22nd National NSF EPSCoR Conference

Tim Killeen, AD GEO
Coeur d’Alene, Idaho
October 25, 2011
Sustainability Issues Remain at the Forefront
Administration Priorities

“We need to out-innovate, out-educate, and out-build the rest of the world.” President Barack Obama, State of the Union Address, Jan. ’11

- Protecting our nation from the serious economic and strategic risks associated with our reliance on foreign oil and the destabilizing effects of a changing climate
- Advancing energy and climate security via promoting economic recovery efforts, accelerating job creation, and driving clean energy manufacturing
FY12 US Priorities
Office of Science and Technology Policy and Office of Management and Budget

- Moving toward a clean energy future to reduce dependence on energy imports while curbing greenhouse gas emissions
- Understanding, adapting to, and mitigating the impacts of global climate change
- Managing competing demands on land, freshwater, and oceans for production of food, fiber, biofuels, and ecosystem services based on sustainability and biodiversity
Director’s Priorities: OneNSF

- **Innovation Agency**
  - Global leader in science and engineering innovation and research into education
  - Important role from discovery to marketplace

- **Strategic Agency**
  - Integrated, systems-level thinking
  - Responsive to societal needs
  - Catalyst for breakthroughs

- **Model Agency**
  - Proactively share best practices across agency and globally
  - Experiment with latest technologies
  - Use new technologies to increase participation
  - Accountable and efficient
Vision: a nation that capitalizes on new concepts in science and engineering and provides global leadership in advancing research and education.

NSF Core Values

- Visionary
- Dedicated to Excellence
- Learning and Growing
- Broadly Inclusive
- Accountable
FY 12 Goal: Catalyze Breakthroughs for National Priorities

- Science, Engineering, and Education for Sustainability (SEES)
- Clean Energy
- Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21)
- National Nanotechnology Signature Initiatives
- National Robotics Initiative (NRI)
Energy consumption growing
... to unprecedented demands
Land Use changes now a dominant factor
Food for a Week, Displaced Family, Chad

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The Natomo Family
© 2005 PETER MENZEL PHOTOGRAPHY

Food for a Week, German Family

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The Ukita Family

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World Investment in Clean Technologies
Mauna Loa Record

CO₂ Concentration (ppm)

Year

Expected rise if 57% of fossil-fuel emissions remained airborne

http://scrippsco2.ucsd.edu/program_history/keeling_curve_lessons_3.html
Breaking records

The ratio of record daily highs to record daily lows observed at about 1,800 weather stations in the 48 contiguous United States from January 1950 through September 2009. Meehl et al. 2009
Climate Modeling
Palmer Drought Severity Index

A Projection of Increasing Drought Risk in the 21st Century

Aiguo Dai, NCAR
Changes that can affect us

The Flood Control Act of 1928 put flood control on par with other major projects of its time with the largest public works appropriation ever.
Both existing and new technologies needed, both with major research opportunities

Note: The curve presents an estimate of the maximum potential of all technical GHG abatement measures below €60 per tCO₂e if each lever was pursued aggressively. It is not a forecast of what role different abatement measures and technologies will play.

Source: Global GHG Abatement Cost Curve v2.0
The Inaccessible “Sustainable Development” Quadrant

Moran et al., Ecological Economics, 64, 470-474, 2008
Anthropocene
Stage 2
(1945 - 2010/2020)


Note the start of the ‘Great Acceleration’ around 1950, when many activities began or accelerated sharply.

From Steffen et al. 2004
The Great Turning?
Lord Nicolas Stern

*Plenary, Climate Change Congress, Copenhagen, March, 2009*

“Business-as-usual is dead”

“This is an externality like none other”

“Risks, scales and uncertainties are enormous”

“. . .a big probability of a devastating outcome”

“We have to look at non-marginal changes in economics”
Era of Observation: Arctic Sea Ice
Era of Observation: Earth
Era of Observation: Oceans
Era of Observation: Ecosystems
Era of Observation: Water
Era of Observation: Satellites
NCAR-Wyoming Supercomputer Center
Opening, June 2012
>1 Petaflop, 150 petabyte. LEED Gold

Era of Simulation
Cyber-infrastructure: *EarthCube*

Goal: to transform the conduct of research in Earths System Sciences by supporting community-based cyberinfrastructure to integrate data and information for knowledge management.
“When we try to pick out anything by itself, we find it hitched to everything else in the universe.”

John Muir

“My First Summer in the Sierra” 1911
Science, Engineering and Education for Sustainability (SEES) – Overview

- Established FY10, multi-year investment
- Involves all NSF research and education Directorates and offices
- Initial focus on intersection of climate and environment, including specific attention to incorporating the human sciences
- Subsequent foci on clean energy and human resiliency
- Systems-based approach to understanding, predicting, and reacting to changes in the linked natural, social, and built environment.
Guiding Principle
“If you want to go fast, go alone, if you want to go far, go together”
*African Proverb*
FY 2010 Activities

✧ Ocean Acidification (NSF 10-530)
✧ Climate Change Education (NSF 10-542)
✧ Decadal and Regional Climate Prediction using Earth System Models (EaSM) (NSF 10-554)
✧ Dimensions of Biodiversity (NSF 11-518)
✧ Water Sustainability and Climate (NSF 11-551)
✧ Statistics for all five competitions
  ✧ 16% overall success rate
  ✧ 719 projects submitted, 113 awards, funding amount $99M*
  ✧ USDA and DOE funds of $19M additional for EaSM competition
SEES FY 2011 and 2012 Activities

- Dear Colleague Letter \( (\text{NSF 11-022}) \)
- Research Coordination Networks–SEES track \( (\text{NSF 11-531}) \)
- SEES submission encouraged in Dynamics of Coupled Natural & Human Systems \( (\text{NSF 10-612}) \)
- **New:** Sustainability Research Networks \( (\text{NSF 11-574}) \)
- **New:** SEES Fellows \( (\text{NSF 11-575}) \)
- **New:** Sustainable Energy Pathways \( (\text{NSF 11-590}) \)
- Exclusive SEES focus in Partnerships for International Research and Education (PIRE) solicitation \( (\text{NSF 11-564}) \)
- Climate-related competitions continue
- SEES Summit planned for March 2012
Science, Engineering, and Education for Sustainability (SEES) – Current Priorities

- Generate discoveries and build capacity to achieve an environmentally and economically sustainable future

- FY 2012 priorities:
  - Advance a clean energy future
  - Nurture the emerging SEES workforce
  - Expand research, education, and knowledge dissemination
  - Engage with global partners
Research Coordination Networks

- **SEES-RCN track (NSF 11-531)**
- To advance sustainability science, engineering, and education as an integrative systems approach
  - Interdisciplinary teams
  - Encourage diverse stakeholder participation
  - Up to 5 years at $150k per year
  - Made 11 awards (~$8M total)
    - Water Diplomacy
    - Urban Sustainability
    - Women – Developing Countries
- **Next deadline: February 3rd, 2012**
Sustainable Energy Pathways (NSF 11-590)

- Sustainability - from Resource to Realization
- Interdisciplinary and System Approach
- Addresses Science and Engineering Challenges, Informed by the Environmental, Societal, and Economic Aspects
- Deadline: February 1, 2012
Create the necessary workforce to enable discoveries leading to environmental, energy, and societal sustainability.

- All areas of SEES
- Early career researchers (PhD within last 4 years)
- Proposals must include: interdisciplinary research, partnership, professional development
- Grant to host institution rather than to individual fellow
- First proposal deadline: **December 5, 2011**
Proposed Future SEES Focus Areas

- Chemistry, Materials, Engineering
  - Renewable, non-toxic materials, process improvements
- Coastal and Arctic Regions
  - Vulnerability, resilience, cultural impacts
- Hazards and Disaster
  - Science, engineering, risk assessment, decision-making
- Information Science and Engineering
  - Energy consumption, clean computing issues
Hazards-related science, engineering, technology, and outreach

NSF planning to initiate a new program -- Creating a More Disaster-Resilient America (CaMRA)

- Catalyze basic research efforts in hazard-related science to improve forecasting and prediction of natural and man-made hazardous events
A Complex Interconnected Earth System

Past and present climate variability and change

Projections of future change

Natural and human forces of change

Impacts, vulnerability, and climate response science
International collaboration essential for Sustainability Challenges

- Challenges are greater than U.S. can address alone
- International assessments are key component of research strategy
- Enhances and complements strengths, interests and needs of U.S.
- Leverage existing and future international scientific capabilities and intellectual resources
- Provides mechanism to obtain new “global” data sets and access to critical research sites
International Leadership

- NSF Partnerships for International Research and Education (PIRE)
- International Council of Scientific Union (ICSU) Grand Challenges:
  - Forecasting
  - Observations
  - Thresholds - abrupt change
  - Responses - institutional, economic, behavioral changes
  - Innovation

- Needs to meet grand challenges include:
  - Enhanced capacity to undertake interdisciplinary and transdisciplinary research
  - Development of a new generation of scholars taking a systems approach to problems of global sustainability

A New 10-Year “Earth System Sustainability Initiative” to be rolled out at the International RIO+20 Conference next Summer
A Dose of Reality for Us

- 6th in global innovation-based competitiveness
- 11th among industrialized nations in the fraction of 25- to 34-year-olds who have graduated from high school
- 16th in college completion rate
- 22nd in broadband Internet access
- 24th in life expectancy at birth
- 27th among developed nations in the proportion of college students receiving degrees in science or engineering
- 29th in the number of mobile phones per 100 people
- 48th in quality of K-12 math and science education

Charles Vest, NAE
Participation of Women in Detailed Geoscience Occupations (2006)

- Oceanographers: 28%
- Environmental engineers: 23%
- Geologists, including earth scientists: 21%
- Natural sciences managers: 19%
- Atmospheric and space scientists: 15%
- Environmental scientists: 13%
- Engineering managers: 9%
- Petroleum engineers: 6%
- Mining and geological engineers: 2%

Source: AGI Geoscience Workforce Program; data derived from NSF's SESTAT2006 Restricted Access Database. SESTAT is the Scientists and Engineers Statistical Data System. The use of NSF data does not imply NSF endorsement of the research, research methods, or conclusions contained in this report.
Grand Challenges in Education:
Driving Questions for NSF

- How does the nation train and develop its Science and Engineering workforce?
- How should we teach and learn science in the 21st Century?
- How does the nation create a science literate citizenry?
- How can we broaden and deepen participation in science and engineering?
- How does NSF most effectively deploy its resources in STEM education and learning?
Expeditions in Education – E^2
Engage, Empower, Energize

- Partnerships Between E-HR and Research Directorates
- Research into learning; sustainability, cyber-learning, undergraduate learning, etc.

Goals

- **Connect:** wide range of learners in a wide variety of settings via technology – cyber-infrastructure, facilities, data sets, research activities
- **Access:** Anywhere, anytime, anybody (AAA) – real time data, widely publicized and available
- **Enrich:** Education+Engagement+Data
- **Content:** Currency and Breadth – relevance and timeliness from the individual to global level
Expeditions in Education – E^2
Engage, Empower, Energize
EPSCoR has a Critical Leading Role to play in all of this!
“New frontiers of the mind are before us, and if they are pioneered with the same vision, boldness, and drive with which we have waged this war we can create a fuller and more fruitful employment and a fuller and more fruitful life”

President Franklin D. Roosevelt to Vannevar Bush, November 17, 1944
Thanks

Irrigation using pumped groundwater plays a crucial role in sustaining agricultural production.
Credit: Mike Mahaffie

Olenellus getzi with preserved antennae
Credit: B.S. Lieberman, University of Kansas

The gorgonian coral, Pseudopterogorgia elisabethae, is found throughout the Caribbean and harvested for pseudopyrosins.
Credit: Howard Lasker

Shishaldin Crater, Aleutian Islands. Volcano instrumentation under Earth Scope program.
Credit: M. Jackson, UNAVCO

Coring Operations on the D/V JOIDES Resolution
Credit: The Integrated Ocean Drilling Program, Texas A&M University

Photomosaic of hydrothermal chimney at Lost City, Mid-Atlantic Ridge
Credit: Deb Kelley, Univ of Washington