Earth System Science Education

Extending a Network of Universities
in support of
Space-based Solutions
for Disaster Management

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Outline

• Universities Space Research Association
• Earth System Science
• ESSE 21 education program and contributions
• Connections to UN-SPIDER
• Next steps
The Universities Space Research Association (USRA) is a non-profit **consortium of 101 universities** offering graduate programs in space-related science and technology chartered under the auspices of the US National Academy of Science in 1969 to serve as …

“… an entity in and by means of which universities and other research institutions may cooperate with one another, with the government of the United States, and with other organizations toward the development of knowledge associated with space science and technology.”
• Broad and deep association with NASA programs and field centers:
  - Goddard Space Flight Center (astrophysics)
  - Marshall Space Flight Center (astronomy, Earth science)
  - Ames Research Center (SOFIA, computer science)
  - Johnson Space Center (life science, planetary science)
  - Glenn Research Center (exploration science)

• Collective interdisciplinary space science and technology expertise of 101 member universities

• ~400 personnel, ~$90M annual budget, headquarters in Columbia, MD
Programs and Institutes

- Astronomy/Space Science
- Lunar and Planetary Institute
- Space Nuclear Research
- Space Life Science
- Advanced Computer Science
- Exploration science / microgravity
- Small university-class satellites (STEDI)
- Stratospheric Observatory for IR Astronomy (SOFIA)
- Earth System Science
- Education

USRA is seeking to broaden international membership and programs … www.usra.edu
The Earth System

Air

Water

Land

Life
The Earth System

Air

Water

Land

Life
What is Earth System Science?

- **Earth system science provides a physical basis for understanding the world in which we live and upon which humankind seeks to achieve sustainability**

- **Earth system science embraces chemistry, physics, biology, mathematics and applied sciences in transcending disciplinary boundaries to treat the Earth as an integrated system**

- **Earth system science has been stimulated by the increasing role of human activity in global change and the capabilities of global monitoring of the Earth from space**

- **Earth system science serves as a framework for applied studies e.g. remote sensing, GIS, disaster management, etc.**

See also [http://www.usra.edu/esse/summer98/oneminuteess.html](http://www.usra.edu/esse/summer98/oneminuteess.html) and [http://www.usra.edu/esse/essonline/whatis.html](http://www.usra.edu/esse/essonline/whatis.html)
Earth System Science Builds on the Disciplines
Earth System Science: Connecting the Global to the Local
Earth System Science is a way to attract **student interest:**

**Accessible** - Students everywhere and anywhere can learn about some part of the Earth system …

**Relevant** - Earth system processes make the news every day and affect people NOW

**Compelling** - People need to know more about the Earth system to make informed decisions (and manage disasters …)
So …

- Earth system science offers a **valuable interdisciplinary framework** for understanding the complex interactions within and among natural and man-made systems.

- **Disaster cycle understanding and management is an example of applied Earth system science.**

- Earth system science curricula, including remote sensing and geoinformatics, can **broaden access to disaster management studies** to a wide range of students, non-majors as well as majors.
What is ESSE 21?

Earth System Science Education for the 21st Century

A collaborative undergraduate/graduate Earth system science education program sponsored by NASA and led by USRA

Emphasizes the understanding of Earth as a system of interrelated air, water, land, life and social processes

Offered colleges and universities small grants to develop Earth system science courses, curricula, learning materials and degree programs

Engaged a collaborative community of educators and scientists as partners in jointly developing and sharing courses and learning resources focused on Earth system science research and application
Earth System Science Education for the 21st Century

From 1992 - 2007 ESSE supported the development of over 130 undergraduate and graduate courses (survey and senior level) in Earth system science that have reached over 100,000 students.

ESSE partners received two years of support for a graduate assistant, teaching materials, or faculty release time to develop courses.

The ESSE Program organized an annual workshop, meeting and field trip for participants to share learning resources, best practices, lessons learned, and receive updates on the status of NASA Earth remote sensing programs and data sets.

ESSE faculty and student participants received travel support to attend ESSE meetings and visit partner institutions, resulting in richer collaborations and partnerships.

ESSE has resulted in the development of a coherent community of partners willing to share Earth system science learning resources and lessons learned. Almost all courses continue today.

>> The ESSE model can be extended globally to applied Earth system science themes e.g. a university network for space-based disaster management education collaborating with regional centers <<
ESSE Participants
ESSE 21 as an Example of Capacity Building

- The long-lasting contributions of ESSE and ESSE 21 to ESS education as a whole include:
  
  - Ongoing ESS courses and programs, and engaged faculty at 57 colleges and universities - over 100,000 students have taken ESSE courses since 1992
  - Design Guide for Undergraduate ESS Education (http://essedesignguide.org)
  - ESS Education Evaluation Toolkit (http://essedesignguide.org/toolkit/)
  - ESS Education Personal Vignettes (http://esse21.usra.edu/designguide/finalvignettes/)
  - Collection of 130+ ESS Course Syllabi (http://esse21.usra.edu/syllabi.html)
  - ESSE 21 portal linking the work of 63 ESSE/ESSE 21 partners (http://esse21.usra.edu)
  - Special issue of the Journal of Geoscience Education dedicated to Earth System Science Education (http://esse21.usra.edu/designguide/JGEabstractsandlinks.htm)
  - ESS in a Nutshell (http://serc.carleton.edu/introgeo/earthsystem/nutshell/index.html)
  - ESSE list serve with ~800 members (http://lists.usra.edu/mailman/listinfo/esse-l)
  - Host of Earth Picture of the Day with > 130,000 unique visitors each month (http://epod.usra.edu)
  - A community spirit of cooperation and sharing, a coherent network of ESS colleagues willing to work together and share their experience and wisdom
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Special Issue:

The Symphony of the Spheres - Recent Advances in Earth System Science Education

Guest Editors:

Eugene Rankey, Univ of Miami
Martin Ruzek, USRA

http://esse21.usra.edu/jgespecialissue  or
http://www.nagt.org/nagt/jge/abstracts/may06.html
Design Guide for Undergraduate Earth System Science Education

A resource for teaching Earth system science

Scientific Framework
Teaching, Learning and Evaluation
Effecting Institutional Changes
Partnerships and Community Building
Pathways to STEM Education
Diversity in the Workforce
Exemplary Learning Modules
Data, Tools and Models
Future Directions and Challenges

The Design Guide is a web-based resource for faculty from multiple disciplines who wish to develop Earth system science courses or programs in their own institutional settings.

This guide represents the lessons learned from 15 years of NASA-supported Earth system science education programs at 57 universities and colleges throughout the United States.

http://www.essedesignguide.org
Increasing the Pool of ESS-trained Minorities

Freddy Wilson, Morgan State University, Baltimore, MD

Few minorities have been trained in the geosciences, especially in the areas of GIS and remote sensing.

The module builds on the lat and methodologies for an analysis as demonstrated by the field, i.e., FAD's GLC/N of the ISGP, USGS and others. It is based on the "how" of detection and image processing to students to look at the "how..." driving forces or human di changes or global change (HDC) in real places.

We ask students to put themselves in the shoes of an explorer and ask how these analyses look like as well as protecting the most important biodiversity in the world. Furthermore, it adds the elements of a refined data model, which trains the students in the areas of GIS and remote sensing.

The data have shown that the minorities trained in the areas of GIS and remote sensing from attending conferences and meetings have enhanced the experience and the think it the development of geospatial analysis and the development of geospatial analysis and self-learning. The students are still learning about volcanoes and geology.

Madame Pele vs. the "Western" Volcano?

Barbara Gibson, University of Hawaii at Manoa

Linking Earth system concepts to resource management using traditional knowledge

Have you ever faced the challenge of linking Western science with the sacred concepts of an indigenous culture? Many of us teaching introductory college science courses at universities in the U.S. take it for granted that our students have been exposed to certain basic scientific concepts and that they accept them as part of their everyday beliefs. But during my first year of teaching at the University of Hawaii at Hilo, I realized that this assumption on my part was far from being true when it came to teaching indigenous peoples, specifically those of Native Hawaiian or Pacific Islander ancestry.

Native Hawaiians have a long, rich history. It is currently believed that Polynesians first settled the eight main Hawaiian Islands in the 3rd century CE. Religion or sacred beliefs played an important role in keeping the people together.

One day in class, after discussing volcanism and having an explanation of how Pele’s tears and hairs are created from a volcanic standpoint, a Native Hawaiian student raised her hand and asked me if, in fact, Pele’s tears and hairs were not created by the goddess Pele. This question left me momentarily speechless. How to relate Madame Pele to the Hawaiian Goddess, to the “Western” scientific explanation of a volcanic process? No one could answer these questions...

Univ of N Colorado

Mike Tabor

ESCG 105

Global Change: A Data Driven Approach to Learning

Univ of Hawaii

Barbara Gibson

GEOS 415

Modeling and Visualizing the Earth System

GEOS 900

Modeling and Visualizing the Earth System

Univ of Illinois

Don Wuebbles

New Program

Earth Systems, Environment and Society

Univ of Miami

Gene Rankov

GSC 556

Complexity in Coastal Systems

ENVS 306

Advanced Composition, Science Writing

ENVS 110

Understanding Earth

ENVS 250

Field Methods in Environmental Geosciences

GEOS 444/544

Geocomputation for Earth and Environmental Sciences

GOED/ENVS 497

Senior Practicum

Morgan State

Fred Wilson

CEGR 498.001

Fundamentals of GIS

CEGR 486.002

Fundamentals of Remote Sensing

CEGR 740

Special Topics in GIS

Univ of Alaska

Anupama Prakash

GEOS 378

Introduction to Geoinformatics

GEOS 422

Introduction to Remote Sensing

GEOS 695

Introduction to Remote Sensing

Clark Atlanta

Randal Mandock

PHYS 104

Introduction to Earth System Science

Jackson State

Ezat Heydari

SCI 205

Earth and Space Science

SCI 215

Global Change: Introduction to Earth System Science

SCI 210

Earth History
A university network for UN-SPIDER Capacity Building:

• Shares common data, case studies, learning resources
• Extends partnerships between universities and regional disaster management centers
• Builds capacity now and in the future
• Trains future decision makers as well as technical people
• Teaches the teachers - leverages resources
• Provides support to regional application centers
• Promotes integrated approach emphasizing space technologies - best practices
• Results in shared courses (eg Decision Support 101)
• Offers international opportunities for student interns

A university network must complement existing regional training centers and programs
Earth System Science Education - Asia

A proposed interdisciplinary collaborative network of Asian and American universities organized to better understand the Earth system through international and inter-institutional partnerships that share knowledge, learning resources and educational opportunities.
Need:

• Asian economies are developing rapidly, placing increased pressure on Earth’s natural resources.

• Planning for the future requires a solid scientific understanding of the Earth system - air, water, land, life and social processes.

• Citizens worldwide need to be more aware of the Earth system to make informed decisions that lead to a sustainable future.

• The disaster management cycle is an example of applied Earth system science.
Approach:

• Foster a global network of educators and researchers dedicated to sharing their understanding of Earth system science (ESS) with students

• Offer opportunities for Asian colleges and universities to work together and with international colleagues to form interdisciplinary partnerships that train Earth-aware scientists and citizens.

• **Emphasize the disaster management cycle** as a part of Earth system science courses and learning opportunities
Objectives:

• Extend and connect an active community of ESS researchers and educators in Asia

• Provide opportunity and incentive for this community to meet and work together e.g. under the theme of ESS applied to disaster management

• Share ESS learning resources, pedagogies, learning technologies and data

• Contribute to a common world-view of equitable sustainability through ESS education

• Contribute to applied ESS communities of practice e.g. the disaster management cycle
Benefits:

• Growth of inter-institutional, interdisciplinary and international ESS partnerships in coordination with existing regional operational and education organizations

• A greater awareness, appreciation and understanding of ESS principles by more people, contributing to sound management and decision making

• Local capacity building and awareness raising for featured themes such as disaster management and sustainable development
Summary

• **Earth system science offers a scientific framework** for better understanding the disaster management cycle
• ESS education is a powerful **tool for building capacity and increasing awareness** of space-based approaches to disaster management
• University networks and partnerships can **share common learning resources** and deliver content “the last mile”
• Universities educate the **next generation of decision makers** and teachers, as well as the scientists and engineers
• The NASA/USRA **ESSE 21 experience offers lessons learned** in capacity building, awareness raising, etc. (UN-SPIDER activities 3, 4, 11 …)
• USRA seeks to **develop and extend international university partnerships** to share applied Earth system science and education resources
• USRA is currently working to get to know the international Earth observing and education community, identify contributions we can make, find partners, identify potential private, corporate and national government sponsors, and prepare joint proposals …

Thank you for your attention!