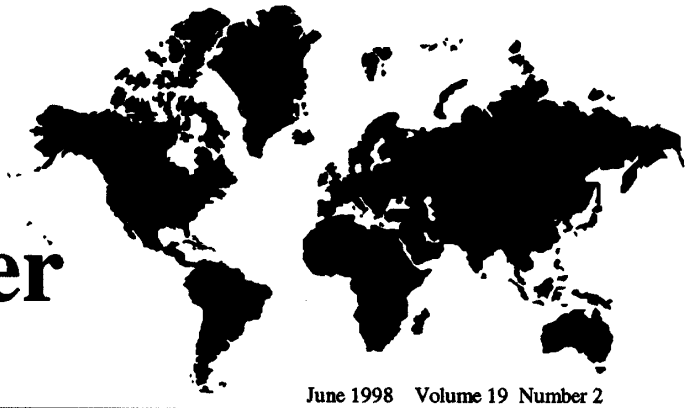
RSSG Newsletter



Remote Sensing Specialty Group
Association of American Geographers

June 1998 Volume 19 Number 2

From the Chair

Greetings and salutations, or should I say "Aloha!" Now is the time to make plans to attend the AAG Convention next March in sunny Hawaii. Once again the Remote Sensing Specialty Group (RSSG) will be sponsoring several sessions at the conference. Papers presented at the RSSG-sponsored sessions are usually well attended, so please make use of your specialty group membership and get your paper into one of our sessions. If nothing else it will at least guarantee you a large and attentive audience! This year the RSSG sessions will be organized by Tom Allen (Old Dominion University), Tim Foresman (University of Maryland-Baltimore County), and Rollie Fraser (Western Michigan University). Rollie will be the main point-of-contact for the specialty group sessions.

I would like to take this opportunity to congratulate Dale Quattrochi (NASA) for being elected RSSG vice chair for the next two years, Jeff Olsenholler (University of Nebraska-Omaha) for taking on the job as our secretary/treasurer, Scott Loomer (U.S. Military Academy) for being elected as our new Director, and Brad Rundquist (Kansas State University) for taking on the job as student director. Our specialty group will remain strong and vibrant as long as such highly qualified people are willing to take on these extra responsibilities. I would also like to thank Kevin Price (University of Kansas), past chair of the

Continued on page 5...From the Chair

Call for RSSG Program Participation

AAG 1999 Annual Meeting
Honolulu, Hawaii

The AAG Annual Meeting will be held March 23-27, 1999 in Honolulu, Hawaii. Remote Sensing Specialty Group (RSSG) sessions are being organized by **Tom Allen** (Old Dominion University; tra100f@hamlet.bal.odu.edu), **Tim Foresman** (University of Maryland Baltimore County; foresman@umbc.edu) and **Rollie Fraser** (Western Michigan University; fraser@wmich.edu).

Rollie Fraser, *chief contact for paper, poster and special sessions*, can be reached at:

Rolland Fraser
Department of Geography
Western Michigan University
Kalamazoo, MI 49008
ph: 616-387-3345
fax: 616-387-3442
e-mail:fraser@wmich.edu

Continued on page 2...Call-for-Papers

Call-for-Papers...continued from page 1.

Submitting Abstracts

Persons who wish to partipate in RSSG-Sponsored Sessions must **send Rollie Fraser:**

1. ***a completed AAG program participation form,***
2. ***the abstract on disk in Wordperfect or ASCII format,***
3. ***two paper copies of the abstract,***
4. ***non-refundable payment ($130 for AAG members, $65 student)***

The **deadline for submitting abstracts to the RSSG Program Committee is Monday, August 24, 1998**. All individual papers and Specialty Group-sponsored sessions are due at the AAG Central Office by September 4, 1998.

For additional details on abstract format, forms and fees see the **AAG Newsletter** (May 1998) or the AAG WWW page (www.aag.org).

RSSG General Sessions

We are looking at a potentially record-breaking participation in Honolulu, which may push the limits of conference space and time. Please submit papers and posters for general RSSG sessions as promptly as possible to the program committee. We also invite participation in one or more "illustrated paper" sessions, which include poster illustrations of your research, in addition to a brief summary presentation. This poster format allows for more presenters in a session, with the advantage of increased question and discussion time after all summaries are presented. Please meet the paper session deadline for these, and specify the submission for "illustrated papers" in a cover letter.

Potential topics cover the entire range of remote sensing research and applications. The program committee invites papers for at least one session emphasizing the theme "geography in remote sensing," in the context of any of the selected topics.

Honolulu Student Travel Grants

The Remote Sensing Specialty Group (RSSG) program committee wishes to remind students that both the AAG and the RSSG will offer limited subsidy funding for those who present papers or posters at the meeting, and the deadlines are fast approaching ... please check the AAG home page (www.aag.org) for information.

Special Sessions

The following special sessions are being organized:

1. The boundaries that separate basic research on the various geographic information techniques and technologies (cartography, GIS, remote sensing) have always been somewhat blurred. In applications, the distinctions are even less clear. The increasing use of the term geographic information science (GISci) represents a general recognition of an integrated field. For these reasons, the program chairs of the **Cartography, GIS and Remote Sensing Specialty Groups solicit papers for special sessions on issues that are common across the three specialties**. We hope to put together several sessions that address cross-cutting issues, i.e., issues that are not specific to the three Specialty Groups, but are of interest to researchers and practitioners of all. Students may seek funding opportunities from any of the SG's.

Potential topics include, but are not limited to: Scale and Generalization, Geographic and Scientific Visualization, Integration Issues, GIScience Education, Technology Transfer, Cognition of Spatial Phenomena and Relationship, Integration of GIScience and Models, Fuzzy Sets, Neural Nets, and Genetic Algorithms, Environmental Applications, Socioeconomic Applications, Social

Continued on page 3...Call-for-Papers

Call-for-Papers...Continued from page 2.

Dimensions of GIScience Technologies, and Role of GIScience in Geography. Contact the committee if you wish to lead in organizing one of these. Contacts for the GISSG and the CSG:

Dan Brown, Vice-Chair
GIS Specialty Group
Department of Geography
Michigan State University
East Lansing, MI 48824
brownda@pilot.msu.edu

Charlie Rader, Program Chair
Cartography Specialty Group
Department of Geography
University of Wisconsin -River Falls
River Falls, WI 54022
Charles.P.Rader@uwrf.edu

2. *Pyrogeography: Remote Sensing Applications to Fire Mapping Science.* Steve Yool, University of Arizona, is organizing a special session, entitled "Pyrogeography: Remote Sensing Applications to Fire Mapping Science." If you are interested in this session, please contact

Steve Yool
Department of Geography
Harvill Building, Box 2
University of Arizona
Tucson, AZ 85721
Ph.: 520-621-8549
e-mail: yool@skydog.geog.arizona.edu

3. *Hyperspectral vs. Multispectral Spectral Scaling.* Rollie Fraser, Western Michigan University, is seeking to organize a session, entitled "Hyperspectral vs. Multispectral Spectral Scaling", the papers dealing with relevant feature analysis or future directions in sensor design and data needs. Please contact Rollie Fraser if you are interested in contributing to this session.

4. Spatial Analysis in Biogeography and Ecology - an International Symposium organized by the Biogeography Study Group, International Geographical Union (IGU), the British Ecological Society (BES), the Biogeography Research Group, Royal Geographical Society/Institute of British Geographers (RGS/IBG), and the AAG Biogeography, Remote Sensing and GIS Specialty Groups. To be held during the Annual Meetings of the BES and RGS/IBG, Leicester, England, January 5-7, 1999 and the AAG, Honolulu, Hawaii, March 23-27, 1999.

Papers in the following areas of biogeography and ecology are encouraged:

- Application of spatial analysis to quadrat and other sampled data
- Spatial aspects of monitoring
- GIS-based modelling
- Simulation modelling
- Scale-dependency and ecological processes
- Metapopulation models and GIS modelling for wildlife distributions
- Modelling environmental gradients
- The nature of boundaries in biogeographical and ecological
- distributions and fuzzy logic approaches
- Landscape metrics
- Landscape and disturbance
- Gap analysis and turnover
- Database development and management
- Spatial aspects of EO-based studies
- Satellite time series data and landscape dynamics
- Spatial aspects of human-environment interactions

Titles and abstracts for the Honolulu AAG (March 1999) Meeting should be submitted to:

Stephen Walsh (AAG Convenor)
Department of Geography
University of North Carolina at Chapel Hill
310 Saunders Hall
Chapel Hill, NC 27599
Ph.: 919- 962-3867
e-mail walsh@geog.unc.edu

Continued on page 4...Call-for-Papers

Call-for-Papers...Continued from page 3.

or

Andrew Millington (IGU Convenor), Dept of Geography, Leicester University; e-mail acm4@le.ac.uk

Abstracts, fees and associated materials should be submitted in accordance with the AAG guidelines (see the May and June issues of the **AAG Newsletter** for specifications). ***Abstracts are due by August 27, 1998 and should be mailed to Professor Walsh*** for handling and final submission to the AAG Central Office.

Titles and abstracts for the Leicester (January) Meeting should be submitted to either:

Andrew Millington (IGU Convenor), Dept of Geography, Leicester University; e-mail acm4@le.ac.uk

Jane Wellens (RGS-IBG Convenor), Dept of Geography, Leicester University; e-mail jw27@le.ac.uk

Patrick Osborne (BES Convenor), Dept of Environmental Sciences, Stirling University; e-mail p.e.osborne@stir.ac.uk

It is the intent to publish selected papers from this meeting either as an edited book or a special issue of a journal. Papers will have to be submitted at either of the meetings to meet publication deadlines.

Remote Sensing Specialty Group 1998 Awards

Three individuals were recognized by the RSSG at the 1998 annual meeting of the Association of American Geographers held in Boston. Drs. Sam Goward, James Merchant, and Robert Holz received the RSSG Outstanding Contribution Award and Medal.

Dr. Samuel Goward, University of Maryland, was recognized for his more than 30 years of outstanding research, teaching, and service to the remote sensing community. His work in thermal infrared remote sensing is particularly noteworthy.

Dr. James Merchant, University of Nebraska, was recognized for his outstanding service and research. He has provided exemplary service to the RSSG and the remote sensing community, and his research in land cover regional mapping in the U.S. is recognized internationally.

Dr. Robert Holz, University of Texas, was recognized for his pioneering work in spaceborne remote sensing, and his long term service commitment to the RSSG and AAG.

Of Note

Ken Duda successfully defended his Master's thesis on May 15, 1998 in the Department of Geography at Michigan State University. He used satellite imagery and GIS data in a forest defoliation detection problem, applying maximum likelihood and backpropagation artificial neural network classifiers. Ken's advisor was Dan Brown, and his website is at http://www.ssc.msu.edu/~geo/stu/duda/home.html

From the Chair...Continued from page 1.

group, for including me in the decision-making loop over the past two years while I have served as vice-chair. This has helped ease the transition for me as I begin my two-year hitch as chair.

Duane Nellis (University of West Virginia), chair of the honors committee, presented the RSSG award to three recipients this year. All three of the honorees were cited for their significant contributions to the discipline of remote sensing. This year awards were presented to Dr. Robert Holz (University of Texas), Dr. Sam Goward (University of Maryland), and Dr. Jim Merchant (University of Nebraska-Lincoln). I would like to add my congratulations to the 1998 award winners.

This is truly one of the most exciting times to be in the field of remote sensing. How many times have we all heard this pat phrase? These are exciting times not just because we are looking at a wide variety of new sensors being readied for launch, but also because the tools that we use to analyze the data are becoming better and less expensive with each passing year. The amount of processing power sitting on our desks today is simply astounding. We are now able to attempt things with our data that were simply too time-consuming or expensive to do in the past. We are also able to concentrate more on the fundamental remote sensing problems and spend less energy on the "mechanics" of how to go about doing it.

I am looking forward to serving as your chair for the next two years. I would like to see our specialty group continue to provide its members with a first-class setting for our paper sessions at the annual meetings. I feel that this is one of the most important functions of a specialty group. I would also like to see our group continue to sponsor workshops at the conference to share our knowledge with others. I would also like to see our group continue and perhaps increase the number of submissions to the RSSG special editions of **GEOCARTO International** and **Remote Sensing of Environment**. By continuing this activity we increase the visibility of our group, increase the quality of our specialty group sessions at the annual meeting, and build a reputation for delivering quality manuscripts to professional journals. Please feel free to contact me via e-mail at tyler@erim-int.com or by telephone at (734) 994-1200, ext. 3609, or fax (734) 665-6559. My mail address is William A. Tyler, ERIM International, P.O. Box 134008, Ann Arbor, MI 48113-4008.

New Publication Reviews Status and Trends in Spatial Data Handling Software

Status and Trends in Spatial Data Handling Software: Results of 1991-97 Surveys by Dawn Buehner, M. Sean Chenoweth and Ashbindu Singh reviews the recent global growth in spatial data handling software. For a copy of the summary report, contact:

United Nations Environment Programme
EROS Data Center
Sioux Falls, SD 57198
tel.: 605-594-6107
fax: 605-594-6119
e-mail: singh@edcmaill.cr.usgs.gov
http://grid2.cr.usgs.gov

The AAG Remote Sensing Specialty Group
News and Information

The **RSSG Newsletter** is your vehicle for communicating with colleagues interested in remote sensing. You are invited to send news regarding research activities, students, publications, awards, honors, academic programs, projects, commercial ventures, jobs and other announcements to the editor, James Merchant (see address below). If possible, please submit contributions on a disk in Wordperfect or ASCII format or by e-mail.

The **RSSG WWW site** is located at **http://www.earthsensing.com/rssg/index.html**
The site was developed, and is maintained, by:

John Althausen
Department of Geography
Central Michigan University
Mt. Pleasant, MI 48859
Telephone: (517) 774-1305
Fax: (517) 774-2907
E-mail: John.D.Althausen_Jr@cmich.edu

Participate in the on-line RSSG discussion list: **rssg@ulysses.unl.edu**
To subscribe to the neb-gisnews list, please send a message to: listserv@ulysses.unl.edu with the line, *subscribe rssg* in the body of your message.

For additional details, contact:

James W. Merchant
Conservation and Survey Division
University of Nebraska-Lincoln
113 Nebraska Hall
Lincoln, NE 68588-0517
Telephone: (402) 472-7531
Fax: (402) 472-2410
E-mail: jm1000@tan.unl.edu

1999 RSSG Outstanding Contributions Award
Nominations Requested

The RSSG Outstanding Contributions Award is presented to members of the AAG RSSG who have made especially noteworthy contributions to the field of Remote Sensing. Past honorees have included: Dr. David Simonett (posthumously), Dr. Benjamin Richason, Jr. (posthumously), Dr. Alan Strahler, Dr. John Estes, Dr. John Jensen, Dr. Duane Nellis, Dr. Kamlesh Lulla, Dr. James Campbell, Dr. Stephen Walsh, Dr. Robert Holz, Dr. Sam Goward and Dr. James Merchant.

Candidates for the award are evaluated by a selection committee appointed by the RSSG board. The Chair of the RSSG Outstanding Contributions Award Committee is Duane Nellis (West Virginia University). Other member of the committee are Kam Lulla (NASA/Johnson Space Center) and Sue Berta (Indiana State University).

Nominations for the 1999 award must be received by **February 15, 1998**. Nominations must include a letter of nomination and a complete vita for each candidate. Send nominations to:

Dr. M. Duane Nellis, Dean
Eberly College of Arts and Science
Woodburn Hall 201
West Virginia University
Morgantown, WV 26506
Tel.: 304-293-4611
Fax: 304-293-6858
E-mail: dnellis@as.wvu.edu

AAG/RSSG and GIS Specialty Group
Student Paper and Poster Competitions
Honolulu, Hawaii

Poster Competition

Eligibility: Abstracts are invited from any current student member of the AAG. Any poster created and presented by a student (sole or first author) that deals with scientific theory or application of remote sensing or GIS is eligible for consideration.

Awards: The two specialty groups have committed a total of $275 as awards for outstanding posters. The first-place poster presenter will receive an award of $150 and a certificate, second place will receive $75 and a certificate, and third place will receive $50 and a certificate. Posters will be judged by an Awards Committee appointed by the specialty groups. These judges will rank posters based on contribution to remote sensing and GIS, quality of content and presentation techniques. Awards will be presented at the AAG Awards Ceremony held during the Honolulu convention. Results of the competition will be published in the AAG, RSSG, and GIS-SG newsletters.

Application Procedures: There are two steps to follow when entering the competition:

1) Submit the AAG registration form, appropriate fees, and the abstract to the AAG by 1 October 1998. These materials should be sent to the AAG office. See the May 1998 AAG newsletter for more details.

2) Submit a second copy of the abstract and a written statement of intention to enter the student poster competition to Brad Rundquist , RSSG Student Director, by 1 October 1998.

For additional details, contact:

Brad Rundquist
Kansas State University
Department of Geography
Manhattan, KS 66506-0801
(785) 532-6727 (phone)
(785) 532-7310 (FAX)
brad@geog.ksu.edu

Paper Competition

Eligibility: Abstracts are invited from any current student member of the RSSG who has met the 4 September 1998 deadline for inclusion in RSSG-sponsored sessions. An eligible paper is one in which the principal research was completed by the student and will be presented by that student at the annual meeting. The student must be the sole or first author. The paper must deal with some aspect of the scientific theory of or applications centered on remote sensing.

Awards: The RSSG has committed $275 for awarding the top three papers. The first-place paper presenter receives an award of $150 and a certificate, second place receives $75 and a certificate, and third place receives $50 and a certificate. Papers are judged by an Awards Committee appointed by the RSSG. These judges rank papers based on contribution to the field of remote sensing, quality of content, and presentation. Awards will be presented at the AAG Awards Ceremony held during the Honolulu convention. Results of the competition will be published in the AAG and Remote Sensing Specialty Group newsletters.

Application Procedures: There are two steps to follow to enter the competition:

1) Submit the following to Rolland Fraser (e-mail: fraser@wmich.edu), RSSG Program Co-Chair, by 24 August 1998: the AAG registration form, appropriate fees, an abstract, and a statement (on a separate sheet of paper) indicating that you are entering the RSSG student paper competition. **See pp. 1-2 of this RSSG Newsletter for details.**

2) Submit the following to Brad Rundquist (e-mail: brad@geog.ksu.edu), RSSG Student Director, by 21 September 1998: a second copy of the abstract and a written statement of intention to enter the student paper competition.

Minutes of the Annual Meeting of the Remote Sensing Specialty Group, Association of American Geographers
Boston, Massachusetts,
March 27, 1998

1. The meeting was brought to order by Kevin Price, Chair who welcomed everyone, made introductions and reviewed the agenda items. The minutes of the 1997 annual meeting were reviewed by R. Douglas Ramsey, Secretary/Treasurer and a motion was made to accept the minutes as printed in the **RSSG Newsletter**. Dr. Ramsey also presented the financial status of the group. As of December 31st, 1997 the RSSG had a balance of $3,322.59. Expenses for that year were $1,041.30 which included newsletter printing and awards provided to student paper competition winners. Income from dues totaled $1,631.00. There was a move to accept the financial report, the move was seconded and the financial report approved by those in attendance.

2. ***Election Results***: This was the last meeting in which Kevin Price officiated as Chair. The new chair for the 1999/2000 meetings will be William Tyler. Dale Quattrochi was elected vice-chair, Jeff Olsenholler is the new secretary/treasurer, Scott Loomer was voted in as Director and the new student director will be Brad Rundquist.

3. ***Boston RSSG Program Report***: Dan Brown reported that there were a total of 9 RSSG sponsored sessions this year. Four of these sessions were organized by Dale Quattrochi. The program committee thanked Dale for his work in organizing these special sessions. The new program chairs for the 1999 meetings will be Rolland Fraser, Timothy Foresman, and Thomas Allen.

4. ***RSSG Newsletter***: Kevin Price presented the report on the newsletter by commending Jim Merchant on his excellent record of service for the past years in organizing, writing, printing, and mailing the newsletter. Kevin also requested that if anyone was interested in taking charge of the newsletter. Jim Merchant has done an exceptional job over the years and it was felt that it was nearing time that someone else had the opportunity to publish the newsletter. Jim will continue to work on it until someone else offers their service.

5. ***Committee Reports***:
Honors Committee: Duane Nellis, chair of the honors committee presented three recipients of this years RSSG award. The three recipients were Dr. Robert Holz, Dr. Sam Goward, and Dr. Jim Merchant. These three individuals were cited for their significant contributions to the discipline of remote sensing. Barry Haack and John Jensen provided a brief overview of Dr. Holz's career and Kevin Price offered a brief history of Dr Coward and Dr. Merchant.

6. ***Student Awards Committee***: Timothy Warner and Mike Hernandez reported on the paper and poster competitions. This year, the RSSG combined with the GIs and Cartography

Continued on page 9...RSSG Minutes

specialty groups to provide awards to the poster presenters. Steve Yool represented the RSSG as judge for the poster competition and Kevin Price, Doug Ramsey and Mike Hernandez acted as judges for the paper competition. Results of the competitions were not available as of the time of the RSSG business meeting. Award amounts for the paper and poster competition were $150, $75, and $50 for 1st, 2nd, and 3rd place respectively. The amounts of the awards will be reviewed next year and Kevin Price will talk to Bill Tyler (who was not able to attend this years meeting) about a change in the award amounts.

7. ***Publications Committee***: Doug Goodin reported that there were 5 submissions to the special issue of the GEOCARTO International from last years AAG meeting. Dale Quattrochi reported that Stan Morain has promised an issue in the fall for PE&RS. They will accept 6 or 7 papers for publication.

8. ***Student Director***: Mike Hernandez reported on the student competitions (see above) and thanked those who submitted papers and posters as well as those that have spent time organizing and judging the competition. He suggested that for future competitions that the papers be combined into one session to facilitated judging. Also some discussion delved into the possibility of providing student travel monies to the Hawaii meetings to those competing in the paper competition. The exact avenue of funding such an award was not fully developed. Mike was also requesting ideas from those at the meeting on how to increase student involvement in the RSSG.

9. ***Communications Committee***: Doug Goodin reported that the RSSG web page is up and a great deal of thanks must be given to Jeff Olsenholler for his work on the web page. The web page is now operated by John Althausen - www.earthsensing.com/rssg/index.html

10. ***Other Business:***

- Kevin Price reported that Gary Gaile of the AAG was selecting approximately 4 authors to update the Geography in America Book.
- Kevin also reported that NSF Funding will increase by 10% next year.
- John Jensen reported that there will be a panel discussion at the annual UCGIS meeting in Park City, Utah in June. The panel will discuss future research agendas for GIS.
- Tim Foresman reported that the Remote Sensing Core Curriculum is undergoing continuous upgrade.

Submitted by: Doug Ramsey
Utah State University

The Digital Earth:Understanding Our Planet in the 21st Century

by
Al Gore
Vice President of the United States

A new wave of technological innovation is allowing us to capture, store, process and display an unprecedented amount of information about our planet and a wide variety of environmental and cultural phenomena. Much of this information will be ***georeferenced*** - that is, it will refer to some specific place on the Earth's surface.

The hard part of taking advantage of this flood of geospatial information will be making sense of it. - turning raw data into understandable information. Today, we often find that we have more information than we know what to do with. The Landsat program, designed to help us understand the global environment, is a good example. The Landsat satellite is capable of taking a complete photograph of the entire planet every two weeks, and it=s been collecting data for more than 20 years. In spite of the great need for that information, the vast majority of those images have never fired a single neuron in a single human brain. Instead, they are stored in electronic silos of data. We used to have an agricultural policy where we stored grain in Midwestern silos and let it rot while millions of people starved to death. Now we have an insatiable hunger for knowledge. Yet a great deal of data remains unused.

Part of the problem has to do with the way information is displayed. Someone once said that if we tried to describe the human brain in computer terms, it looks as if we have a low bit rate, but very high resolution. For example, researchers have long known that we have trouble remembering more than seven pieces of data in our short-term memory. That's a low bit rate. On the other hand, we can absorb billions of bits of information instantly if they are arrayed in a recognizable pattern within which each bit gains meaning in relation to all the others, e.g., a human face, or a galaxy of stars.

The tools we have most commonly used to interact with data, such as the desktop metaphor employed by the Macintosh and Windows operating systems, are not really suited to this new challenge. I believe we need a ***Digital Earth***. A multi-resolution, three-dimensional representation of the planet, into which we can embed vast quantities of geo-referenced data.

Imagine, for example, a young child going to a Digital Earth exhibit at a local museum. After donning a head-mounted display, she sees Earth as it appears from space. Using a data glove, she zooms in, using higher and higher levels of resolution, to see continents, then regions, countries, cities, and finally individual houses, trees, and other natural and man-made objects. Having found an area of the planet she is interested in exploring, she takes the equivalent of a magic carpet ride through a 3-D visualization of the terrain. Of course, terrain is only one of the many kinds of data with which she can interact. Using the systems= voice recognition capabilities, she is able to request information on land cover, distribution of plant and animal species, real-time weather, roads, political boundaries, and population. She can also visualize the environmental information that she and other students all over the world have collected as part of the GLOBE project. This information can be seamlessly fused with the digital map or terrain data. She can get more information on many of the objects she sees by using her data glove to click on a hyperlink. To prepare for her family=s vacation to Yellowstone National Park, for example, she plans the perfect hike to the geysers, bison, and bighorn sheep that she has just read about. In fact, she can follow the trail visually from start to finish before she ever leaves the museum in her hometown.

Digital Earth...Continued on page 11

Digital Earth...Continued from page 10.

She is not limited to moving through space, but can also travel through time. After taking a virtual field-trip to Paris to visit the Louvre, she moves backward in time to learn about French history, perusing digitized maps overlaid on the surface of the Digital Earth, newsreel footage, oral history, newspapers and other primary sources. She sends some of this information to her personal e-mail address to study later. The time-line, which stretches off in the distance, can be set for days, years, centuries, or even geological epochs, for those occasions when she wants to learn more about dinosaurs.

Obviously, no one organization in government, industry or academia could undertake such a project. Like the World Wide Web, it would require the grassroots efforts of hundreds of thousands of individuals, companies, university researchers, and government organizations. Although some of the data for the Digital Earth would be in the public domain, it might also become a digital marketplace for companies selling a vast array of commercial imagery and value-added information services. It could also become a *collaboratory*-- a laboratory without walls for research scientists seeking to understand the complex interaction between humanity and our environment.

Technologies needed for a Digital Earth

Although this scenario may seem like science fiction, most of the technologies and capabilities that would be required to build a Digital Earth are either here or under development. Of course, the capabilities of a Digital Earth will continue to evolve over time. What we will be able to do in 2005 will look primitive compared to the Digital Earth of the year 2020. Below are just a few of the technologies that are needed:

Computational Science: Until the advent of computers, both experimental and theoretical ways of creating knowledge have been limited. Many of the phenomena that experimental scientists would like to study are too hard to observe - they may be too small or too large, too fast or too slow, occurring in a billionth of a second or over a billion years. Pure theory, on the other hand, cannot predict the outcomes of complex natural phenomena like thunderstorms or air flows over airplanes. But with high-speed computers as a new tool, we can simulate phenomena that are impossible to observe, and simultaneously better understand data from observations. In this way, computational science allows us to overcome the limitations of both experimental and theoretical science. Modeling and simulation will give us new insights into the data that we are collecting about our planet.

Mass Storage: The Digital Earth will require storing quadrillions of bytes of information. Later this year, NASA's Mission to Planet Earth program will generate a terrabyte of information each day. Fortunately, we are continuing to make dramatic improvements in this area.

Satellite Imagery: The Administration has licensed commercial satellites systems that will provide 1-meter resolution imagery beginning in early 1998. This provides a level of accuracy sufficient for detailed maps, and that was previously only available using aerial photography. This technology, originally developed in the U.S. intelligence community, in incredibly accurate. As one company put it, "It's like having a camera capable of looking from London to Paris and knowing where each object in the picture is to within the width of a car headlight."

Broadband networks: The data needed for a digital globe will be maintained by thousands of different organizations, not in one monolithic database. That means that the servers that are participating in the Digital Earth will need to be connected by high-speed networks. Driven by the explosive growth of Internet traffic, tele-Digital
Earth...Continued from page 13.

communications carriers are already experimenting with 10 gigabit/second networks, and terrabit networking technology is one of the technical goals of the Next Generation Internet initiative. The bad news is that it will take a while before most of us have this kind of bandwidth to our home, which is why it will be necessary to have Digital Earth access points in public places like children=s museums and science museums.

Digital Earth...Continued on page 12

Digital Earth...Continued from page 11.

Interoperability: The Internet and the World Wide Web have succeeded because of the emergence of a few, simple, widely agreed upon protocols, such as the Internet protocol. The Digital Earth will also need some level of interoperability, so that geographical information generated by one kind of application software can be read by another. The GIS industry is seeking to address many of these issues through the Open GIS Consortium.

Metadata: Metadata is "data about data." For imagery or other georeferenced information to be helpful, it might be necessary to know its name, location, author or source, date, data format, resolution, etc. The Federal Geographic Data Committee is working with industry and state and local government to develop voluntary standards for metadata. Of course, further technological progress is needed to realize the full potential of the Digital Earth, especially in areas such as automatic interpretation of imagery, the fusion of data from multiple sources, and intelligent agents that could find and link information on the Web about a particular spot on the planet. But enough of the pieces are in place right now to warrant proceeding with this exciting initiative.

Potential Applications

The applications that will be possible with broad, easy to use access to global geospatial information will be limited only by our imagination. We can get a sense of the possibilities by looking at today's applications of GIS and sensor data, some of which have been driven by industry, others by leading-edge public sector users:

Conducting virtual diplomacy: To support the Bosnia peace negotiations, the Pentagon developed a virtual-reality landscape that allowed the negotiators to take a simulated aerial tour of the proposed borders. At one point in the negotiations, the Serbian President agreed to a wider corridor between Sarajevo and the Muslim enclave of Gorazde, after he saw that mountains made a narrow corridor impractical.

Fighting crime: The City of Salinas, California has reduced youth handgun violence by using GIS to detect crime patterns and gang activity. By collecting information on the distribution and frequency of criminal activities, the city has been able to quickly redeploy police resources.

Preserving biodiversity: Planning agencies in the Camp Pendelton, California region predict that population will grow from 1.1 million in 1990 to 1.6 million in 2010. This region contains over 200 plants and animals that are listed by federal or state agencies as endangered, threatened, or rare. By collecting information on terrain, soil type, annual rainfall, vegetation, land use, and ownership, scientists modeled the impact on biodiversity of different regional growth plans.

Predicting climate change: One of the significant unknowns in modeling climate change is the global rate of deforestation. By analyzing satellite imagery, researchers at the University of New Hampshire, working with colleagues in Brazil, are able to monitor changes in land cover and thus determine the rate and location of deforestation in the Amazon. This technique is now being extended to other forested areas in the world.

Increasing agricultural productivity: Farmers are already beginning to use satellite imagery and Global Positioning Systems for early detection of diseases and pests, and to target the application of pesticides, fertilizer and water to those parts of their fields that need it the most. This is known as precision farming, or "farming by the inch."

The Way Forward

We have an unparalleled opportunity to turn a flood of raw data into understandable information about our society and out planet. This data will include not only high-resolution satellite imagery of the planet, digital maps, and economic, social, and demographic information. If we are successful, it will have broad societal and

Digital Earth...Continued on page 13

Digital Earth...Continued from page 12.

Commercial benefits in areas such as education, decision-making for a sustainable future, land-use planning, agricultural, and crisis management. The Digital Earth project could allow us to respond to manmade or natural disasters - or to collaborate on the long-term environmental challenges we face.

A Digital Earth could provide a mechanism for users to navigate and search for geospatial information - and for producers to publish it. The Digital Earth would be composed of both the user interface - a browsable, 3D version of the planet available at various levels of resolution, a rapidly growing universe of networked geospatial information, and the mechanisms for integrating and displaying information from multiple sources.

A comparison with the World Wide Web is constructive. [In fact, it might build on several key Web and Internet standards.] Like the Web, the Digital Earth would organically evolve over time, as technology improves and the information available expands. Rather than being maintained by a single organization, it would be composed of both publically available information and commercial products and services from thousands of different organizations. Just as interoperability was the key for the Web, the ability to discover and display data contained in different formats would be essential.

I believe that the way to spark the development of a Digital Earth is to sponsor a testbed, with participation from government, industry, and academia. This testbed would focus on a few applications, such as education and the environment, as well as the tough technical issues associated with interoperability, and policy issues such as privacy. As prototypes became available, it would also be possible to interact with the Digital Earth in multiple places around the country with access to high-speed networks, and get a more limited level of access over the Internet.

Clearly, the Digital Earth will not happen overnight. In the first stage, we should focus on integrating the data from multiple sources that we already have. We should also connect our leading children's museums and science museums to high-speed networks such as the Next Generation Internet so that children can explore our planet. University researchers would be encouraged to partner with local schools and museums to enrich the Digital Earth project - possibly by concentrating on local geospatial information. Next, we should endeavor to develop a digital map of the world at 1 meter resolution. In the long run, we should seek to put the full range of data about our planet and our history at our fingertips.

In the months ahead, I intend to challenge experts in government, industry, academia, and non-profit organizations to help develop a strategy for realizing this vision. Working together, we can help solve many of the most pressing problems facing our society, inspiring our children to learn more about the world around them, and accelerate the growth of a multi-billion dollar industry.

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