Proposal

Consortium for Environmental Science, Education and Research (CESER)

(Feb. 26, 2004)

Mission

Conflicts between the need to provide for an expanding human population while also protecting the natural environment from anthropogenic impacts are accelerating rapidly. Such environmental problems are inherently multidimensional and therefore resolved only by interdisciplinary approaches. CESER integrates and unites the outstanding expertise in environmental sciences that exists among many of Stony Brook University's leading departments and institutes with that of neighboring world-class laboratories and industries in the natural, social, engineering, and health sciences. By combining strengths across disciplines, CESER positions SBU to become a leading institution in environmental research and education at regional, national and international levels, and to seize emerging opportunities and challenges that stem from the complex interactions between humans and the natural world.

Objectives

Unite the outstanding collective research and teaching expertise of Stony Brook University's natural, social, engineering, and health science programs with that of nearby private and federal laboratories and industry to develop coordinated team-based research on environmental science.

Focus on complex environmental problems that have multiple causes and effects and that therefore require multi- and interdisciplinary efforts.

Promote an approach to graduate training that emphasizes in-depth knowledge of a particular discipline combined with a commitment to apply that expertise to broad, inherently multidisciplinary environmental problems that are often tackled by teams of scientists working collaboratively.

Educate managers, public officials and the public about environmental issues and suggest appropriate policies that can be employed to provide solutions, including cost/benefit analyses of various alternatives.

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Justification

There is a wide spectrum of exciting, state-of-the-art research in many areas of environmental science at Stony Brook University. However, much of this research is being conducted in relative isolation. Too often there is little coordination among environmental scientists at Stony Brook, particularly among scientists from different

administrative units. Moreover, there is little in the way of collaborations between different disciplinary groups that could bring together teams of researchers who could address the complex, multidisciplinary issues that typify many environmental problems. Consequently, applications of new technologies or approaches have only been slowly applied (if at all) to forge new directions or breakthroughs in environmental science. Most environmental issues are multidimensional and must be addressed from interdisciplinary perspective that includes the natural, social, health, and engineering sciences. We expect that, with the establishment of CESER, more formalized ties and new collaborations would be generated among faculty from various administrative homes but with a common interest in environmental issues. We further expect that synergistic interactions among faculty of varying disciplines would, in essence, lead to cross-fertilization of different disciplines and promote new and innovative approaches to address environmental problems. A consortium of this kind would help put the "universe" back in "university" and would energize our faculty and students to seek new and exciting ways to pursue their research and educational interests. Such a consortium will help SBU attract and retain the best students across disciplines who are interested in the environment.

Stony Brook University is a particularly appropriate place to establish a consortium of environmental scientists, owing in part to our unique blend of talent on this campus and to important geographic considerations. First, there are few universities that have leading science and social science departments, marine and atmospheric scientists, and a research-oriented medical school all co-located on the same campus. While the expertise and reputation of Stony Brook's faculty is formidable, if it functioned in a more coordinated manner, then our ability to seek external funding and generate new teams and innovative approaches for addressing environmental research and education would be stronger. Further, the close administrative and geographic ties with the Brookhaven National Laboratory and Cold Spring Harbor Laboratory could bring added value and unique facilities to interdisciplinary efforts. The geographic location of Stony Brook is also ideal for such a consortium. Stony Brook has a wide range of oceanic, coastal, and terrestrial ecosystems close at hand, and also lies about halfway along a gradient in human population density and environmental degradation (habitat destruction, contamination, etc.). Furthermore, it is also located in a region that is solely dependent upon an aquifer as its sole source of freshwater and that is also inextricably linked to coastal waters for recreational and commercial purposes. Consequently, the studies conducted here could serve as a model for many of the world's cities, particularly those in coastal regions. No other program or institution on the Eastern Seaboard has a public mission to identify, study, publicize, and resolve the unique, multidimensional environmental problems of New York's coastal zone from a comprehensive perspective.

This is a particularly propitious time to establish CESER for several reasons. First, there are numerous important advances being made in various disciplines that could very effectively be applied to environmental studies. The formation of an environmental consortium would expedite interactions between disciplines and make possible new approaches that would likely not occur, or would occur slower and less efficiently, in the absence of such a consortium. Examples of emerging technologies that could be applied

to environmental problems include (1) synchrotron-based x-ray fluorescence for measuring contaminant concentrations in living and abiotic particles and exploring surface coordination chemistry; (2) advances in molecular genetics and proteomics that can enhance the field of environmental toxicology and give rise to a new discipline in molecular epidemiology; (3) breakthroughs in information technology, including data processing, visualization, and sensor and molecular instrumentation, can greatly enhance processing of large data streams and modeling complex systems. Further, by taking the lead and establishing such a consortium now, rather than follow the lead taken by other institutions, Stony Brook will also attract new and better graduate and undergraduate students who would want to be part of this forward-looking and interdisciplinary approach to environmental science education. Such a consortium would provide a unique and exciting opportunity that would give us an advantage in drawing talented students who would easily be able to distinguish this approach from programs (including Stony Brook at present) that rely on more traditional environmental education.

Establishment of an environmental consortium would also position Stony Brook scientists to approach, more effectively than ever, large funding programs that increasingly seek an interdisciplinary approach before handing out funds. Big programs, such as at the National Institute of Environmental Health Sciences and at the National Science Foundation, now require multidisciplinary research with a public education component. A new environmental consortium at Stony Brook may also enable us to respond more effectively to new funding opportunities, for example through the Department of Homeland Security, where public outreach and the involvement of social scientists would almost certainly be necessary. An established research and education program in environmental science would provide the platform to effectively launch these types of collaborative proposals. Such a consortium would also provide the logical point-of-contact on this campus with other regional organizations interested in collaborating with Stony Brook faculty in mounting large environmental programs and would help integrate environmental activities at Stony Brook with the new School of Public Health.

Potential Focal Areas

Six foci are described here as examples where CESER can greatly enhance Stony Brook's intellectual environment and capability in addressing multidisciplinary environmental problems. For each case, it would be considerably more difficult to involve scientists from the appropriate disciplines without the formation of a consortium of environmental scientists. The five areas described below are only examples: there are many other opportunities that can be developed.

- *Environment and human health*

Establishing the impact of human activities on environmental health, and relating environmental factors to human health, are two of the most critical issues of our times. The urban environment in the New York metropolitan area presents an ideal setting

within which to evaluate these issues. The interdisciplinary approach that many Stony Brook University faculty embrace, and the broad spectrum of expertise available on this campus, provide an excellent opportunity to make important new contributions at understanding environmental impacts at the organismal, community and ecosystem levels, and as well draw links between diverse environmental factors and public health.

Many human diseases can be linked to environmental causes, including exposure to pathogens and chemical contaminants. An important route of contaminant and pathogen exposure to humans is through food consumption, including seafood, and risks associated with the consumption of contaminated seafood need to be addressed. This is particularly important in urban areas where aquatic organisms are frequently exposed to elevated contaminant concentrations. Critical pathway analyses should focus in particular on subsets of the population that rely on locally caught animals as a source of protein, as they may be at high risk. Faculty at Stony Brook University are well suited to lead a multidisciplinary effort to describe the cycling and bioaccumulation of select contaminants in coastal and freshwater systems; this information would provide a data base to help quantify the exposure of humans to select contaminants (pesticides and maybe other organic contaminants, metals [e.g., mercury], metalloids [e.g., arsenic, selenium], and radionuclides from regional facilities and accidental or terrorist releases). Scientists at Stony Brook's Health Science Center can incorporate these data into physiological and epidemiological studies to explore links between environmental contamination and disease.

An emerging area of future research involves the interface between ecology and the spread of infectious disease. It is well known that spatial arrangement of the landscape, human interaction, and population fluctuations of natural vectors figure importantly in the spread of disease, both within humans and naturally occurring species populations. Examples include certain pests (ticks, mosquitoes) and exploited fishery resources. Stony Brook is a major center for the understanding important diseases of this sort, namely Lyme disease and West Nile virus. Exploring the interface between humans and the ecology of natural disease vectors would provide important new advances in our understanding of the spread and genetic diversity of virulence.

The link between sewage and pathogens should also be explored. Marine scientists at Stony Brook employing new methods for detecting sewage related contaminants and tracers of sewage inputs could collaborate with microbiologists, infectious disease experts and epidemiologists. Pathogens can affect human consumers of seafood (e.g., cholera) and affect populations of marine animals themselves. Further, scientists associated with the Marine Animal Disease Lab at MSRC could be involved to evaluate impacts on aquatic species and explore potential links to human consumers through this vector.

The potential link between groundwater contamination and human health is especially critical on Long Island. The reliance of Long Islanders on a sole source aquifer, and its use for irrigation water in farming enterprises in Suffolk County (NY State's most valuable agricultural county), and the high level of concern regarding increased cancer

incidence among the populace make this an especially good study site. There are risks associated with pharmaceutical agents, hormones, pesticides, and more conventional persistent contaminants that Stony Brook faculty can play a significant role in addressing.

Formation of CESER can help the faculty in various science departments to take advantage of the proximity to a major medical center (HSC and Stony Brook Hospital), one of the world's foremost laboratories on molecular genetics (Cold Spring Harbor), and a major federal laboratory with an environmental sciences program (BNL) to address this important problem. It will facilitate increased collaboration between environmental scientists and faculty in the medical community, including epidemiologists and specialists in community medicine, as well as basic scientists in infectious diseases, pharmacology and other units. This interdisciplinary endeavor can become a platform to attract top graduate students.

- *Regional climate change: science, impact, mitigation, and policy*

Global climate change as a result of increasing amounts of atmospheric greenhouse gases caused by human activities has received much attention in recent years. Once definitive observational signatures of global warming become evident from measurements (this should be considered imminent), societal emphasis will necessarily shift to regional patterns of global climate change. Regional climate change, however, involves unique multidisciplinary problems. Aside from global influence, human activities around large cities such as NYC impact regional climate through urbanization, land use, construction, and pollution. Evidence exists, for example, that changes in certain climate variables in NYC differ greatly from those near Stony Brook on Long Island.

At the present time, there has been very little research focusing on regional climate change, yet, it is the regional climate change that directly influences living standards, economic activities, energy consumption, insurance, transportation, resource management, and public policy. The science of regional climate change involves the quantification of human forcing on the regional climate system and the physical, chemical, and hydrological feedback processes associated with local circulation such as sea-land breeze, clouds, precipitation, turbulence, convection, biomass, and human behavior. A complete understanding of these processes requires mathematical modeling of the coupled land-ocean-atmospheric system with regional landscape and human activities, which also bring challenges and opportunities in computational sciences and computer graphics, imaging, satellite technologies and human-environmental interactions. Successful development of a computer based modeling system of the regional climate also has the potential to be applied to long-range environmental forecasting, insurance, risk management, financial weather derivatives, and homeland security. These issues therefore require application of atmospheric and marine sciences, physics, chemistry, mathematics and computer sciences to understand the cause and response of the physical system. It also requires economics and management sciences to describe and project human forcing factors specific to the region.

Regional climate change will impact marine and terrestrial ecosystems, including human societies, and such factors as energy consumption, health, transportation, and management. Quantitative understanding of these links can help stimulate interdisciplinary thinking that brings together many disciplines in natural and social sciences. The problem naturally requires a mitigation strategy. Significant engineering opportunities exist to explore new energy resources and methods to offset the inadvertent human impact on the natural environment. Policy and management are also an integral part of the mitigation strategy. This focus area therefore needs social scientists, ecologists, economists, analytical chemists, and medical scientists to address the regional climate change impact, and engineers and managers to study mitigation and public policy.

Stony Brook has national and international reputations in climate change and climate modeling and several other key areas. The formation of CESER can help to organize Stony Brook's expertise in various disciplines on this subject so that it can lead the nation in a systematic way on this subject. This will also facilitate the development of collaborative efforts in this area with BNL.

- *Environmental conservation*

One of the leading challenges, and opportunities, facing environmental science in the 21st century involves the conservation of biological diversity (CBD). From an ecological perspective, CBD lies at the heart of the functioning of environmental systems. That is, all environmental processes are mediated, and many regulated, by organisms. From a public policy perspective, CBD is at the heart of nationally prominent legislation, e.g., the Endangered Species Act of 1972. As a vehicle for both education and outreach, biological diversity is one of the most effective ways to capture the attention and interest of both students and the public.

Stony Brook is superbly suited to address the breadth and depth of issues involved in CBD. Faculty from diverse departments are leaders in research on biological diversity. In efforts ranging from microbial biology at both geochemical and evolutionary scales to vertebrate diversity across landscapes, Stony Brook has faculty in Anthropology, Ecology and Evolution, Marine Sciences, and Geology. For example, studies on microbial diversity at Stony Brook have been useful in highlighting the dynamics of disease-causing bacteria and the interplay of microbial ecology and pathogen virulence. Studies on vertebrate diversity at Stony Brook have played a major role in both basic ecology and land-use policy in regions as diverse as the Long Island Pine Barrens and the rain forests of Madagascar.

The role of organisms and the importance of diversity in mediating biological processes provide a central core in modern environmental science. On issues ranging from phytoremediation to toxicology to air and water pollution, biological diversity is crucial. For example, the plants in terrestrial ecosystems are important sinks of ozone in the lower atmosphere, and the diversity of plant species is important in modulating ozone concentrations. Bacterial diversity is essential for the cycling of important nutrients such

as nitrogen and phosphorus, and human activities that reduce fertility often act through effects on microbial diversity. Also, in the realm of human disease, studies of microbial and viral diversity have proven essential to understanding the dynamics of disease transmission and virulence.

In the realm of public policy, much environmental policy is based on legislation designed to preserve biological diversity or that uses indices of diversity to evaluate environmental impacts. As noted above, the ESA of 1972 is central to many environmental efforts in the USA from local to national scales. Other crucial legislation, e.g., the Clean Water Act, uses biological diversity as a core criterion for evaluating the impacts of human activities on the environment. Diversity, per se, has become an important tool in the shaping of public policy. Many conservation efforts are grounded upon in the goal of diversity preservation, and diversity as a concept has been highly successful in shaping public debate.

Stony Brook particularly has great cross-departmental strength in the study of the conservation of tropical environments. Topics range from the design and surveying of large tropical preserves to multidisciplinary ecological studies of threatened species of groups such as primates, that have major ecological impacts on forests and are also of great interest to the public. The Institute for the Conservation of Tropical Environments, our world-renowned faculty in primate ecology, and the recent SBU alliance with Richard Leakey are all great strengths in this area.

- *Marine zoning*

Many of the world's most precious and ecologically valuable marine habitats have declined dramatically, some to the brink of collapse. The causes are a combination of over-harvesting, pollution, over-development in the coastal zone, and habitat damage to due excessive human activity. These pressures will accelerate in the near future as global fishery landings continue to decline and new forms of offshore development, such as the creation of wind energy farms, increase. In New York, the problem is especially severe. Nearly all of New York's shellfish fisheries (hard clams, oysters, scallops, lobsters) are economically extinct, hypoxia and harmful algal blooms plague our waters, and salt marshes are being lost at an alarming rate. With sea level expected to rise another 1-3 ft within the next 50-100 years, combined with shoreline hardening (e.g., by sea walls) caused by human development, New York may lose much of its productive shallow habitat in the very near future.

The rapid pace of marine ecosystem decline in many parts of the world has led many scientists to argue that a completely new approach to protection of the marine environment is needed. As has been done for years in terrestrial habitats, human activities in the marine environment may need to be regulated in a spatially-explicit manner so as to protects ecologically sensitive habitats. Some areas would be set aside as fully-protected marine sanctuaries or reserves, while other areas would be designated for recreational or commercial fishing, transportation and dredging (shipping, ferries), wind

energy farms, jet skiing, and waste disposal, etc. The U.S. Oceans Commission Report is expected to strongly endorse this approach when released in January 2004 and the Pew Foundation Oceans Commission has already called for extensive use of protected areas. Such plans are highly controversial and their implementation and/or likelihood of success is a multidimensional problem, involving not only marine scientists but also social scientists, economists, and public planners. With strengths in many of these areas, SBU is poised to play a leadership role in designing new approaches to protecting marine biodiversity while sustaining economic benefits provided by ocean resources.

- *Transferable Development Rights*

The State of New York passed the Long Island Pine Barrens Protection Act in 1993. This began one of the most interesting ongoing experiments in limiting development in environmentally fragile areas. It is based on the concept of transferable development rights. For a number of reasons, now is a good time for a multidisciplinary team to evaluate how well the Act has done in protecting the Pine Barrens. One reason is that the Act has now been operational for long enough for its effects to be observable. A second reason is that CESER can now bring together a multidisciplinary group with a great deal of experience both with environmental change in the Pine Barrens and with the economics of transferable development rights policies. The lessons from the Pine Barrens are potentially important for producing better environmental policies across a wide spectrum of problems. Because transferable development rights policies are relatively market-friendly they can often achieve good results at a comparatively low social and economic cost.

- *Environmental engineering and industrial outreach*

A consortium approach is extremely valuable for pursuing new research and educational directions related to environmental engineering. For example, a systems approach to energy issues needs to incorporate electrical and mechanical engineering, materials expertise, environmental science, computer science, operations research, risk analysis, and economic and management skills to be successful. An integrated approach to environmental remediation must take into account various technological issues (such as materials science, molecular and dynamic computer modeling, sensor technology and bioengineering) as well as issues related to societal impact (such as long-term site stewardship by communities), human and ecological health, the political landscape and economic feasibility of new methods for pollution prevention and clean up. Without this type of integrated approach -- highlighted by access to diverse skills and knowledge -- the process of identifying opportunities, competing for new funding, and succeeding in development of sustainable collaborative programs is extremely difficult (if not impossible). Likewise, using engineering approaches to problem solving can bring added value to collaborative efforts in the basic sciences and other areas. Hence a model for university-industrial collaboration could be developed along the lines of proven CEAS/University programs for industrial outreach and partnering for design, research and development, and technology transfer.

Research Funding

Perhaps the most important reason for creating CESER is enable SBU and its partners compete more effectively for large interdisciplinary grants that require integration across traditional academic boundaries while also providing enhanced opportunities for education and public outreach. In 1998, the National Science Board established the Task Force on the Environment within its Committee on Programs and Plans. The Task Force provided guidance to the National Science Foundation (NSF) in defining the scope of its role with respect to environmental research, education, and scientific assessment and in determining the best means of implementing related activities.

The report, *Environmental Science and Engineering for the 21st Century: The Role of the National Science Foundation* was issued in February 2000. One major result of this report was the establishment of the NSF Working Group on Biocomplexity in the Environment, later renamed the Working Group on Environmental Research and Education (ERE). NSF's commitment to ERE is underscored by the following:

> *"In supporting activities at the interdisciplinary frontiers, NSF has sought to integrate holistic multidisciplinary investments with disciplinary-intensive opportunities. Because of the tremendous opportunity for advances in environmental science and engineering revealed by this integrative approach, NSF considers environmental research and education a strategic priority for the Foundation. In FY 2001, funding in ERE areas totaled approximately $825 million, roughly one-fifth of NSF's research budget."*

NIH has also begun programs that deal with the connection between environmental science and human health. The table below lists some of the recent and current federal funding opportunities that involve environmental sciences:

Recent Interdisciplinary Funding Opportunities in Environmental Sciences

Agency	area/ title	funding level	comment
NIH: National Inst. of Environm Health Sci (NIEHS)	Superfund basic research and training	$2.1 M direct cost annually, 5 yrs	RFA 2003/04
K12 Clinical Research Training Grant	Multidisciplinary Clinical Research	Up to $20 M over 5 years	not only environmental
NIH:NIEHS and NSF	Center for Oceans and Human Health	$1 M direct annually, 5 years	2002/2003
EPA -Star	Multidisciplinary	about $300k for 3 years total	small collaborative teams or single PI
NSF: IGERT	Graduate Interdisciplinary Training	$3 M for 5 years, mostly direct	not only environmental
NSF:Biocomplexity Total $$: $51 M in FY04 $17 M in FY 05	Dynamics of Coupled Human and Natural systems	$2 M per award, 5 yr	04/05
	Coupled Biogeochemical Systems	$2 M per award, 5 yr	04/05
	Instrumentation Development for Environmental Activities (IDEA)	$2 M per award, 5 yr	04/05
	Genome-enabled Environmental Science and Engineering (GEN-EN)	$2 M per award, 5 yr	04/05
NSF/NIH	Ecology of Infectious Disease (EID)	$8 M total annual	FY 03
NSF/EPA	2003 Environmental Technologies and Systems	$ 10 M total	Pollution prevention, remediation, FY 03
NSF: NEON	National Ecological Observatory Network (NEON)	($6 M to set up NCC and Natl. Proj. Office)	Much more funding in future

Start-up proposal

Numerous departments and institutes at SBU already focus attention on different facets of environmental science. The most prominent of these include the Center for Environment Molecular Science, the Long Island Groundwater Research Institute, the Institute for the Conservation of Tropical Environments, the Living Marine Resources Institute, the Waste Reduction and Management Institute, the Institute for Terrestrial and Planetary Atmospheres, the Marine Sciences Research Center, the Department of Ecology and Evolution, and the Department of Geosciences. This units and others on both east and west campus provide a firm foundation for building an umbrella organization that could coalesce and draw heavily from existing talent on campus, especially at the beginning. However, we also believe that CESER must have a core faculty whose principal goals are to build the institute through research and teaching collaborations that extend across departments and other organizations both on and off campus.

Following a model used at other peer institutions (e.g., Princeton, Stanford, Wisconsin, Brown), the Consortium could begin by hiring an internationally-recognized leader in environmental science to become its first Director. The Director should be given discretion to conduct a series of strategic faculty hirings in cluster areas through negotiation with the Deans on both east and west campus and BNL. We believe that a minimum of six full-time faculty lines should be allocated to CESER, which will result in 12 new faculty hires through 50:50 splits with SBU departments and BNL. Each of the faculty members would have a home in one of the existing SBU departments or at BNL but would also have a commitment to the activities and mission of the Consortium. They would form the core faculty from which, together with many affiliated and adjunct faculty, would emerge an intellectual community dedicated to broad-based environmental research, education, and policy issues. Phase 1 could proceed without waiting for resolution of issues about forming a college, creating new degree programs, etc. The Director together with the Dean of MSRC would take the lead in strategic planning, program development, fund-raising, and coordination of Consortium research and educational proposals. During Phase 2, it is expected that PhD and M.S. programs will evolve once a core faculty are in place. Eventually, a new college may or may not emerge as a natural outgrowth of this process. Because much of the research effort of CESER will focus on applied problems of particular importance to the metropolitan New York and Long Island regions, we believe there is ample justification for seeking state funding to establish the Consortium. Private foundations should also be approached.

Summary of Phased Start-up Plan and Future Goals

1. Hire new Director -- allocate six faculty lines.
2 Director negotiates with Depts., HSC, and BNL to fill 12 co-funded appointments.
3. New core faculty together with existing faculty create new Graduate Program and provides focal point for Environmental Studies majors and the environmental tracks in the science majors.
4. Optional: A “College of the Environment” emerges with new Building to house its administration and core members.

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