants, and the interaction between the two. Remote sensing provides geographers with an important tool to study Earth's people, its environment, and how they relate to each other. Geographers use remote sensing to investigate diverse subjects such as urban growth, tropical deforestation, climate change, water pollution, and agricultural productivity.

Reporter: The Department of Geography also hosts the Laboratory for Geographic Information Analysis. Is that the same as remote sensing?

Dr. Hardin: No, the laboratory supports both teaching and research in the field of **Geographic Information Systems** (or GIS). GIS is concerned with how geographic information is represented and analyzed using computer technology. To a large extent, GIS combines computer graphics, computer cartography, and database management into a single discipline concerned with the representation

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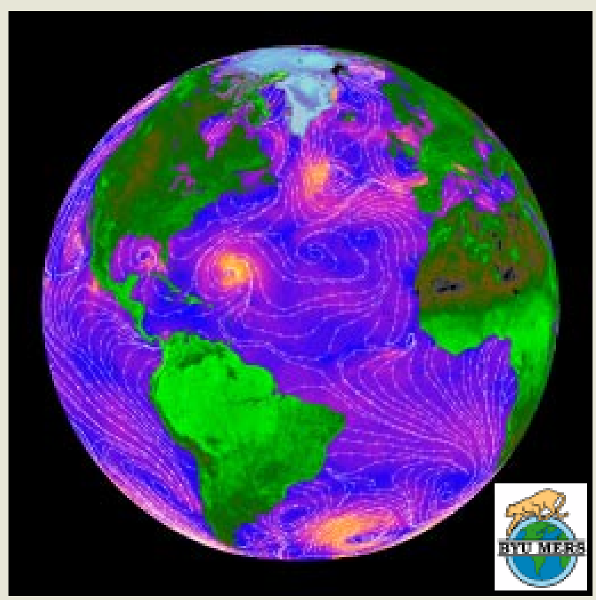


A remote sensing view of the Earth from space. This computer image was created from radar satellite data. Over the ocean, the color shows the wind speed. The orange area east of North America is Hurricane Floyd. Colors over land and ice reveal variations in vegetation and ice cover.

"Remote Sensing: studying from a distance. The distance can be from a few inches to billions of light years."

An Interview with Perry Hardin continued...

of spatial information. Remote sensing is an important conduit of information into that geographic information system.

Reporter: Can you give me an example of work performed in the Laboratory for Geographic Information Analysis?

Dr. Hardin: Dr. Brandon Plewe is directing a fascinating project with some important implications for genealogical research. He is designing data structures and algorithms to store dynamic historical data for user query and mapping. Since boundaries change through time, it is not a trivial problem. In another project, Dr. Mark Jackson is measuring landscape degradation in the southeastern United States using high-resolution imagery. The data comes from remote sensors, and he is assessing the environmental change between dates using routines provided by the GIS. The work of Dr. Jackson has caught the eye of the Environmental Protection Agency, who may want to take his research and turn it into an operational system for automatically monitoring coastal areas for environmental degradation.

Reporter: What is your specialty in remote sensing?

Dr. Hardin: Geographers by nature and training tend to be generalists rather than specialists, so it is hard to define a specialty. I have published in journals of agronomy, engineering, optics, archaeology, wildlife management, and geography. If I were forced to define a specialty, I would say my primary interest is studying nontraditional approaches (such as artificial neural networks) to evaluate global land cover and atmospheric state. You see, humans are very good at looking at pictures and identifying objects such as clouds, mountains, water, agricultural crops, and urban areas. Humans can also tell when it is raining, just by looking out the window. The trick is teaching the computer to do the same job without operator intervention.

Reporter: Any interesting future projects?

Dr. Hardin: Yes, we recently got two proposals approved by the National Space Development Agency of Japan (NASDA). Drs. Jeff Durrant and Chad Emmett of the Department of Geography will direct the first project. Using data provided by NASDA, Drs. Durrant and Emmett will be looking at the causes and effects of deforestation in Indonesia. My job will be to map the extent of the deforestation using satellite-borne radar. Dr. Mark Jackson, also a geographer, will lead the second project. It involves the mapping of sea ice in the Bering Sea using both radar and more traditional remote sensing technology. If Dr. Jackson's research is successful, we may be able to use sea ice growth and retreat as an indicator of climate change.

Reporter: How are students involved in your research?

Dr. Hardin: In general, they conduct the research under the direction of CERS faculty. When we organized CERS, we had four primary objectives. The first objective was to enhance the academic experience for students. Currently, the ratio of students to faculty in CERS is about 6 to 1. I have five students working for me now, all undergraduates conducting interesting research projects on state-of-the-art computing hardware. Dr. Long has about fifteen. These students are not only helping us, but they are learning skills that will help them in their future life. These same students will have increased opportunities (and salaries) when they leave BYU. Many of our students complete their Ph.D. at schools like MIT, Illinois, Michigan, UCSB, South Carolina, and Kansas. Those are prestigious schools. We have had equivalent successes in industry. Oh yes, and one of those students, Mark Jackson, has returned to BYU as a faculty member.

We are also in the process of creating an academic certificate program. With a combination of coursework and practical research experience, students will be able to obtain an M.S. in Engineering or an M.S. in Geography with a certificate of remote sensing.

Reporter: Can you elaborate?

Dr. Hardin: The certificate program is a work in progress and we're still working out the details. When we formed the center, we wanted to benefit not only the faculty, but also students. In talking to various remote sensing professionals who are also BYU alumni, we found them excited by the idea of a certificate that documented their particular skills in remote sensing in addition to their usual coursework in electrical engineering or geography. The certificate helps our students to stand out from the competition. The certificate requires that students take extra coursework in various campus departments, and is approximately equivalent to a graduate minor. However, there are still quite a few details to be worked out.

MERS Lab Obtains Blimp

The Microwave Earth Remote Sensing Laboratory recently acquired a 33 foot long, remote-controlled blimp. Powered by two small gasoline engines, this lighter-than-air vehicle will be used as a platform for remote sensing research and for experiments in remote piloting. It will be used to carry small radars to measure wave profiles over the ocean and to take aerial photographs.

Photograph of new MERS Lab blimp prior to its first test flight.

The *CERS Observer* is published by the BYU Center for Remote Sensing. Electronic copies of the newletter (in PDF format) are available on the CERS web site at URL http://www.cers.byu.edu If you would like to be added to the Center email list, send email to cers@byu.edu

Laboratory for Geographic Information Analysis

"Seeing is understanding."

"Currently, the ratio of students to faculty in CERS is 6 to 1."

"Remote sensing provides geographers with an important tool to study Earth;s people, its envrronment, and how they relate to each other."

Environmental Modeling Research Laboratory

Highlighting Student Research: Nawajish Sayeed Noman, EMRL

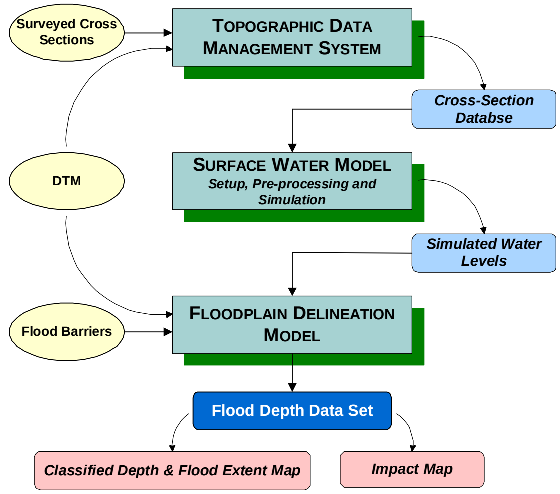
"GIS has been recognized as a powerful tool to integrate and analyze data from various sources..."

Flooding and flash flooding pose serious hazards to human populations in many parts of the world. In addition to destruction caused by river and tidal flooding along coastal areas, flash flooding is a serious threat to all countries. Devastating floods occur throughout the United States every year. Changing weather patterns, coupled with over-development and leveling of forests that reduce the land's natural ability to absorb water, are increasing the flood risk for many, even those who don't live near water. The Flood Disaster Protection Act of 1973, passed by Congress, required the identification of all floodplain areas within the United States and the establishment of flood-risk zones within those areas. In the last few decades engineers have put considerable time and effort into developing methodologies for delineation of floodplain boundaries. Most of these early methods are manual and require a significant amount of time and effort. A robust automated technique for delineating floodplains could reduce the computation time and improve the accuracy of a flood depth and extent map.

With the advancement of computer and satellite based survey technology, the Geographic Information System (GIS) has been recognized as a powerful means to integrate and analyze data from various sources in the context of comprehensive floodplain management. A number of automated floodplain delineation and management systems have been developed and applied in different parts of the world. In general, the process requires the creation of a water surface from hydraulic model results, or observed water levels. This water surface is then subtracted from a Digital Terrain Model (DTM) to generate a flood extent map, which represents the water-land boundary on a floodplain. However, the technique involved in spreading water from a river over a floodplain, considering the river network, land surface elevation, and natural and artificial barriers, is complex.

The results from surface water models are frequently used in floodplain delineation process. It is absolutely imperative that the models are accurate over the floodplain with extended river cross-sections. The best way to gather floodplain data is survey. However, surveying over a large area is not only expensive, it's also time consuming. On the other hand, a Digital Terrain Model (DTM) contains topographic data over the floodplains. Any means of extracting these data in the form of profiles could save considerable amount of money and time, and can speed up the model development dramatically. The extracted profiles from DTM can be combined with surveyed river cross-sections to get a complete topography. This research also focuses on the development of a standardized data structure for river cross-sections and a cross-section database management system.

The ultimate goal in comprehensive floodplain management is implementing existing flood management practices through an integrated system consisting of surface water models, floodplain delineation and the management system. This research develops such an integrated system as shown in the figure, with the primary objective of floodplain delineation from a Digital Terrain Model (DTM).



The Topographic Data Management System (TDMS) is capable of creating, editing and managing cross-section profiles stored in different formats. It also has the capability of extracting profiles from a DTM and merging with surveyed cross-sections. The cross-section database created by this system is easily accessible through an inter-

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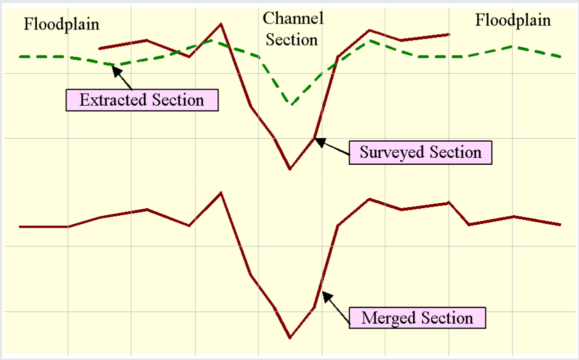
About the Author:

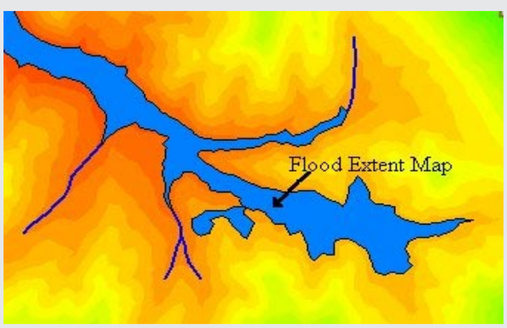
Nawajish Sayeed Noman is a Ph.D. student of Civil and Environmental engineering at Brigham Young University (BYU) and a researcher in the Environmental Modeling Research Laboratory (EMRL). He graduated from BUET, Bangladesh in 1991 with a bachelor degree in Civil Engineering and obtained M.Engg. from AIT, Thailand in 1997. He has been involved in many flood control, management and impact assessment projects. He has also developed many GIS based applications for flood management, crop damage assessment, and an information system for irrigation projects. His primary interest is in integration of GIS with water resources engineering.

Noman has received the "Graduate Fellowship Award for 1999-2000" from BYU for his research proposal and is currently working on a dissertation titled "An Integrated Approach for Automated Floodplain Delineation from Digital Terrain Models" under the supervision of Dr. Jim Nelson. Noman's professional interest in solving flood-related engineering problems is rooted in the suffering of his own country, Bangladesh, caused by flooding.



The TDMS combines surveyed and extracted cross-sections to provide a better extended channel cross-section representation.

face of the UNET surface water model. The improved floodplain delineation system reads the results of the UNET model and generates maps showing the extent and the depth of flooding from digital terrain models. This floodplain delineation method overcomes most of the limitations found in the currently available tools. It provides a mechanism to incorporate natural and artificial barriers that are not represented by the DTM. Intelligent consideration of hydraulic connectivity over the floodplain is also a key feature of this system. This integrated system will be an excellent tool for water resource professionals striving to provide better floodplain management solutions.



Flood extent and depth map created from a digital terrain model.

About EMRL

The Environmental Modeling Research Laboratory was founded in 1985. It is part of the Civil and Environmental Engineering Department in the College of Engineering and Technology. EMRL specializes in state-of-the-art environmental software for ground water, watershed, and surface water modeling. This software is being used by over 4,000 consulting firms, universities and government agencies in over 60 countries. Much of EMRL's research is funded by the US Army Engineers Waterways Experiment Station. Dr. Norm Jones is the director of EMRL. Other faculty include Drs. Jim Nelson and Alan Zundel. More information about EMRL is available on the web at URL http://www.emrl.byu.edu/

Center Benefits from new Super Computer

Student and faculty research has received a much appreciated boost from the new BYU supercometer known as Mary Lou, named after the wife of the generous donor, Ira Fulton, who funded the purchase of the machine. The SGI Origin 2000 supercomputer is being used for generating and visualizing images from radar data as well as analyzing remotely sensed data. It has enabled student researchers to develop new software techniques for data analysis not previously possible.

Number of BYU Conference Papers Sets New Record

This summer at the IEEE International Geoscience and Remote Sensing Symposium, students and faculty associated with the BYU Center for Remote Sensing presented and published a record 28 papers (out of approximately 1500 presented at the conference), believed to be the largest number of papers from a single organization ever presented at this important international conference on remote sensing. Most of the papers were authored by students.

NASA Interactive E-Theater Returns

In January, 2000 the Center sponsored a campus visit by the NASA Interactive E-Theater program. While only a single showing was originally planned, the audience turnout was so large that a second showing had to be quickly arranged. The JSB auditorium was more than filled to capacity for both showings. Given the response to this program, the Center will be sponsoring a revisit of the E-Theater program to the BYU campus. January 11, 2001 marks the second annual CERS NASA Interactive E-Theater Presentation.

Center Colloquia

The BYU Center for Remote Sensing has sponsored a number of colloquia with invited external speakers this past year. Each talk has highlighted some aspect of remote sensing. Some of our invited guest speakers have included Paul Saylo (University of Illinois), William Emery (University of Colorado), Dudley Chelton (Oregon State University), and Rulon Simmons (Kodak).

Center Faculty in the News

Professor David G. Long of the MERS Lab in the Department of Elecrical and Computer Engineering attracted attention this past year when he found a missing iceberg in the ocean around Antarctica. Using a new technique for making images from satellite scatterometer data, he spotted a supersized iceberg in shipping lanes near Antarctica last year. The iceberg, known as B10A, was 35km by 65km or about the size of Utah Valley. The story was the subject of several newspaper articles and an interview on a national TV news broadcast. Images that he and his students have produced have been used in NASA press releases. A picture of the satellite he used is in the Oct. issue of the *National Geographic* Magazine (pgs 88 & 89).

"This integrated system will be an excellent tool for ... floodplain management...."

Students authored or were co-authors on 23 out of 28 papers presented by Center faculty and students at the prestigous International Geoscience and Remote Sensing Symposium.

The second annual NASA Interactive E-Theater program is scheduled for 11 January, 2001 in the JSB auditorium.

When found floating in the ocean off the coast of Antarctica, the lost iceberg B10A was about the size of Utah Valley.