Motivation for Earth Institute

- Natural and socioeconomic systems of our planet are on non-sustainable paths
- This represents biggest challenge for humankind for foreseeable future
- Academia as most fundamental generator of knowledge and new ideas has to respond to this challenge
- Question of defining position of Sustainable Development within Academia
- CU: Earth Institute as immediate response
- Future: Sustainable Development as Discipline
Vision: ‘Pillar Concept’

‘Pillars of academia’

- **Cultural Core Driven:** Arts & Sciences Core (Civilization & Culture)
- **Quality-of-Life Driven:** Health Sciences (Human Health)
- **Economics & Social Needs Driven:** Professional Schools (Professional Education)
- **Sustainability Driven:** Columbia Earth Institute (Global Citizenship)
The Earth Institute at Columbia University aims to become the world’s leading academic center for the integrated study of Earth and its environment, human society, and the interactions between the two. The Earth Institute advances and promotes excellence in its basic disciplines—Earth sciences, biological sciences, engineering sciences, social sciences, and health sciences—and stresses cross-disciplinary innovation. Through research, education and global partnerships, it mobilizes science and technology to address the complex environmental issues facing the planet and its inhabitants, with particular focus on sustainable development and the needs of the world’s poor.

‘Sustainable development signifies the ability of the world to narrow the gap between the rich and the poor, and the ability of all to pursue further progress in overall human well-being. The world as a whole, and each major sub-region, ought to be able to accomplish these goals without irreparable harm to vital ecosystems, depletion of essential resources or unjustifiable risks to future generations.’
Earth Institute: Guiding Framework

Feedback Loop is very simplistic but turned out to be useful for conceptualization of EI and identifying gaps in program

Implementation (1)

• Provide basic understanding of the factors determining the capacity (and limits) of the planet for further development (physical and biogeochemical systems, socioeconomic dynamics, political institutions, societal choices),
• Design solutions to problems caused by anthropogenic pressure on the environment (degradation of life supporting systems and depletion of natural resources),
• Analyze socioeconomic factors influencing local, regional, and global development activities
Implementation (2)

- Examine adequacy of political institutions to recognize non-sustainable development and formulate solutions to this problem
- Develop the organizational capacity in government, NGOs and the private sector to implement and manage the practice of sustainable development
- Provide knowledge on the factors that drive individual and collective decision making in situations of threats that are developing on long time scales (generational or longer).

Evolution of EI at CU

- 1992: Concept of Earth Institute developed: ‘Future of Planet’
- 1996: Launch of Earth Institute
- 2001: AC retreat at BRF concludes that main goal of EI is Sustainable Development
- 2003: Strategic vision document: Sustainable Development as main mission; question of nature of Sustainable Development studies posed
- 2007: Self study: discussion of Sustainable Development as academic discipline; Models for institutionalization of EI were explored in principle
- 2008: External and internal reviews
- 2008/2009: EI Faculty model introduced
- 2009: EI faculty established
Sustainable Development in Academia

Pressure on Earth due to human activities. Understanding of and solutions to problem of over-development of planet.

Projection of future states of Earth System under varying development scenarios. Assessment of sustainability of the projected states.

Education

Research

Practice

Educate students with the goal of creating new, interdisciplinary professional profiles for studies of complex Earth system including socioeconomic domain and problem solving.

Research programs that enable studies of Earth's environmental systems. Production of knowledge on complex, changing dynamics between Earth system components due to human activities.

Transfer of knowledge from academia to real world problems. Test of effectiveness of options for problem solving and feedback of unsolved real world problems into academic domain.

EI Faculty and Research Staff

Undergraduate Special Concentration and Major in Columbia College and School of General Studies (fall 2010); fastest growing Special Concentration at CU

PhD in Sustainable development; started in 2005; 23 graduate students

Masters Programs:
1. MPA in Environmental Science and Policy (SIPA)
2. MS in Climate & Society (GSAS)
3. MPA in Development Practice (SIPA)
4. Masters in Development and Society (CE)
5. Masters in Sustainability Management (SEAS; under development)
Course Enrollments

Pressure on Earth due to human activities. Understanding of and solutions to problem of over-development of planet.

Sustainable Development as Academic Discipline

Projection of future states of Earth System under varying development scenarios. Assessment of sustainability of the projected states.

Education

Research

Practice

Departments
Typically basic research; Home of EI faculty; Student research; DEES, DEEE, E3B, Env. Health Sciences, DIPA; also: Barnard, Law, Architecture, Econ, …

El Units
Basic research; components of interdisciplinary research, LDEO, IRI, CIESIN, GISS, …

CCI
Trans-Disciplinary Research; Seed funding projects, seeding cross-cutting centers, seminar series, book project;

CC Centers
Focus on themes, integrated approach; LCSE; CWC, CCC, CERC, CGSD, UDL, CUSD, … CRED
Transdisciplinary Centers

The Columbia Climate Center seeks to improve humankind’s capacity to understand, predict, and respond to climate variability and change within a multidisciplinary approach to sustainable development. By integrating basic and applied research in climate science, engineering, public health, economics, social science and political science conducted throughout Columbia University, the Center will develop strategies for adaptation to and mitigation of climate change, while communicating the science and impacts of climate change to society and providing policy analysis and advising to stakeholders and decision makers.

Transdisciplinary Centers

The IRI's mission is to enhance society's capability to understand, anticipate and manage the impacts of seasonal climate fluctuations in order to improve human welfare and the environment, especially in developing countries. The IRI conducts this mission through strategic and applied research, education, capacity building, and by providing forecasts and information products, with an emphasis on practical and verifiable utility and partnership.
The Columbia Water Center, in collaboration with other Earth Institute units and external partners, is leading intellectual inquiry into the assessment, understanding and resolution of the potentially global crisis of freshwater scarcity.

The mission of the Lenfest Center is to develop technologies and institutions to ensure a sufficient supply of environmentally sustainable energy. To meet this goal, the Center supports research programs across Columbia University to develop solutions that will satisfy the world’s future energy needs. Most of the Center’s work is focused on the technology and institutions needed for development of the three major energy resources sufficient to support the world’s projected population in 2100 without increased carbon emissions: solar, nuclear, and fossil fuels combined with carbon capture and storage.
CRED is an interdisciplinary center that studies individual and group decision making under climate uncertainty and decision making in the face of environmental risk. CRED's objectives address the human responses to climate change and climate variability as well as improved communication and increased use of scientific information on climate variability and change.

Sustainable Development as Academic Discipline

- Projection of future states of Earth System under varying development scenarios. Assessment of sustainability of the projected states.
- Pressure on Earth due to human activities. Understanding of and solutions to problem of over-development of planet.

Education
Research
Practice

The Earth Clinic: Solving Real-World Problems

- Millennium Village Project
- Arsenic Contamination in Bangladesh
- Evaluation of the Efficacy of a School-Based Education for Reducing Arsenic Exposure in Bangladesh
- A pilot subsidized cook stove program for sub-Saharan Africa
- Bamboo bicycles as sustainable transportation in Africa: A feasibility study
- Pastoral education in Dertu: Challenges, Milestones, Lessons Learnt and Way Forward
Earth Institute faculty

- **Academic Governance of Earth Institute**
- 36 faculty members (from 16 different departments or schools)
- Joint appointments with existing departments
- Appointments co-terminus with Home Department appointments
- Regular (25), Associate (2) and Ex Officio (9) membership
- Rapidly growing (Approaching 50 in 2011/2012)
- Ca. ¼ of compensation from EI core
Budget and Staff

- The total budget of the Earth Institute for 2011 is ca. $120 million including ca. $6 million core budget
- The Earth Institute has a staff of ca. 750

SD as new Academic Discipline

- Questions concerning Sustainable Development are too big to be addressed between existing disciplines
- Knowledge base required for studies in Sustainable Development has to be developed and refined in dedicated effort
- Sustained, focused effort required to develop research, education, and practice agendas for Sustainable Development challenge
- New generation of scientists with capability to analyze and address problems in Sustainable Development has to be trained
## Overall Goals of discipline

- The key goal of the discipline is prediction or projection of extremely complex systems into the future, including natural systems and socioeconomic systems and finding solutions to problems revealed by such extrapolations.
- The academic discipline of Sustainable Development has a mandate similar to that of professional schools, i.e., finding solutions to specific societal needs with immediate impact.
- This mandate can only be fulfilled on the foundation of sustained excellence in basic research.

## Definition of Academic Discipline

**Discipline:** A branch of learning or knowledge. ...The word is generally reserved for a subject that is well established and has recognizable methodology associated with it. For example, science, mathematics, and philosophy are disciplines. French, social studies, and drama are not.

*A CRITICAL DICTIONARY OF EDUCATIONAL CONCEPTS, 2nd Ed, (Teachers College Press) 1990, p.101*
Definition of Academic Discipline

Disciplines of knowledge: On the surface it refers to a body or domain of knowledge where precision of meaning and depth of analysis are achieved by the use of distinctive concepts. More basically, a discipline, such as history, philosophy or physics, can be seen as activity committed to the refinement or extension of knowledge in accordance with conventions about how intellectual enquiry should be conducted, and its outcomes evaluated.

A DICTIONARY OF EDUCATION, 1982, p.132

Reasons for new disciplines

The Academic Profession: National, Disciplinary, and Institutional Settings, c. 1987
- Burton R. Clark, ed.

"The industrial Revolution of the late 18th century...began to stimulate the demand for higher education from a rapidly expanding industrial and commercial middle class..." (p. 17)
"The revolution within the universities belatedly reflected the revolution in society at large. The Industrial Revolution had created a larger-scale, more complex society based on great cities and requiring a wider range of expert services. The old universities had been ill-equipped to provide these and a host of new institutions emerged. Dissenting academies, mechanics' institutes, medical schools, and private-venture colleges had grown up to meet the demand for skilled technicians, managers, accountants, doctors, local public officials, and the like." (p. 18)

"...Some subjects gained admission to the college course not by descending from a respected ancestor, but by overcoming an initially ignoble reputation... let us call it the process of subject dignification..."

- 1st 1/2 1700s: English
- 2nd 1/2 1700s: French
- 1819: Harvard grants first American professorship in modern (live) languages
- late 1840s: applied sciences and engineering

(p. 129)
Thoughts on future needs

- Center on complex system studies and projection? Partnerships needed?
- Funding opportunities have to be enhanced within federal funding agencies
- Traditional barriers in academia have to be overcome (e.g., promotion, rewards, awards, recognitions for transdisciplinary work)
- Academic institutions have to embrace SD as central part of their mission
- International Alliance in SD? (EI will convene RF–supported conference at Bellagio to explore such a construct)

Perspectives

- Earth Institute is on its way towards establishing SD as new academic discipline.
- Education, research, and practice programs have been developed and are being refined
- EI has a rapidly growing faculty to provide the intellectual underpinning and the academic governance
- Permanent position within CU still has to be determined
- International Alliance in SD is being explored
Transdisciplinary Centers

- **Improve our understanding** of future climate impacts.
- Develop and evaluate **strategies for adaptation and mitigation**.
- Effectively **communicate the science and impacts** of climate change.
- Work with stakeholders to **develop best practices** for adaptation and mitigation.
Why Discipline?

- Questions concerning Sustainable Development are too big to be addressed between existing disciplines
- Knowledge base required for studies in Sustainable Development has to be developed and refined in dedicated effort
- Sustained, focused effort required to develop research agenda for Sustainable Development challenge
- New generation of scientists with capability to analyze and address problems in Sustainable Development has to be trained -> educational programs of EI are being re-positioned (e.g., Major in SD, PhD in SD; Masters programs in SD).

Reasons for new disciplines

The Academic Profession: National, Disciplinary, and Institutional Settings, c. 1987
- Burton R. Clark, ed.

"...[T]he academizing of new subjects speeded up dramatically particularly after 1880"

- Economics begat Sociology
- Natural History had begotten Biology which begat Genetics and Microbiology -> coalesced with border sciences to produce Biochemistry and Biophysics
- Retinues/Spinoffs: Pharmacy, Nursing, Dentistry, Veterinary Medicine
- Self-defined new professions: Education, Journalism, Engineering in many subfields, Social Work, Accountancy, Finance (p. 130)
Sustainable Development

... body or domain of knowledge where precision of meaning and depth of analysis are achieved by the use of distinctive concepts ...

Domain of knowledge:
Understanding of Earth and its socioeconomic systems in the presence and in the future
Interaction between them
Analysis of projected future states of the world concerning the ability to sustain the pursuit of global society of further progress in overall human well-being.
Earth and socioeconomic systems dynamics
Prediction of complex systems

Sustainable Development

... body or domain of knowledge where precision of meaning and depth of analysis are achieved by the use of distinctive concepts ...

Distinctive concepts:
Integrated prediction of evolution of physical and socioeconomic systems.
Analysis of the present and projected future Earth system (including human domain) in integrated fashion (no disciplinary fragmentation).
Sustainable Development

... activity committed to the refinement or extension of knowledge in accordance with conventions about how intellectual enquiry should be conducted, and its outcomes evaluated...

**Refinement and extension of knowledge:**
- Improvement of understanding of Earth system and predictions of its evolution
- Improvement of understanding of human development options in harmony with natural resources

**Outcomes:**
- Will be evaluated against success in finding options for socioeconomic development on sustainable path

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System Theory

As a transdisciplinary, interdisciplinary and multiperspectival domain, the area brings together principles and concepts from ontology, philosophy of science, physics, computer science, biology, and engineering as well as geography, sociology, political science, psychotherapy (within family systems therapy) and economics among others. Systems theory thus serves as a bridge for interdisciplinary dialogue between autonomous areas of study as well as within the area of systems science itself.
System Theory

In most cases the whole has properties that cannot be known from analysis of the constituent elements in isolation.

The systems view is a world view that is based on the discipline of SYSTEM INQUIRY. In the most general sense, system means a configuration of parts connected and joined together by a web of relationships. The Primer group defines system as a family of relationships among the members acting as a whole.

The emphasis with systems theory shifts from parts to the organization of parts, recognizing interactions of the parts are not "static" and constant but "dynamic" processes.

with the possibility of misinterpretations, von Bertalanffy ... believed a general theory of systems "should be an important regulative device in science," to guard against superficial analogies that "are useless in science and harmful in their practical consequences." ...
Complex System Studies

‘The study of complex systems is using the integration of ideas and methods from many disciplines and a large number of interacting components to answer questions that cannot be addressed by focusing on individual forces or parts with the goal of changing traditional understanding of our world’.

‘Complex systems is often used as a broad term encompassing a research approach to problems in many diverse disciplines including anthropology, artificial life, chemistry, computer science, economics, evolutionary computation, earthquake prediction, meteorology, molecular biology, neuroscience, physics, psychology and sociology’.

Modeling Complex Systems

Understanding complex systems and, even more so, projecting their future states, provides a considerable challenge.

Even comparably simple physical systems such as the climate system require substantial intellectual and computer resources.

Biological and biogeochemical systems are adding complexity to the problem of simulating their future states.

Modeling and projection of economical, political and social systems are hardly developed due to their high degree of complexity.

The ultimate challenge is projection of the coupled system including the physical, biological, and socioeconomic sub-systems.
Modeling Complex Systems

‘… three approaches can be highlighted:
(i) models based on the extension of global climate models (i.e. General Circulation Models (GCMs)) extended to include more physical and biological processes as interacting components in the model;
(ii) Earth System models of Intermediate Complexity (EMICs), which are constructed from the outset to include all critical biophysical processes in the appropriate balance; and
(iii) integrated models that fully include the human dimensions and the biophysical dynamics of the Earth System in an interactive way, at any level of complexity.’

Modeling Complex Systems

‘Adding the human domain to models originally designed for simulations of the physical and biogeochemical components of the Earth system presents the biggest challenge and efforts towards the development of such highly integrated models are still in their infancy. ’

‘Although to many, the inclusion of human processes in Earth System models is a very new challenge, the origins of integrated human - biophysical models at the global scale go back at least to the early 1970s with the World2 and World3 models used in the Club of Rome’s “Limits to Growth” analysis. Integrated human - biophysical models have evolved considerably since the early days of those globally aggregated models, and a wide array of approaches is now being developed.'
Modeling Complex Systems

‘It is likely that a single approach to building integrated Earth System models will not be the optimum strategy. Rather comparing and synthesizing results from a range of different approaches would be a more robust plan. Alternatively, perhaps a number of individual modelling approaches can be integrated into a singly hybrid modelling framework. The next few years will see interesting times for Earth System modeling.’

El approach: Options

There are several options for gaining access to information on future states of the planet.

(1) utilizing models developed by other institutions (universities or research centers),

(2) collaboration with institutions who take the lead in developing coupled models,

(3) initiating a consortium of institutions for development of complex models, or

(4) dedicating significant resources to the development of complex models within the (Earth Institute).
Peer Institutions

Complex system studies are not new to the scientific community. Many of our peer institutions have efforts underway in this field. Typically, they lack:

1. Full integration of human domain
2. Focus on Sustainable Development
3. Participation of wide range of disciplines
4. Focus on future states of the world