



Science, Engineering and Education for Sustainability (SEES)

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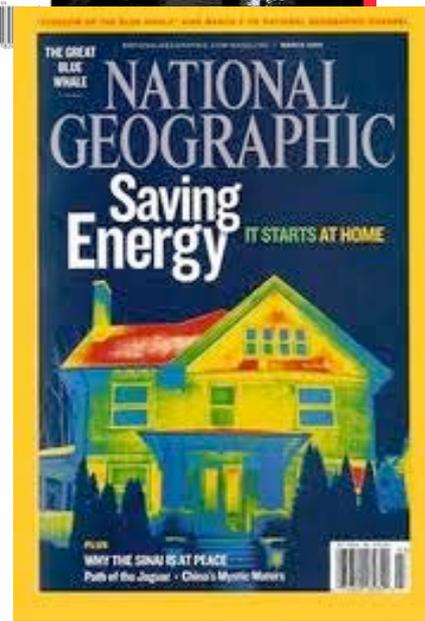
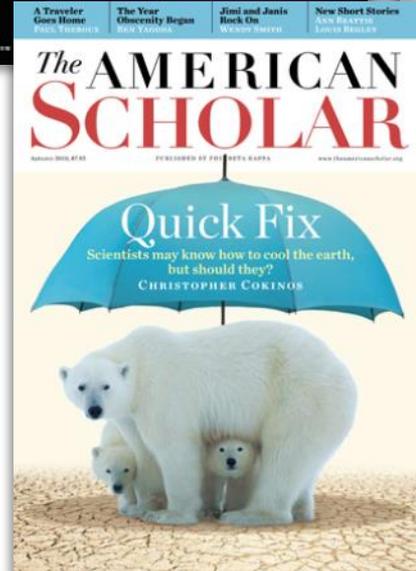
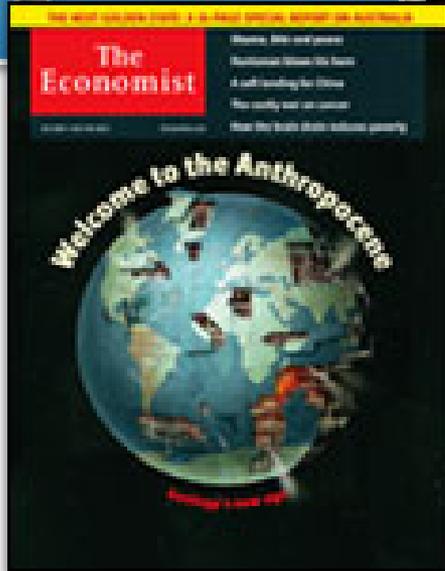
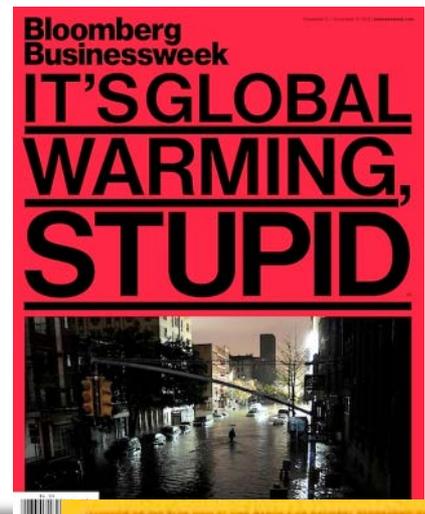
NSF Directorate for Geosciences

**NSF Grants Conference
Arlington, October 2014**





Our most pressing contemporary problem





Complex interactions at multiple scales





Meeting Sustainability Challenges...



...requires the simultaneous consideration of social, economic, and environmental systems and the long-term viability of those systems.





SEES: Science, Engineering and Education for Sustainability

Mission: Advance science, engineering, and education to inform the societal actions needed for environmental and economic sustainability and sustainable human well-being

- Established in Fiscal Year 2010
- Portfolio of existing and new programs
- All NSF Directorates and offices involved
- Partnerships (e.g. other agencies, CNRS, Belmont Forum)





SEES Goals



1. Interdisciplinary research and education...towards global sustainability
2. Link projects and **partners** and add **new participants** to sustainability endeavors
3. Develop the **workforce**...to address...sustainability



SEES Characteristics



Systems Thinking

- Holistic approaches that link human, built and natural systems, and reach across disciplines

Partnerships & Networks

- Connect intellectually and spatially disparate communities, institutions and organizations

Workforce & Education

- Development and education of new researchers and students on critical aspects and issues of sustainability



A Brief History of SEES 2010

Five new initiatives:

- **Dimensions of Biodiversity**
- **Water Sustainability & Climate (WSC)**
- **Decadal Regional Climate Prediction using Earth System Models (EaSM)**
- **Ocean Acidification**
- **Climate Change Education**

SEES tracks for two existing programs:

Dynamics of Coupled Natural Systems (CNH)

Research Coordination Networks (RCN)





A Brief History of SEES 2011-13

Added new initiatives and tracks (*some one-time):

- **SEES Fellows**
- **Sustainability Research Networks (SRN)**
- **Sustainable Energy Pathways (SEP)***
- **SEES Focus for Partnerships for International Research & Education (PIRE)***
- **SEES STTR (Small Business Technology Transfer Program)***
- **Arctic SEES**
- **CyberSEES**





SEES Financial Commitments

- **FY 2010: \$70 million**
- **FY 2011: \$93 million**
- **FY 2012: \$170 million**
- **FY 2013: \$184 million**
- **FY 2014: \$153 million (estimate)**
- **FY 2015: \$139 million (budget request)**

**Grand total 2010-2014: ~5,800 projects reviewed
and ~700 awards made (including co-funds)**





SEES in FY 15

CNH (Dynamics of Coupled Natural and Human Systems)
Coastal SEES
CyberSEES
Dimensions of Biodiversity
Earth Systems Modeling (EaSM)
SusChEM (Sustainable Chemistry, Engineering and Materials)
ArcSEES (Arctic) Belmont Forum call. Closed 07/31/14, Notifications in 01/15
Hazards Letter of Intent due 09/26/14, Full proposals due 12/03/14
Sustainability Research Networks – Urban Focus Closed 04/29/14
Ocean Acidification
SEES Fellows
Water, Sustainability and Climate (WSC)

Solicitation/DCL in FY15
Reviewing proposals from FY14
Ended





SEES – Future Plans

Evaluation: Program-wide evaluation began April 2014

Other activities: PI Meetings, workshops; presentations & other outreach

Transition: Planning for long-term support for sustainability research in NSF after 2017





Coastal SEES

Coastal SEES projects are expected to lead to **generalizable theoretical advances** in natural sciences and engineering and to **integrate key aspects of human processes** to address issues of coastal sustainability.

- 3rd and final proposal deadline: October 2, 2015
- \$800,000 - \$2 million, 3-5 year projects
- Typically collaborative, multi-institutional projects



Alexandra Fries, IAN Image Library



Tim Carruthers, IAN Image Library



Don Merritt, IAN Image Library



Coastal SEES Collaborative Research:

A cross-site comparison of salt marsh persistence in response to sea-level rise and feedbacks from social adaptations



Karen McGlathery and colleagues

- University of Virginia
- Marine Biological Laboratory
- University of Georgia
- Virginia Institute of Marine Sciences
- Clark University

14 ★ Coastal LTER study sites

Marsh vulnerability to current and projected sea-level rise



Jane Thomas, IAN Image Library

Marsh protection actions

- Local stakeholder opinions
- Economic costs and benefits
- Sustainability value



Coastal SEES Collaborative Research:

Developing High Performance Green Infrastructure Systems to Sustain Coastal Cities

Patricia Culligan and colleagues
Columbia University, Drexel University, Barnard College

Green Infrastructure Performance and Design

Partnerships

Geosyntec
Industry Partner

Bronx River Alliance
Community Awareness

Green Streets



Green Roofs



Bioswales



Policy and Legal Framework

Risk Perception and Decision Making

Adoption of Green Infrastructure





Dimensions of Biodiversity



A 10 - year campaign to fill in *major gaps* in our knowledge of the diversity of life on Earth





The pace of biodiversity discovery is being challenged by global environmental change and the permanent loss of biodiversity

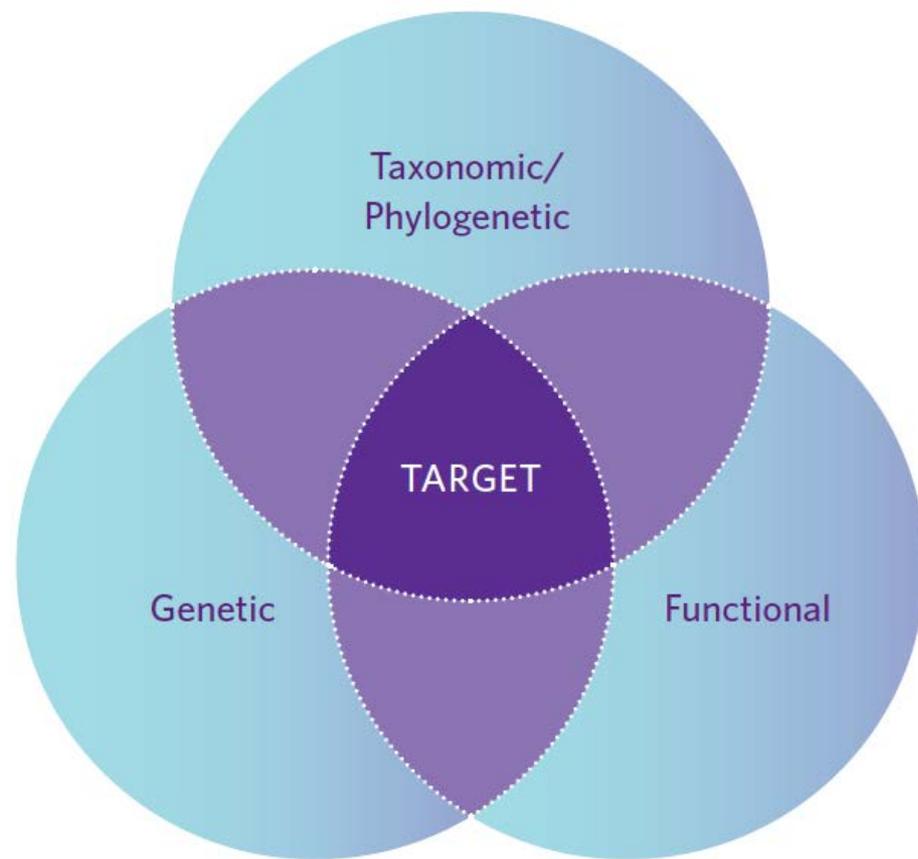




Dimensions of Biodiversity

Purpose:

- Integrative approaches
- Innovative concepts
- Rapid advances





Dimensions of Biodiversity

STREAMS OF ACTIVITY

2020 GOALS

Research

An integrated understanding of the key but unknown dimensions of biodiversity on earth

Cyberinfrastructure

Informatics and infrastructure that support accessible, interoperable information capability for dimensions of biodiversity

Collections

Digitization of collections and enhanced physical infrastructure to link to cyberinfrastructure and leverage the enormous investments of the past

Workforce

A diverse, interdisciplinary, globally-engaged, scientific workforce capable of transforming and communicating our understanding of biodiversity on Earth

Synthesis

Scientific analyses and syntheses that generate and disseminate useful information for scientists, educators and decision makers

APPROACH

Planning & partnering

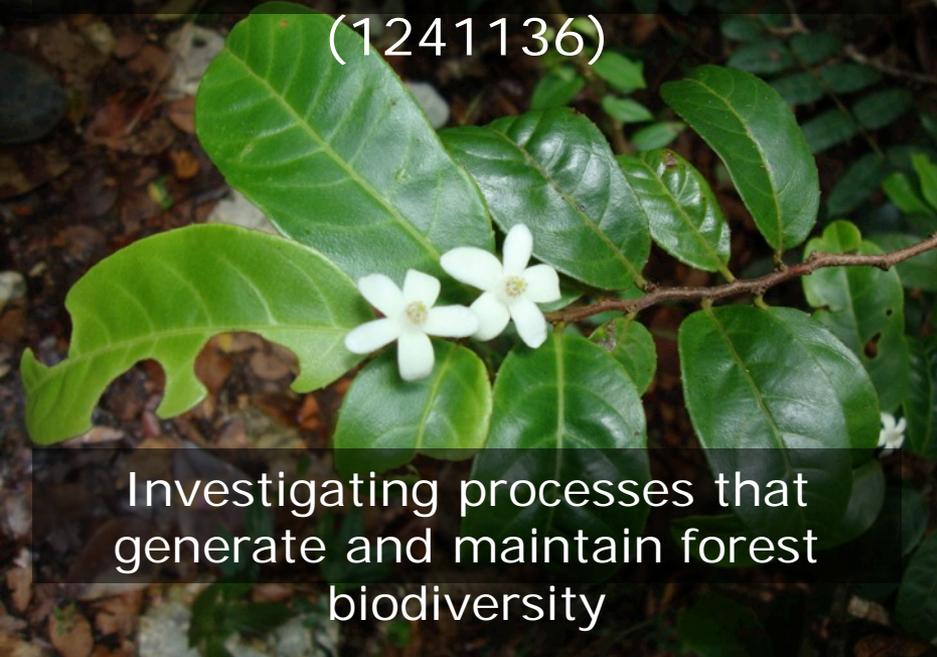
Base lining & synchronizing

Assessing progress

Aligning investments with emerging priorities

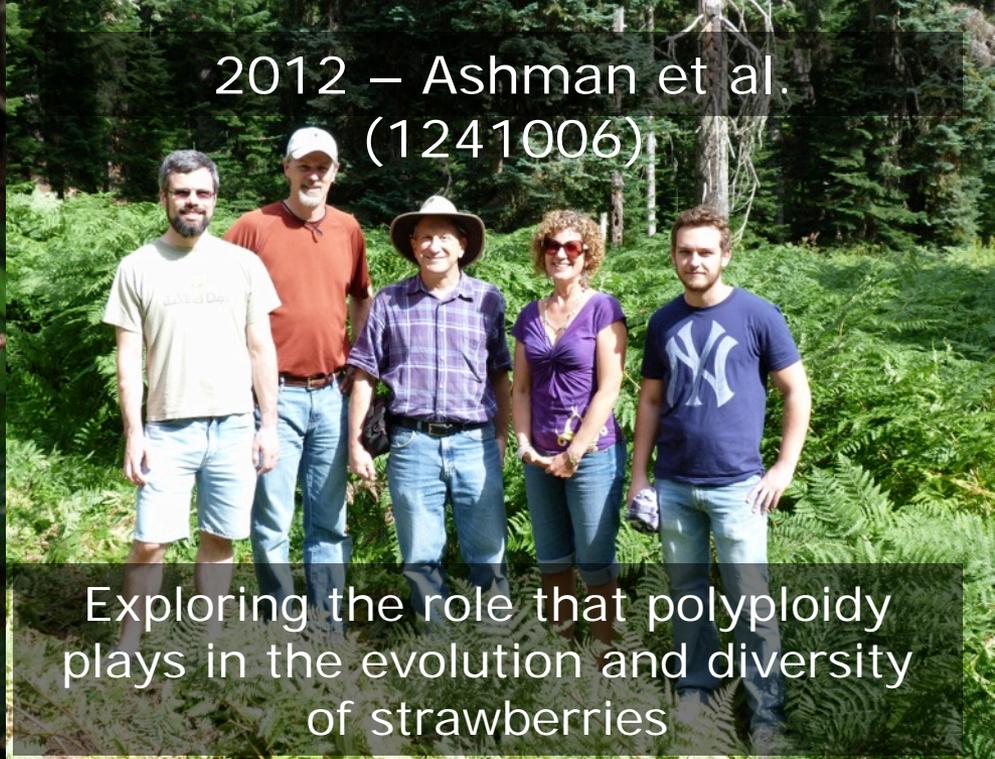


2012 – Swenson et al.
(1241136)



Investigating processes that generate and maintain forest biodiversity

2012 – Ashman et al.
(1241006)



Exploring the role that polyploidy plays in the evolution and diversity of strawberries



2013 - Jiang et al. (1342754)

Understanding biodiversity in a highly fragmented environment, using woody plants and arthropods in the Thousand-Islands Lake of China



Dimensions of Biodiversity

- Funded 67 research awards to date
- NSF invested >\$125,000,000
- Enabled collaborations and research in over 37 countries
- Hundreds of articles published
 - Nature, Science, Ecology, Ecology & Evolution, & PNAS*
- >1000 students have been trained

Looking ahead towards the next five years, we are eager to achieve an integrated understanding of the key but unknown aspects of biodiversity on Earth





Cyber Innovation for Sustainability Science and Engineering (CyberSEES)

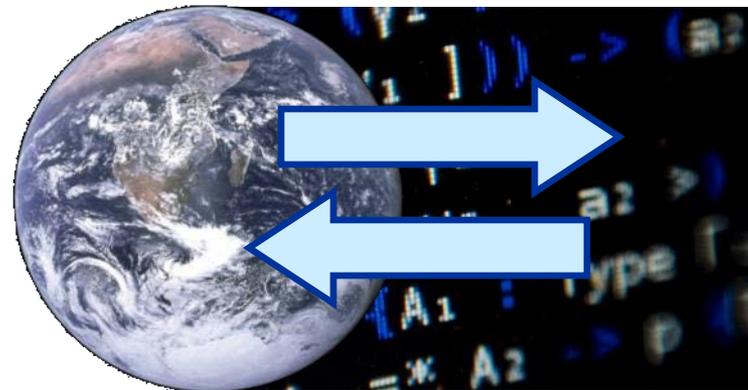
to advance **interdisciplinary research** in which

NSF 14-531

the **science and engineering of sustainability** are enabled by **new advances in computing,**

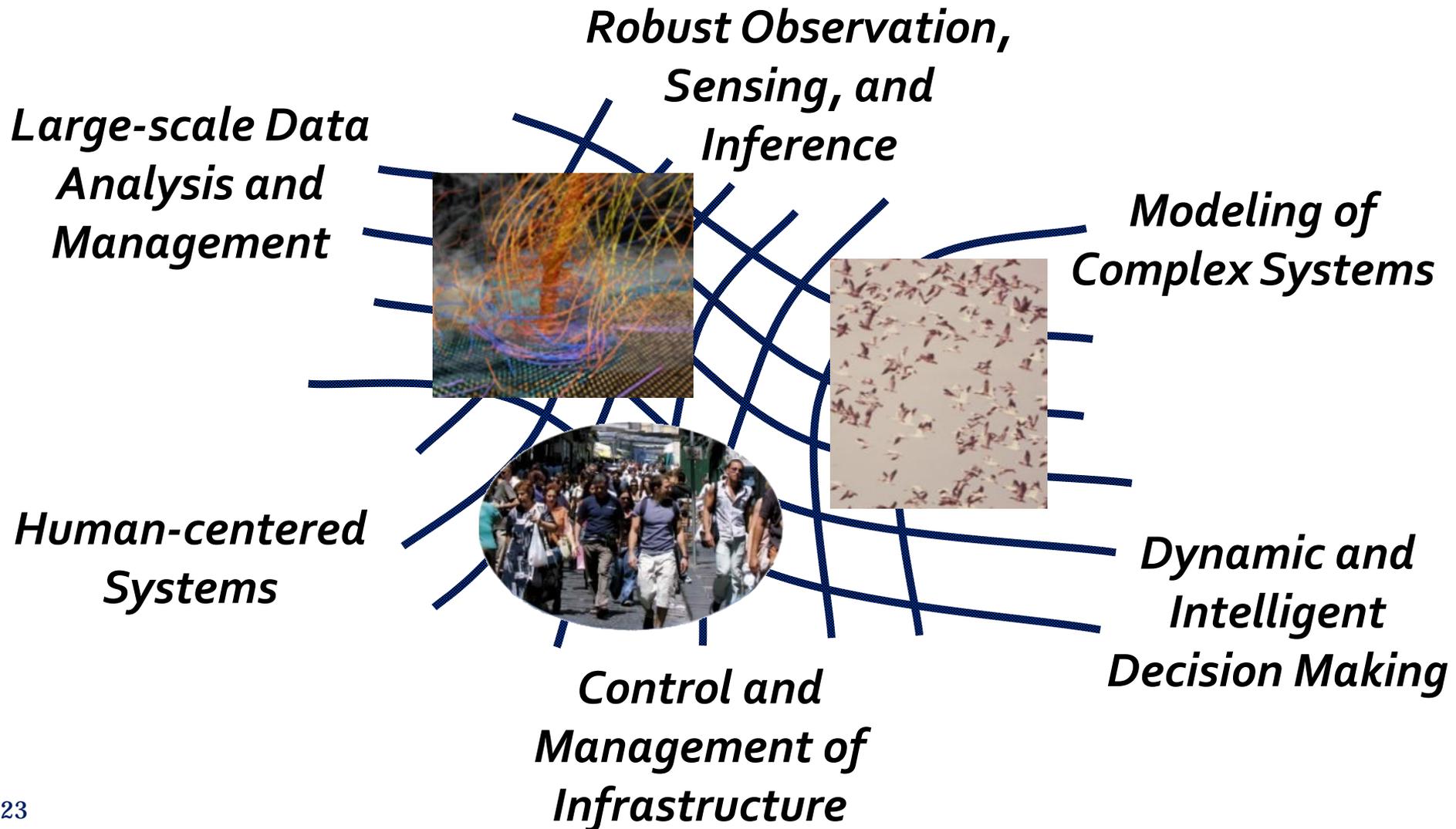
and where

computational innovation is grounded in the context of **sustainability problems**





Interdisciplinary computational challenges are woven into many areas of CI-focused sustainability research examples include, but are *not limited* to:





Sustainability of computing technologies

Challenges in managing consumption of **energy, materials, and other resources** have become a critical sustainability issue.

CyberSEES welcomes interdisciplinary research that addresses **holistic, integrative approaches** to sustainable computing, including consideration of design and use with **impact across the lifecycle** in mind.





Sustainability challenges are shaped by human, societal, and economic factors

All SEES projects must consider the social, behavioral, and economic requirements of creating long-term, viable sustainable systems, and incorporate those dimensions in the proposed research.



Examples include human interface, security and privacy, socio-cultural norms, non-compliance, herding behavior, economic incentives, real-world deployment





CyberSEES Requirements



The research must be **well-grounded in sustainability issues**.



The research objective must **advance computing or cyberinfrastructure knowledge**, while enabling research in another discipline.



The team composition must be synergistic and interdisciplinary, and must consist of at least **two investigators** from different scientific disciplines.



Type 2 projects must **address education and workforce development** in sustainability science.



Sustainable Chemistry, Engineering & Materials (SusChEM) (NSF 13-013)

- **DCL:** Opportunities for interdisciplinary research & education in chemical sciences & engineering related to sustainable synthesis, use and reuse of chemicals & materials
- Advance science, engineering & education to inform societal actions aimed at environmental & economic sustainability
- Partnerships and educational experiences to train workforce strongly encouraged
- Existing programs with co-review & co-funding involving:
 - Chemical, Bioengineering, and Transport Systems & Civil, Mechanical and Manufacturing Innovation (Engineering)
 - Chemistry & Materials Research (MPS)
 - Earth Sciences (Geosciences)

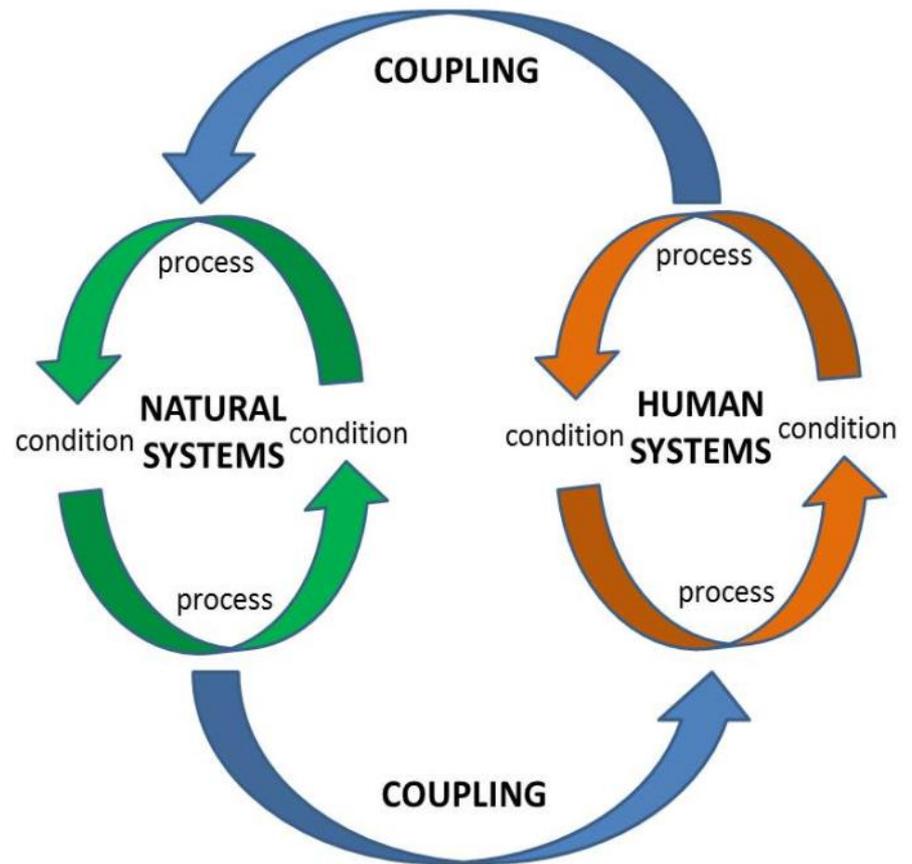




The Dynamics of Coupled Natural and Human Systems competition promotes...

... interdisciplinary research that examines human and natural system processes and the **complex interactions among human and natural systems** at diverse scales.

Research projects to be supported by CNH must include **analyses of 1) a human system; 2) a natural system; 3) processes through which the natural system affects the human system AND 4) processes through which the human system affects the natural system.**





Urban Vulnerability to Climate Change: A System Dynamics Analysis

PI: Sharon Harlan, Arizona State University

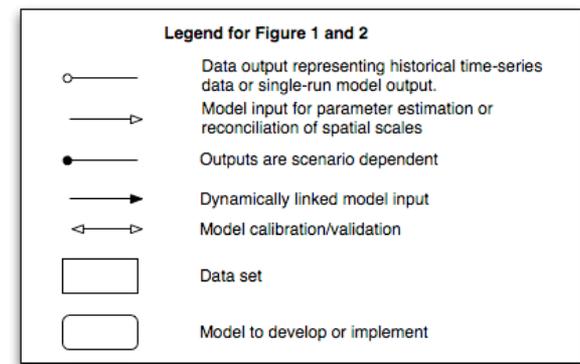
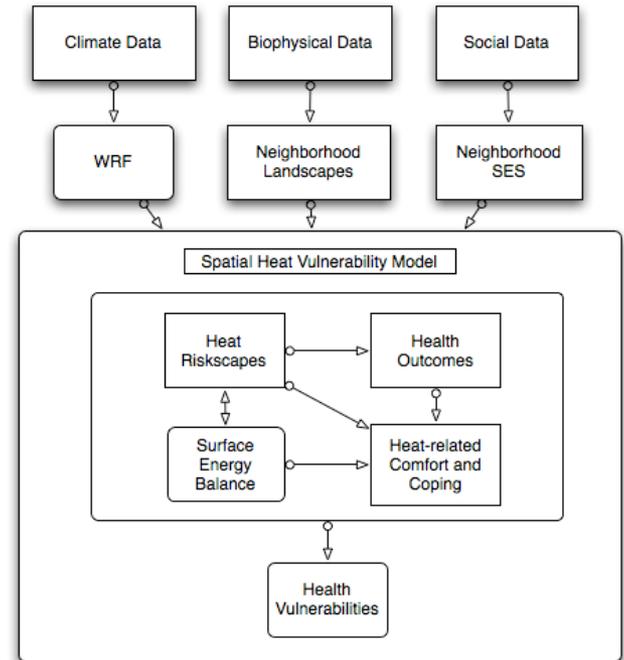
NSF Award 0816168, \$1.4 million

Examining vulnerability of different urban neighborhoods and socio-economic groups to heat-related health hazards.

Developing future scenarios under climate change.

Devising local adaptation strategies, landscape changes.

Strong involvement of local communities in project.





CNH: Cooking Up Clean Air: Scaled-Up Air Quality and Health Impacts of Clean Cookstoves in Ghana

PI: Christine Wiedinmyer, University Corporation for Atmospheric Research

NSF Award 1211668, \$1.475 million

Nearly half the world's population cooks over open flames on a daily basis. This releases greenhouse gas and exposes people to toxic emissions that contribute to respiratory disease. In Ghana and other countries in the "meningitis belt," emissions from cooking have been linked to meningitis. We hypothesize that widespread use of efficient, or "clean", cookstoves - which produce less smoke than open fires even while burning the same available materials - will reduce people's exposure to toxic emissions, improve health outcomes, and improve regional air quality. To test this hypothesis, the project team will introduce cookstoves into households in northern Ghana. In addition to determining whether they do, in fact, improve air quality and health outcomes, we will explore the social and economic factors that encourage or discourage cook stove use, and consider the impacts of climate change.





Advice to SEES PIs

Take all words in the competition title very seriously:

e.g. **Urban Sustainability Research Networks**

You will probably need to involve researchers from a variety of disciplines – for some programs, this is a stated requirement

We encourage:

- generalizable theoretical development
- analysis and synthesis

We generally do not encourage:

- descriptive studies
- normative or prescriptive projects
- projects where the primary outcome is a tool

Make sure your proposal includes everything (including all the sections, and supporting documents) the solicitation says we need...

...but no more than that.





CNH Success Rates

Year	Project Proposals	Highly Competitive / Competitive (fundable)	Funded	Funding Rate (total received) %	Funding Rate (fundable) %
2007	80	26	12	15	46
2008	64	30	9	14	30
2009	94	34	14	15	41
2010	97	25	14	14	56
2011 (f e R)	98 37 4	24 13 2	14 5 1	14 14 25	58 38 50
2012 (f e R)	91 35 6	31 12 3	12 6 0	13 17 0	39 50 0
2013 (f e R)	93 40 3	25 9 1	14 6 1	15 15 33	56 67 100





Common Problems in Sustainability Proposals

Unbalanced – examines only a small part of the system (e.g. only the natural system)

Not studying relevant feedbacks and connections

Team lacks expertise in ...

Missing relevant literature in ...

Project is unlikely to result in theoretical advances

Results would not be generalizable beyond study site

No clear statement of the research question(s) / hypothesis

Project does not address research question(s)

Methodology is not clear / important details are missing

No synthesis

Project is tool development, not research

Project is driven by agenda, not scientific enquiry

Proposal is poorly written / is confusing / has errors / is hard to navigate

Proposal is not compliant





Press releases show the awards made for each program

The screenshot shows the NSF website interface. At the top left is the NSF logo with the tagline "WHERE DISCOVERIES BEGIN". To the right is a "QUICK LINKS" button and a search bar. Below the logo is a navigation menu with links for HOME, FUNDING, AWARDS, DISCOVERIES, NEWS, PUBLICATIONS, STATISTICS, ABOUT NSF, and FASTLANE. The main content area features a "News" section with a "Press Release 14-122" titled "NSF awards \$15 million in second set of coastal sustainability grants". Below the title is a sub-headline: "In wake of storms such as Hurricanes Sandy and Isaac, awards will lead to better management of coastal environments". An aerial photograph of a coastal area with a river and houses is shown. Below the photo is the text: "River management strategies affect flood risk for coastal communities. Credit and Larger Version". To the right of the main article is a "View Video" section with a video thumbnail titled "Fostering Coastal Sustainability: NSF's Coastal SEES Awards" and a description: "A video interview about the coasts with Debbie Bronk, NSF Division Director for Ocean Sciences. Credit and Larger Version". Below the video is another thumbnail showing a scientist working with oysters, with the text: "Coastal SEES scientists are studying oysters to advance sustainable shellfisheries. Credit and Larger Version". At the bottom of the main article is the date "September 15, 2014" and a paragraph: "More than half the world's human population lived in coastal areas in the year 2000; that number is expected to rise to 75 percent by 2025." On the left side of the page is a sidebar menu with categories like "News From the Field", "Special Reports", "Research Overviews", "NSF-Wide Investments", "Speeches & Lectures", "NSF Current Newsletter", "Multimedia Gallery", "News Archive", and "News by Research Area" with sub-links for various scientific fields.





www.nsf.gov/sees

Shows the latest (known) status of each SEES program

NOTE: Several of the programs have ended

Contains links to the program pages and solicitations for each program

The program pages list contacts

The solicitations describe each competition and due dates

The screenshot shows the NSF SEES website interface. At the top, there is the NSF logo and the text "National Science Foundation WHERE DISCOVERIES BEGIN". A search bar and "QUICK LINKS" button are in the top right. A navigation menu includes HOME, FUNDING, AWARDS, DISCOVERIES, NEWS, PUBLICATIONS, STATISTICS, ABOUT NSF, and FASTLANE. The main content area is titled "Science, Engineering and Education for Sustainability NSF-Wide Investment (SEES)". It includes sections for "Crosscutting/NSF-wide", "SEES Mission Statement", "CONTACTS", and "SYNOPSIS". A table lists various programs with their most recent solicitations and status/deadlines.

Program	Most Recent Solicitation	Status / Most Recent Deadline
Arctic SEES	Belmont Forum call for proposals: Arctic Observing and Research for Sustainability	July 31, 2014
Climate Change Education Partnership	12-1312	The CCEP program has been discontinued as a SEES program and