Leadership

The Shell Center for Sustainability relies on the support and participation of many partners to advance its multi-disciplinary work on sustainable development. The primary commitments are from Rice University, and Shell Oil Company, and community partners.

**Advisors Board**

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Evan Siemann
Frazier Wilson

To the individual members of these committees, the collaborating Rice University Centers and Institutes, the many involved students and faculty on campus, and our many partners and friends beyond the hedges, we express our thanks and appreciation for your support in 2013.
The Shell Center for Sustainability (SCS) at Rice University is an interdisciplinary program of research, outreach and education that addresses actions that can be taken to ensure the sustainable development of living standards, interpreted broadly, to encompass all factors affecting quality of life, including environmental resources.

2013 marked the eleventh anniversary for the Shell Center for Sustainability, a partnership between Rice University and Shell Oil Company.

Vision 2015

The Shell Center for Sustainability is the regional expert in Gulf Coast sustainable development by fostering academic research, outreach and education initiatives in interdisciplinary partnerships and through collaborations that extend to the U.S. Gulf Coast and greater Houston area.
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2013 was a year of bold new directions for the Shell Center for Sustainability. The center shifted from its prior mode of providing seed grants to Rice faculty conducting research on sustainability-related projects to one of funding multidisci-
plinary, multi-investigator projects that focus on more specific problems that threaten sustainable growth and development of the Gulf Coast Region. We intend to follow this path in the coming year and will soon be issuing a new call for proposals. We made this change only after extended deliberation by our operating committee and with colleagues in the field. We also completed the initial phase of our Houston Indicators project, which has yielded the first comprehensive data-based investigation of multiple factors influencing the future of our city. I am extremely proud of what the center has accomplished and look forward to an even more exciting year watching the progress of projects we are currently funding.

Regards,

John B. Anderson, Ph.D.
Executive Summary

Selection of research projects under the Stress Nexus 2050 (food water and energy) request for proposals took place in 2013. These three projects bring together multidisciplinary teams to address critical issues in the Gulf Coast region.

The Stress Nexus of Coastlines will evaluate the nexus of social and natural sciences for the upper Texas Gulf Coast bringing together a team of earth, engineering, and social scientists focusing on the greater Freeport region located south of Houston.

Zero Carbon Development looks at our high-energy lifestyle and will develop alternative, low impact ways of living to demonstrate what environmentally sound ways of living may look like. The focus of this project is the Fifth Ward, a 6.25 square mile area located north of downtown Houston. The team includes scientists in architecture, engineering, finance, sociology, and political science.

Water, Nutrients, and Sustainability is a project that will look at the poor management of fertilizer and water and the contamination of watersheds. The project will consider biochar as a nutrient and water management technique. The team of scientists in earth, ecology and evolutionary biology, energy, and anthropology collaborates with an
industry partner to support a postdoctoral researcher.

The impact of current and past research support is typically long-term and continues to deliver successes and outcomes beyond the research term. Several of these examples are listed in this report and include ongoing collaborations, presentations, and publications.

The Gulf Coastal Science Consortium continued to support the disbursement of scientific data supporting key issues affecting the Gulf of Mexico coast. The GCSC hosted international scientists and provided expert representation on various panels in the region and abroad.

The Houston Sustainability Indicators project advanced to present its second report through a Town Hall Meeting format that enabled active participation from stakeholders and decision-makers in areas representative of the 24 indicators used to measure social, economic, and environmental impact of Houston’s development. The project has raised the level of awareness and interest as gauged by requests for expert representation and media coverage.

Ongoing outreach activities included participation in efforts by various partners and collaborators to leverage and generate greater synergy both on campus and beyond.

In closing, the budget reflects the greatest investment this year to be focused on supporting the new research initiative to increase multi-disciplinary, and multi-investigator participation.
Research

Research project selection under the 2012 Request for Proposals for 2013 was extended and took place in the early spring of the academic year. The selection of projects closed the call for proposals for 2012 and extended the typical one-year term through the 2014 year, effectively making it a two-year research term. Further details of the rationale can be found in the 2012 Annual Report.

Three projects were selected as sound examples that focus on the Stress Nexus 2050 (food, water, and energy). The three selected efforts present research opportunities that consider a projected view of key sustainable development issues. The first project considers resiliency of the upper Texas Coast, focusing on the areas between Surfside Beach and the Brazos River mouth, an area considered one of the most vulnerable to the impacts of sea-level rise and severe storms; the second project looks at the urban development structure that can define success for the future of a community; and the third project looks at the urban waterways and the value their viability brings to our quality of life. In combination, these three projects address critical issues to be faced over the coming 30 years.
Coastal landscapes are among the most dynamic environments on Earth’s surface. These regions also offer extraordinary natural resources and are therefore relied upon for societal welfare; consequently, coastlines are inhabited by 60% of the world’s population. However, as a result of global sea-level rise and increasing severe-storm frequency and magnitude associated with climate change, coastlines are ever more vulnerable to significant geomorphological change. Nevertheless, infrastructure development and population of coastal landscapes continues to grow. A recent study by the Wall Street Journal has estimated that coastal neighborhoods in the U.S.A. have drawn new residents at a rate of 1.3 million per year in the past two decades, which has helped increase the coastal population by nearly 50% since 1970. This development has fostered a 40% increase in property values since 2004, to an estimated $10.2 trillion (Gulf and Atlantic coasts combined). Therefore, there are
tremendous social, engineering, and economic incentives to evaluate the future viability of coastal settings.

Coastal sustainability is a complex issue that necessitates combining social, engineering, and geomorphology studies to address trends of increasing population, infrastructure development, and landscape dynamics. The frontier of coastal sustainability science therefore necessitates cross-disciplinary studies, which is the prerogative for this research effort. The project integrates specialists in the fields of coastal geomorphology, inundation modeling, population and society development, and infrastructure engineering. The goal is to produce a comprehensive evaluation of coastal adaptation schemes that account for geomorphology and regional development.

Specifically, this research will evaluate the intersection of social and natural sciences for the upper Texas Gulf Coast. The study site focuses on the greater Freeport region (south of Houston), where intense development intersects a dynamic coastal landscape modified by the Brazos River delta and adjacent barrier islands. The project aims to forecast the private and public development, as well as measure and model regional coastline development. The research will be coupled with studies that assess sustainable engineering
of transportation infrastructure, and analyze regions that are at significant risk to storm-surge flooding. The broad aim is to apply these regional-scale assessments to the entire Texas Gulf Coast, especially where ecologically diverse and low-lying landscape is heavily developed and relied upon for recreation, trade, and commerce.

For more information, visit http://shellcenter.rice.edu
In the very near future, climate science tells us that cities will have to confront a series of dramatic ecological challenges. Regardless of how these challenges are met, or not met, it is already clear that upcoming generations will have to occupy cities in a very different way than we occupy them today. New, low energy patterns of occupation will cut deeply into our accustomed ways of life and call for a ground up restructuring of urban environments. This restructuring will have to take place across several fronts. Technical, economic, or political solutions to the problem of climate change are ineffective in and of themselves. Taken separately, they only provide partial solutions that have proven to be inadequate. An urban plan is a vehicle for a holistic response that combines technical, political and economic solutions synergistically in order to propose alternative, low impact lifestyles scaled to our new limitations.

In many of the attempts to address climate change, vested interests have been targeted — auto manufacturers, fossil fuel companies, real-estate developers, pocketed politicians — as culpable in the climate crisis. These attempts have fallen short because they avoid indicating the real culpability, which is our
own high-energy lifestyle. While we may fully grasp the climate crisis, we are still unable to envision the admittedly drastic changes that need to be made in our way of life. The key to bridging this gap between understanding and action is to show precisely what environmentally sound ways of living may look like. We intend to present alternative, low impact ways of living by simply describing their physical settings in concrete design proposals.

**Climate Change and Urban Redevelopment**

Solutions that work only for wealthy countries, wealthy cities, wealthy neighborhoods or wealthy individuals, are ineffective inasmuch as any solutions to climate change must go mainstream in order to work. Like nothing else before it, climate change is an interconnected problem that is global in scope. Anything less than broad based solutions end up creating life rafts for those who can afford them leaving behind an increasingly dysfunctional world. In other words, environmental problems and social problems have to be taken on together. To that end, this project has chosen one of the most disadvantaged communities in the city of Houston — the historic Fifth Ward — to make the best case demonstration for environmental reforms.

The Fifth Ward is a 6.25 square mile
area (4,000 acres) directly adjacent to the city’s central business district. It has a population of 50,000 people. In 2010, the median income for the Fifth Ward ($22,237) was approximately half that of Houston ($43,365). Over the last five years the district has seen 60% more crime per capita than the City of Houston. The population within the Fifth Ward has gone from majority African American to majority Hispanic ethnicity in the past decade but remains 98% nonwhite. With a median age of 31, 42% of all residents are under the age of 25. There are an estimated 20,370 jobs located in the Fifth Ward, but only 12,767 employed residents live in the area. The majority of the residential population (55%) over age 16 is not in the labor force. Additionally, only 39% of Fifth Ward residents are employed. As a stress nexus between society, economy and environment, the Fifth Ward represents a challenge that is daunting at face value. The goal will be to design a redevelopment plan that is based on a very specific political, economic and cultural situation. While an actual urban constituency drives the plan, it will ultimately address a large range of environmental/urban problems that face every major city in the nation. The design will not only be relevant to the Fifth Ward, but will create a template of sustainable intervention in low-income areas that can be played out in any large city with a similar stress nexus. The intention is
that the project becomes a model of carbon free development, not just for lower-income neighborhoods.

Working with students in the Rice University School of Architecture, the research team will author a redevelopment plan for the year 2020 (first year) and another for the year 2050 (second year). Addressing one of the most challenging areas of the city, planning proposals will be produced which seek to transform the Fifth Ward into a new model of public/private redevelopment and a new model for sustainable urban design. The project will bring together the social and natural sciences with business, engineering and design in a single effort.

For more information, visit: http://shellcenter.rice.edu

Eric Ratkowski
Water, Nutrients, And Sustainability

River water quality is a major challenge in virtually all urban watersheds where fertilizer use and wastewater act as unwanted nutrient sources. This in turn can result in increased algal production in surface waters that, if allowed to grow, can cause problems in the coastal ocean like dead zones and harmful algal blooms. This wasteful management of water and fertilizer can have negative environmental and economic consequences for coastal communities. Simultaneously, ineffective retention of fertilizer and water where they are needed on the land surface, such as in crops and urban trees, can lead to wasteful urban use of water and fertilizers, further contaminating watersheds. While technologies exist to manage these problems, implementation hinges on their cost-effectiveness and cultural acceptance. The project proposes a suite of low-cost, high yield social science-natural science collaborative projects focused on one nutrient- and water-management technique, biochar. Biochar is charcoal produced intentionally for environmental uses like carbon sequestration and water purification.

This project will help support a post-
doctoral researcher who will determine the economic conditions under which biochar improves nutrient and water management sufficiently to be profitable. Because the specific area of valuing biochar ecosystem services is of interest to researchers at Shell Oil Company, this postdoc will be co mentored by Dr. Christian Davies at Shell as well as by Ken Medlock and Carrie Masiello at Rice. Besides addressing a significant problem in ecosystem water and nutrient management, the creation of this postdoctoral fellowship would jump-start a new natural science-social science collaboration, expand the currently science-only biochar group into the social sciences, and formalize a nascent relationship between Shell and Rice in the area of sustainable water management.

The project also proposes three other high-impact, low cost projects related specifically to biochar, water, and nutrient management. Undergraduate researchers and staff would be focused on these areas of research:

1. Determining the water management benefits of biochar produced from sewage sludge.
2. Documenting the ability of biochar and mycorrhizae to immobilize metals in contaminated soils.
3. Conducting an ethnographic study of biochar-producing communities to
better understand how they perceive the hydrologic cycle benefits of their work.

Ongoing Success And Outcomes

The Shell Center for Sustainability has provided research funding to sustainable development initiatives for over 10 years. Seed funding in this field has given an avenue for ongoing outcomes to many researchers advancing their work towards greater success that began with one seed. The following are some of the outcomes leveraged in 2013:

2013 Publications from SCS Funded Projects


Actar Publishers published The Petropolis of Tomorrow, edited by Neeraj Bhatia and Mary Casper of the Rice University School of Architecture.
The book represents the results of the Award winning work by students and faculty on the project with the same name and funded in the 2011 and 2012 grant awards.


Peifer, Jared, Elaine Howard Ecklund, and Cara Fullerton, How Evangelical Christians Frame Their Environmental Concern and Apathy, revise and resubmit, Review of Religious Research.


Barnes, R. T., Gallagher, M. E., Masiello, C. A., Liu, Z., & Dugan, B.


Other outcomes are listed in the Appendix at the end of this report.

Additional information on funded research is included in the 2013 Annual Report Addendum available as a separate document.

More information can be found at: http://shelllcenter.rice.edu
Outreach

Gulf Coastal Science Consortium

Three years ago the Shell Center for Sustainability launched its Gulf Coastal Sustainability Project. The objective of this project is to improve prediction of coastal response to accelerated SLR and other factors for greater coastal resiliency.

Toward this goal, we have taken a number of important steps.

1. Creation of the Gulf Coastal Science Consortium (GCSC), a group of the most widely published and cited scientists conducting research on sea-level rise, subsidence, sediment management, and storm impacts on the Gulf Coast. The goal of the consortium is to promote coordination of research and better communication of scientists working in the region. During its first workshop this group generated a list of critical issues and research needs (see SCS website for more details).

to Inform Management”. The conference was convened in Galves-
ston, Texas and was attended by 82 coastal and social scientists from
12 countries. The results from that conference were summarized in a
list that included consensus statements and recommendations for re-
search, both scientific and policy related (Anderson et al., 2013a,b,
available on request).

3. In 2013, Dr. Anderson was one of a few academic scien-
tists invited to participate in a Gulf of Mexico Foundation sponsored
workshop in Merida, Mexico aimed at developing stronger col-
laboration between U.S. and Mexican scientists engaged in coastal
change research. This conference highlighted the inadequacies of
existing passive inundation models and steps needed to develop bet-
ter models for predicting coastal response to SLR.

4. In 2013, the SCS funded its first major coastal project aimed
at assessing the response of the upper Texas Coast to accelerated SLR
(see Research), limited sediment supply and severe storm impacts.
This project involves collaboration between Rice faculty, post-docs
and graduate students and social scientists from Texas A&M Uni-
versity, who have an ongoing research project on socio-economic
impacts of coastal change in the region. The Rice Principal Inves-
tigators are Dr. Jeff Nittrouer of the Earth Sciences Department, an
expert in riverine sediment management and coastal processes, and
Dr. Phillip Bedient, an expert in severe storm impacts and coastal
flooding and co-director of the SSPEED Center. Dr. John Anderson
is also involved in the project but is not directly funded by SCS. The
team includes a postdoc, Dr. Jorge Lorenzo Trueba, who specializes
in numerical modeling of coastal response to SLR, and a number of
undergraduate and graduate students.
The GCSC contributed to the following events:

As panelist for the Environmental Challenges Facing the Houston Region Over the Next 25 Years, Rice Design Alliance Workshop, presented a talk on potential impacts of rising sea level on the greater Houston area.

Members of the GCSC also published several papers to communicate findings to the scientific community and decision makers. Reference was made in the following articles: CLEAN, Coastal Communities Face Rising Sea, Sinking Land and Powerful Storms; GSA Today, Coastal Processes and Environments under Sea-Level Rise and Changing Climates: Science to Inform Management; and EOS, Adapting to Shifting Tides.

Read more about the Gulf Coastal Science Consortium at: http://shellcenter.rice.edu
SUSTAINABLE DEVELOPMENT OF HOUSTON DISTRICTS: A Sustainability Indicators Study

LESTER KING, PH.D.
Houston Sustainability Indicators

The Houston Sustainability Indicators (HSI) project entered its third year under the leadership of Dr. Lester King, SCS Fellow. The 2013 HSI report was the focus of the annual SCS sustainability conference. To that effect, the following activities were held:

HSI Workshops were held to discuss the indicators and gather expert and stakeholder feedback. Prior to presentation of the report, a briefing was offered to City officials to allow for their contribution.

The Sustainable Development of Houston Districts: The Health of the City Town Hall Meeting, was held in October to present the findings that focused on the indicators at the City Council District level. (See 2012 report with city-wide results in the 2012 Annual Report).

The event was kicked off with two keynote speakers: Jason Roberts, who spoke of The Better Block Project, and Rob Hopkins, who spoke on The Art of Resilience: Communities in Transition.

The event closed with a full-day workshop that garnered the contribution of community stakeholders and leaders in the area of environment, economy and community. (See more at http://shellcenter.rice.edu, click Outreach).

Presentations Stemming from Houston Sustainability Study:

2013 – Shell Powering Progress Together: Pathways for managing the Stress Nexus in an urban context. Panelist, Stress Nexus in Houston. Houston, TX.

2013 – Association of European Schools or Planning/American Collegiate Schools of Planning – Annual Conference. Presenter,
The Rise of the Hispanic Demographic in Houston. Dublin, Ireland.

2013 – American Planning Association, Texas Chapter – Annual Conference. Galveston, TX.

Presenter. Texas Planning Schools and Sustainable Community Development.

Moderator and Session Organizer. Multidisciplinary Planning for Texas Coastal Communities.

Moderator and Session Organizer. Essential Special District Planning in Texas.


Outcomes

Impact

ABC Houston Channel 13, Viva Houston. http://tinyurl.com/mptdpnr


Culture Map Houston. http://tinyurl.com/m9xwjg2

Culture Map. http://tinyurl.com/kmyb9ar

Eco-Ology - KPFT 90.1. http://tinyurl.com/mc58vsq

Fox News Houston Channel 26 KTRV-TV. http://bit.ly/1dLwNyI


Houston Chronicle. http://tinyurl.com/ls9d66h

Houston Chronicle. http://tinyurl.com/n4zlbcb
Houston Matters - KUHF 88.7. http://www.houstonmatters.org/show/2013/09/18/2048

Houston Tomorrow – Houston faces tough quality of life issues. http://tinyurl.com/lq92r78

NBC Houston Channel 2, Houston Newsmakers. http://tinyurl.com/7665aual


Rice News. http://tinyurl.com/k7zefrv

For more information on the Houston Sustainability Indicators project, visit http://shellcenter.rice.edu
Other Outreach Activities

United States Netherlands Connection

SCS participated in the United States Netherlands Connection (USNC) Academic Workshop at the Miami Dutch Consulate. The partnership includes US and Dutch Universities, led by Florida Earth Foundation, to create an exchange of knowledge and professional expertise in water management and climate change resilience and adaptation.

Shell

SCS continued to be an active member to forge ongoing research collaboration partnerships with Shell. Participation included attending the Shell Innovation Summit-Technology Center, Shell/Rice Workshop, Shell Powering Progress Together Forum, and Shell Partners Forum providing opportunities to network with other Shell partners.

Odebretch

Rice University and SCS hosted Odebretch as they kicked off their Sustainable Development Award with a presentation and Q & A session for Rice students.

Partners

Ongoing participation, collaboration, and support continued with other research centers on campus and beyond, such as the Center for the Study of Environment and Society, Center for Energy and Environmental Research in the Human Sciences, Rice Environmental Club, Department of Sociology, Transition Houston, the Center for
Houston’s Future, Houston-Galveston Area Council, Our Region, Transition US, Star of America’s Energy Coast Focus Group, and the Post Carbon Institute.

**Visitors**

SCS received visits from various guests including local and international representatives from NASA, Shell, India, and Latin America.

**Rice Undergraduate Research Symposium**

SCS supported the Sustainable Development Award in the Rice Undergraduate Research Symposium (RURS) for the second year in a row. This award recognizes undergraduate student research papers in sustainable development. The criteria for selection matches the objectives of our research proposals generating further synergy in the work that SCS supports.
Web Reach

Annual visitors to the SCS website reached 14,159 in 2013. There were an average 1,179 visitors a month. Lows were over the summer. Visits rose as SCS prepared for the HSI event and peaked at 2,276 in October.

*SCS Web Reach, 2013. Data by Google.*
**Budget**

The Shell Oil Company term endowment of $3.5 million has supported SCS for over 11 years through wise investment and stewardship by Rice University. The distribution of these earnings has allowed for the continuous operation of SCS.

Through the end of 2013, SCS has awarded over $2M in sustainable development research funds providing funding for three new projects this year.

The annual budget distribution of $420,000 is projected to continue through Fiscal Year 2016.

The chart below reflects expenditures and encumbrances through the end of the 2013 calendar year (the fiscal year runs through the end of June).
Appendix

This appendix to the Shell Center for Sustainability 2013 Annual Report lists additional outcomes from funded research and is continued from page 21.

Presentations


Gullapalli S., Velazquez J.C., Pretzer L.A., Wong M.S. “Reductive Photocatalysis Using In-situ Generated Hydrogen” *South- west Regional Catalysis Meeting*, 2013: Houston, TX.


The results of Effects of anthropogenic nutrient enrichment and climate change on invasion success and impacts on native freshwater communities were presented at Ecological Society of America Annual Conference, Ford Foundation Fellows Conference, SACNAS National Conference, and Emerging Researchers National Conference.

Dr. Schuler presented to M.D. Anderson Cancer Center Perioperative Services group on the Solar-Autoclave project’s free-standing sterile processing suite to be designed in 2014.
Y.J. Leong, C. Gutierrez, R.J. Griffin, and B.L. Lefer, Measurement of aerosol number concentrations in Houston, TX, American Association for Aerosol Research Annual Conference, Minneapolis, MN, October 2012.


**Awards**

Dr. Lydia Kavraki and Dr. George Bennett received the NSF ABI Innovation: Mining Metabolic and Enzyme Databases grant for the Composition of Non-Canonical Pathways. With this almost $700,000 grant they will be able to follow up on the computational metabolic search supported by SCS funds awarded in the 2010-2011 round for Computational guidance of efficient CO2 fixation through optimized biochemical pathways.

Among various publications on his project High Performance Polymer Voltactics (see website for details), Dr. Rafael Verduzco was recently awarded an NSF CAREER grant, based in part on work made possible by SCS funding. In addition, two of his students will be graduating in the 2013-2014 academic year.

**Collaboration**

Sponsored research funds awarded to Dr. Volker Rudolf, for Consequences of Climate Change on Ecosystems, helped establish collaboration with Chinese scientists to study climate change. Dr. Rudolf was invited to visit the Institute of Plant Protection (IPP), Chinese Academy of Agricultural Sciences (CAAS), in Beijing, where he led a seminar on this subject.

Doug Schuler and Jean Boubour, two PIs of the SCS-sponsored project Solar Autoclave for Off-Grid, Developing Countries Health Services, continued ongoing collaboration with government officials of the Kono
District of Sierra Leone as well as Wellbody Alliance, to install and train users, and develop solutions for process concerns raised at the test clinic in Kono. This collaboration has allowed continued study of the sterile processing of medical instruments for remote areas of developing countries.

The Carbon Sequestration Through Biochar Soil Amendment project has lead to collaborations with Shell biochar researchers Christian Davies and Jay Wise.

**Courses & Seminars**

The Urbanization and Carbon in Waterways grant became the nucleus for a field-based Freshman Writing Intensive Seminar (FWIS 187, The History and Science of Houston’s Bayous). The seminar will begin in the spring of 2014 and will be taught by Dr. Masiello.

Dr. Masiello built a course for incoming Rice students based on the field sites and science developed in her class. The course meets both their freshman writing requirement and a D3 science requirement. It focuses students to the concepts of watershed sustainability in cities. The goal in this course is to direct students early in their time at Rice toward sustainability-focused majors.