

The Grand Challenges: Energy, Development, and Global Health

Final report of the 2008 Princeton Colloquium on Public and International Affairs, April 11–12, 2008

Event cosponsors: School of Engineering and Applied Science; Princeton Environmental Institute; Woodrow Wilson School of Public and International Affairs

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Several of the most significant problems facing humanity today are also the most complex: energy, environment, and security; rural poverty, land use, biodiversity, and water in Africa; global health and infectious disease; and environmental justice. Recognizing that these issues represent irreducible mixtures of social, political, and environmental challenges, the Princeton Environmental Institute, the Woodrow Wilson School, and the School of Engineering and Applied Science have launched a new program of teaching and research to focus on these “Grand Challenges.” The 2008 Princeton Colloquium on Public and International Affairs examined these issues in depth with a focus on their interrelated causes and the identification of potential interdisciplinary solutions.

“Grand Challenges” captures the irreducible, complex nature of the energy, development, and global health challenges that this new, campus-wide initiative will tackle across academic disciplines, bringing together the best minds in social, natural, and engineering science. Science, politics and economics are at the grounding core of the endeavor, and the initiative will reduce barriers between disciplines to allow researchers to tackle critical intellectual and social challenges collaboratively. Keynote speaker Julie Louise Gerberding, Director of the Centers for Disease

Control and Prevention, and five panels explored these issues in collaboration with departments and programs from across Princeton University.

Introduction to the Grand Challenges

Nolan McCarty, Acting Dean and Susan Dod Brown Professor of Politics and Public Affairs, Woodrow Wilson School

Stephen W. Pacala, Director, Princeton Environmental Institute; Frederick D. Petrie Professor in Ecology and Evolutionary Biology, Princeton University

H. Vincent Poor, Dean, School of Engineering and Applied Science; Michael Henry Strater University Professor of Electrical Engineering, Princeton University

Sponsors: Princeton Environmental Institute, School of Engineering and Applied Science, Woodrow Wilson School of Public and International Affairs

Woodrow Wilson School Acting Dean Nolan McCarty opened the Colloquium by stressing that solutions to the Grand Challenges do not lie within any single academic endeavor. For example, our energy challenges encompass the environmental problems of climate change and air pollution, the political and economic problems of energy security, price volatility and Middle East instability, and a myriad of clean energy engineering challenges. Princeton is uniquely positioned for this ambitious initiative. Students and faculty are involved at all levels, through new

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freshman seminars, internship opportunities, senior thesis research funding, competitive fellowships, and innovative cooperation among faculty members. Each of the three grand challenge initiatives will support and integrate undergraduate education, graduate education, and research to focus on interrelated causes and interdisciplinary solutions.

As Professor Stephen Pacala, Director of the of the Princeton Environmental Institute put it: “Grand Challenges was designed with one of the most vexing and long-standing issues in academic life in mind – the tension between the basic and the applied, the tension between the disciplinary and the interdisciplinary and the tension between the tractable and intractable.” Sharpening minds through disciplinary education continues to be absolutely critical, but can leave us “unprepared to deal with the problems of the world.” Delivering on the social and humanitarian aims of the program requires using time wisely on interdisciplinary research, within and outside of the academic year, including during the summer and intersession periods.

Diagnosing and developing actionable solutions to vexing humanitarian problems will require the pursuit of the most intractable problems in the world, rather than pursuit of the most pregnant and ready to be answered problems often focused on by scholars. The initiative will help harness and build on the incredible talent at Princeton, allowing researchers and students to inject new ideas and energy by “lowering the price of admission” to focus time on these problems, and “migrate over into these problems organically and naturally and in a way that’s productive.” Doing so will allow Princeton researchers to “light up some of these problems” and “make some headway that others haven’t.”

Dean H. Vincent Poor of the School of Engineering and Applied Science emphasized what an “exciting time” the Grand Challenges program presents, spurring partnerships all over campus, elevating focus on these issues, and inspiring students and faculty to improve societies. He heralded Princeton’s “bold vision and a commitment that these challenges must be solved and they can be solved.” As Dean Poor emphasized, engineering students, among others, have tremendous opportunities to contribute to answering the most vexing problems facing society – including producing cleaner

energy while protecting the global economy, developing better social infrastructure, and providing basic services to the billions of people who still do not have access. Delivering technological solutions, integrated with social solutions, is an important way to inspire students to study engineering and develop the next generation of leaders and technologies that can have a major impact on the lives of people and improving society. Working on Grand Challenges “shows them how important technology is to society, how important things like policy and science are in technology and how it all has to fit together.”

KEYNOTE ADDRESS

Infectious Disease in the Age of Globalization

Julie Louise Gerberding, MD, M.P.H., Director, Centers for Disease Control and Prevention

Introduction

In her introduction, Princeton University President Shirley Tilghman expressed her excitement at having so many members of the university community, graduate alumni and distinguished visitors together to discuss the Grand Challenges – energy, development, and health – which she agreed are too interdependent to study from just one vantage point. She praised the sponsors for embracing an interdisciplinary model: “Today’s grand challenges are both multidimensional and interconnected and any viable solution will have to balance competing global needs for the benefit of all.”

President Tilghman extended a special welcome to the keynote speaker, Julie Gerberding, “who has made the challenge of preserving human health a lifelong calling.” She noted that under Dr. Gerberding’s leadership, the organization has strengthened its international role through an ambitious global disease detection program which operates centers in China, Egypt, Guatemala, Kenya and Thailand.

Dr. Gerberding joined the faculty at the University of California San Francisco after medical school, which brought her face to face with AIDS and cemented her interest in infectious diseases. As head of the epidemiology prevention and intervention center at San Francisco Hospital she took pioneering steps to prevent the transmission of HIV to health care providers nationwide. In

1998, she moved to the CDC, and in 2001 was named acting deputy director of the National Center for Infectious Diseases just in time to confront the anthrax scare and provide a voice of reason to ease the public's fears. In 2002, she was named the director of the CDC. Since then she has ably confronted the public health threats surrounding SARS and more recently avian influenza. "Whether the enemy is bioterrorism, multi-drug resistant tuberculosis or a yet to be identified virus," President Tilghman said, "Dr. Gerberding is in the forefront of our nation's response."

Keynote

Dr. Gerberding provided a broad perspective on global infectious diseases and the challenge of moving beyond mitigation efforts to address root causes. She began by going back in time to her appointment as acting deputy director of the National Center for Infectious Diseases, on September 1, 2001. Beginning with the World Trade Center attacks 11 days later, her experience has been marked by a series of urgent crises. These included the anthrax attacks, the national outbreak of West Nile virus in 2002, a monkey pox problem, then SARS, and then an even worse West Nile outbreak, followed by smallpox vaccine program issues, the emergence of H5N1 avian influenza, and mad cow disease problems.

She showed a map with some of the highlights of the emerging or reemerging infectious diseases over the last decade or so, a sobering reminder of the scope and implications of global disease threats. She reminded the audience that old, endemic diseases continue to pose significant and reoccurring threats, with risks knowing no boundaries in a global world. She mentioned tuberculosis, HIV, malaria, and neglected tropical diseases. Further, diseases like measles can make a comeback because Europeans have stopped fully immunizing their children, putting the United States and other countries at risk as well when cases travel by airplane. "These threats are without borders, they have no respect for continents and it doesn't really matter whether they're old or new, they're formidable foes." With an increasing juxtaposition of animals and humans, coupled with water and other resource issues, we need to think ecologically, not organistically (or pathogen by pathogen) when we look for solutions to these very significant challenges.

As Dr. Gerberding described, global extremes and movement are creating fast-moving global threats. At the same time, the CDC and other government agencies are operating within an environment of very high expectations for institutions and desire for flawless performance, instantaneously, with complete transparency. Agencies like the CDC are also "operating in an environment of intense resource competition," with a discretionary federal budget that is going to get smaller and smaller, as the costs of health care delivery are going up and our aging population is going to be requiring more of the resources that we have. Discretionary dollars to spend on things like global health are going to be under very high competition.

Finally, she emphasized that "time really matters" and lives are at stake. For instance, "if we had invested \$15 billion at the beginning of the AIDS epidemic we would not be dealing with 15 million orphans today." The faster we act, and hopefully prevent these diseases from emerging in the first place, the less expensive it is and the more likely we are to be successful.

SARS is a quintessential illustration of these insights about the global nature of disease threats and the importance of timely response. The physician who was taking care of early SARS patients in China got sick and went to Hong Kong to see his brother. He stayed in the Metro Hotel in Hong Kong, and overlapped with others on the ninth floor for about 48 hours. Just going to a hotel and staying there led to 11 other people being infected with SARS. As they traveled, those 11 individuals brought the virus to Vietnam, to Singapore, to Germany, to Vancouver and to many countries around the world literally overnight. A problem like SARS, from any remote part of the world, can become a problem in our backyard instantaneously.

Dr. Gerberding went on to ask, "what are the root causes and drivers of infectious disease spread?" Her broad and illuminating perspective on underlying drivers focused on the following:

- **conflicts and instability**, including terrorism threats, provide conduits for disease risks. In addition, conflict has significant direct impacts on

humans in those areas, with crowding hastening the spread of disease between individuals, healthcare situations compromised, and water sources unsafe and often contaminated;

- **extreme poverty**, with almost one billion people living on less than \$1 a day, with no access to medical services and little access to clean water, who are at extreme risk for all kinds of health problems including infectious diseases; and
- **climate, weather, and increasingly, climate change** pose a third root cause for infectious disease spread, with extreme weather events disrupting our normal ecological systems. Severe droughts also lead to political battles and conflict over water resources in many parts of the world.

To illustrate the types of impacts climate change will have, Dr. Gerberding showed a map of Bangladesh, where the vast majority of people live at very high population densities within five meters of sea level, making it a very insecure area. The same types of risks are significant in parts of China, in Egypt near the Nile River, and in many other parts of the world. These situations create environments with no water security, major human displacements, and prime opportunities for water borne diseases and the diseases of refugees and immigrants that that entails.

Dr. Gerberding emphasized that these root causes – conflict, poverty, and climate change – interact in a synergistic way that makes it very difficult to deal with any of them successfully. As she sees it, the integration of these root causes creates the context for infectious diseases, both the new ones and the inability to solve the old ones. “Is there hope that we can create a better world?” Further, she asked “how can we overcome complacency?” She noted that the public often doesn’t know who to believe, including when there are scientific debates between experts. Not knowing who to believe makes it difficult to reassure the public. In addition, we like to believe that problems can’t happen here, and if they do, we’ll fix them. Alternatively, we often think there is nothing we can do and concentrate on other things.

She believes we can get past complacency, and cited the important work being done by the Gates Foundation and

the President’s program for AIDS relief, the malaria initiative, the influenza preparedness initiatives, and the global disease detection running at the CDC. In the past few years, there are many things that have happened that we were never able to do before and they fall generally into mitigation strategies:

- trying to create new vaccines, new drugs, new counter measures;
- really pushing the envelope on diagnostics that work in the field;
- developing faster ways to detect and respond to global outbreaks and prepare ourselves so that they pose fewer problems for us; and
- preparedness planning and stockpiling.

However, although mitigation is vitally important, Dr. Gerberding reminded us that mitigation is not a solution – getting to root causes is required. She pointed to three common and critical features of success:

- **commitment to a big goal** – figure out what’s the biggest thing you can do that would have the greatest impact for the largest number of people in a reasonable period of time and then make it visible and bold and never waver from that aspiration no matter what;
- **capacity**, because “a goal without capacity is hallucination” – meaning a real scientific foundation to your choices, investment of dollars, people, time and energy, and the ability to stay for a long time until you’ve finished the job; and
- **connectivity**, with people from different sectors coming together, and looking at the problem from a lot of different dimensions, so you can bring all these things together and really make solutions that work at the front end.

She stated that if she could commit to one thing, it would be water security. In order to provide clean water globally, including to the 1.2 billion people who don’t have it now, we would have to solve a lot of other problems, including regional conflict, climate change, and poverty. To emphasize her point, she presented the audience pictures of innovations coming out of deep commitments to water security, at least on local levels.

One example showed water vessels from a small village on the Laotian border on the Thai side that collect rain water to use for watering and non-human consumption to preserve and protect the water that they purify for ingestion. Another example from Uganda showcased women learning how to make water vessels out of clay that don't allow you to put your hand inside, to carry water without cross-contamination.

Noting that all of her pictures were of women, Dr. Gerberding emphasized that “the most important capacity we need to concentrate on to really solve problems in the world is women. They are the most underutilized resource. We have placed the least investment in them. We have created the most vulnerability for women.” Her experience has shown her that when you free up women and give them a chance they are incredible innovators, and she sees women reinventing the health system around the world. For example, she showed a picture of two women in Ethiopia who created a clinic dealing with both HIV and tuberculosis, and talked about a system in Thailand of health workers, usually women, who have special information and serve their communities. These women have created an incredible network of care delivery but also sentinel disease detection across Thailand. Dr. Gerberding went on to share similarly inspiring stories about women health workers in Rwanda and grandmothers forming networks to raise their grandchildren in Mozambique after their parents died of AIDS.

In closing, she emphasized that connectivity is critical not only at the local level but also through the very complex network that all of us are a part of as well. The biggest hope and optimism that she has for the 21st century with all of these threats and challenges is that the network will evolve faster than the pathogens, and the capability of people to come together on a global basis and share information and resources is really just beginning to take off, a network of shared responsibility.

She also stressed that “we really need your advice and your help - we rely on think tanks but we don't really have access to the kind of brain power that exists in a place like Princeton on an ongoing basis, so I hope that some of you would be challenged to think differently and to think into the future about getting to real solutions for the problems that we're facing, particularly those that relate to the urgent threats of infectious diseases.”

PANELS

In addition to the keynote address by Dr. Gerberding, the Colloquium presented a variety of panels on themes related to the Grand Challenges initiative. The panels highlighted issues and their causes, and also challenged participants to work together to solve those most threatening to humanity and the planet.

The Engaged Campus

Moderator: Kiki Jamieson, Class of 1951 Director, Pace Center for Civic Engagement and Lecturer, Department of Politics

Panelists: Kimberly Bonner, '08

Lisa Kelley, '08

Aritetsoma K. Ukueberuwa, Graduate Student, Woodrow Wilson School

Sponsor: Pace Center for Civic Engagement

Panel Moderator Kiki Jamieson, Director of Princeton's Pace Center for Civic Engagement and lecturer in the Department of Politics began by describing the Pace Center as bridging the gap between academics and related real world experience, creating opportunities for students to take active leadership roles beyond the classroom. The Center aims to teach students “how to gather and analyze information about public problems, how to propose and test solutions, how to rework ideas that may not work in the field, how to consult with colleagues both in the academy and out, how to teach and learn with peers and, importantly, how to practice public work.” She emphasized how excited she and others at the Pace Center are to participate as partners in “Grand Challenges,” which she sees as “an opportunity to transform themselves from students into scholars and, importantly, to participate in scholarship that not only adds to knowledge but has the opportunity and indeed the promise of helping to change the world.”

Kim Bonner, a senior in the Department of Molecular Biology, spoke first about her involvement with public service at Princeton, including internships at the House Committee on Science and the U.S. State Department, and thesis research in Tanzania on malaria control. Ms. Bonner is also a member of the inaugural class of Scholars in the Nation's Service. She credits Princeton with allowing her

to experiment with different possibilities for living a life of civic engagement and public service, beginning with an early focus on energy policy. Sponsorship from the Pace Center allowed her to intern on Capitol Hill and gain first-hand experience with the realities of the DC policy-making process. During her summer in DC, she read *Mountains beyond Mountains*, by Paul Farmer, founder of Partners in Health, which challenged “both my perceptions of what is possible for someone to accomplish and the inertia that I see about solving these problems.” Inspired by the potential and need for change, Kim redirected her policy focus to global disease and health issues, and opportunities for the U.S. to improve global health substantially.

Ms. Bonner’s senior thesis research is within the Grand Challenge area of global health, and is focused on malaria control programs in Tanzania, where half the population contracts malaria annually and fully 95% of the population is at risk. A grant from Princeton allowed her to travel to Tanzania to interview policy makers, donor agencies, researchers, factory owners, and ordinary people about various aspects of malaria control. Impressed by results from a voucher program that allows people to have access to bed nets at an affordable price, she has recommended that a similar policy be applied for drug combination therapies that are currently too expensive for infected individuals to buy. This research was particularly meaningful because it is connected to larger, pressing global health challenges. After Princeton, Ms. Bonner intends to work in Tanzania for the President’s malaria initiative, a government partnership between USAID and the Centers for Disease Control (CDC).

The second speaker was senior Lisa Kelley, an Ecology and Evolutionary Biology major with a certificate in environmental studies. A freshman course on the ethics of conservation sparked her interest in ecology, and led her to a summer internship studying Pierce’s Disease in northern California and making the case for preserving intact riverside habitat. Participating in a field biology seminar in Panama, focused on field studies, data analysis, and write-ups, further inspired her interest in field ecology. While in Panama, she began discussing senior research interests with Professor Pacala and was connected to the ongoing Water in

Africa project, a joint effort between the School of Engineering, Ecology and Evolutionary Biology, and the Politics Department. The project investigates the interplay between vegetation, climate, water, wildlife, livestock, and humans to better inform water management in semi-arid and arid regions.

Ms. Kelley’s related interest in land-use and development led her to rural China in the summer after her sophomore year to teach at a teacher’s college, which informed her academic interests in sustainable development. Funding from the Princeton Environmental Institute allowed her to conduct her senior research in Kenya, focusing on the impact of surface water on livestock, wildlife and vegetation. After graduation, Ms. Kelley will be returning to China to lead another round of teachers and then will go to Hanoi, Vietnam to work for a nonprofit organization dealing with the illicit trade of wildlife products.

The final panelist to speak was graduate student Aritetsoma (Tetse) Ukueberuwa, a masters degree candidate in public affairs (M.P.A.) and urban and regional planning. She is also a representative on Princeton’s Sustainability Committee. Before coming to Princeton, Ms. Ukueberuwa focused on environmental studies at Dartmouth, was trained as a climate justice organizer, attended the 11th United Nations Framework Convention for Climate Change conference, and interned at the U.S. EPA and National Council of Churches Eco-justice programs. She is a Nigerian citizen and worked as an international fellow for the United Nations to design safety protocols and training manuals for workers in Nigeria’s nuclear and hazardous waste industries. While at Princeton, she interned at the Trenton Center for the Urban Environment, studying how New Jersey’s new climate change policies impact the livelihoods of urban populations.

Ms. Ukueberuwa called opportunities to apply her academic interests to on-the-ground work through the Princeton Environmental Institute “the highlight of my experience here.” In particular, she spoke about her Woodrow Wilson School second-year policy workshop on urban expansion and land-use in rural China, which included group research in China and the presentation of findings to the World Bank. She focused on agricultural land-use conversion and implications for urban planning practices, and the project further developed her “ability to look at the human impacts of environmental decision making.”

Her deep interest in environmental justice issue stems from her father's family experience in the Niger Delta area, where oil drilling by multinational oil companies devastated fishing populations and the community's economy. While at Princeton, she served as a preceptor for the University's first environmental justice course. She also worked through the Princeton Environmental Institute to develop a study design for sub-standard housing in Trenton to measure energy consumption levels prior to and after weatherization to reduce energy costs and Trenton's carbon footprint, for the Home Energy Action for Trenton (HEAT) project. Finally, she was the co-founder of Princeton's chapter of Students United for a Responsible Global Environment (SURGE), and helped lead a campus-wide campaign to help Princeton become a leader in climate change policy. Part of the impact of this work was encouraging the passage of Princeton's first comprehensive Sustainability Plan, which includes greenhouse gas emissions reduction targets.

Energy, Climate, and Security

Moderator: Robert H. Socolow, Professor of Mechanical and Aerospace Engineering, Princeton University

Panelists: Carol Dumaine, Deputy Director for Energy and Environmental Security, Office of Intelligence and Counterintelligence, U.S. Department of Energy

*Ann Florini, MPA *83, Director, Centre on Asia and Globalisation, Lee Kuan Yew School of Public Policy, National University of Singapore*

*David Goldwyn, MPA/JD *86, President, Goldwyn International Strategies LLC*

*Richard C. Vierbuchen, *79 S*77 P05, Vice-president, Caspian/Middle East Region, ExxonMobil Exploration Company*

Sponsor: School of Engineering and Applied Science

Introducing the first Grand Challenge, Panel Moderator Robert Socolow, Professor of Mechanical and Aerospace Engineering at Princeton University and former Director of the Princeton Environmental Institute, reflected that the boundaries of the energy challenge stretch across critical issues of energy security and climate change. These issues "are a single ball of wax," he emphasized, to be addressed simultaneously using some new structure appropriate to the intractable nature of the problems. Throughout his career, Professor Socolow has been fascinated by the challenge of humanity fitting on the earth. Only now does he feel that we are becoming fully aware of the interconnected problems of running out of low-cost oil and the impact of our

energy use on the carbon dioxide in the atmosphere. He also emphasized the need to focus more on energy efficiency across technological and social dimensions, urban planning dimensions, and the need for additional focus on biofuels through the energy Grand Challenge initiative.

The first speaker, Richard Vierbuchen, is a Ph.D. geologist who has worked on oil exploration at ExxonMobil in the Middle East and Caspian Sea for most of his career. He began by highlighting the major "take-aways" from Exxon's Annual Energy Outlook through 2030, and then spoke about the global hydrocarbon resource base and future supply outlook. He emphasized that Exxon's energy outlook is an objective, annual process, and is a key input into their strategic planning process as a company. The major conclusion from the outlook is that economic growth will drive energy growth 40% higher by 2030 and 80% of this growth will be in the developing world.

Dr. Vierbuchen noted three key challenges to meeting demand: 1) improving efficiency; 2) developing a wide range of new supplies; and 3) managing environmental risks. He believes that technology is going to play a key role in meeting all these challenges. Large populations and increases in energy consumed in the developing world have a compounding effect, as the huge gap between energy use per person in the developed and developing countries narrows. He expects electricity to continue to be the largest source of demand, while transportation will be the fastest source of growth in energy demand. Overall, though, oil and coal will both lose market share through 2030.

"Why are renewables growing so slowly?" Dr. Vierbuchen asked, a question that jumps out from the data. The apparent slow growth comes from lumping all forms of renewables together. When broken out, it is easier to see that the rates of growth for wind, solar, and biofuels are very high, but are beginning from such a small base that Exxon expects renewables to provide only about 2% of our energy supply in 2030! However, if you just play out Exxon's outlook without any adjustments other than the accelerating efficiency improvements, we would expect CO₂ emissions to grow by 1.2% per year on average to 2030 to 37 billion tons. "Obviously, people are going to try to do something about this."

To give the audience a sense of how challenging reducing emissions growth will be, he also showed the relatively minor impacts that some popular alternative scenarios would have. These scenarios include doubling cellulosic biofuels growth, doubling expected increases in the fuel economy of cars, using nuclear or carbon capture and storage technologies to replacing half of the current coal plants, or replacing all coal plants at 40 years. This last alternative would have the largest impact, reducing 2030 emissions by 10%, but would require many new nuclear power plants.

Dr. Vierbuchen then discussed world oil consumption, which is expected to grow about 86 million barrels a day today to about 116 million barrels per day by 2030. Critically, he pointed out that non-OPEC supplied oil, which has been growing in Russia, the Caspian Sea, and Brazil, is expected to plateau and then decline around 2020, at which point we'll be very reliant on OPEC oil; oil sands, coal-to-liquids methods, and other alternative production; and biofuels. "Does OPEC have the resources to meet the global needs as they grow?" This is a hugely important question, due to expected declines in oil reserves elsewhere. Further: "What's on the mind of these people in the gulf, the resource owners, as they look out at the future?"

He pointed out that most of the people that write about "peak oil" and other expectations aren't involved in the business in the region and don't really appreciate the amount of discovered, undeveloped resources or the potential to add resources through improved and enhanced oil recovery. "A lot of the people that think we're about to run out of oil, again they're focusing on what's been produced and what's the remaining developed, not fully appreciating the very large additional components to the world's resource space."

In conclusion, Dr. Vierbuchen summarized four key challenges:

- **Access to the resources.** Will the governments allow us to come into their countries and assist them with developing these resources? The countries that own the resources don't really have the technology to do it.
- **Physical capacity constraints in the industry.**

Are there enough drilling routes, is there enough steel for pipe, is there enough cement, etc.? We're really stretched thin today in costs and it's very expensive and time consuming to find what you need to do a major development today

- **Financial capital required.** There's a huge amount of money, trillions and trillions of dollars, needed to meet demand for hydrocarbons. Will there be enough money to do this?
- **Human capacity.** Over the next ten years about 40% of the scientists and engineers will retire, leaving a great shortage of experienced workers. That's a challenge; it's also a great opportunity for young scientists and engineers looking for a challenging place to work.

The second panelist, David Goldwyn, holds an MPA from the Woodrow Wilson School and is the president of Goldwyn International Strategies Limited. His experience includes working as National Security Deputy to Ambassador Richardson at the United Nations, Assistant Secretary of Energy for International Affairs at the Department of Energy, the Council on Foreign Relations, and the Center for Strategic and International Studies. He focused his presentation on the intersecting challenges of energy use and national security. He emphasized that the first place action needs to be taken is domestically, to put in place a policy framework that will drive the technological change needed and reduce the role of carbon and the role of oil in our economy over the long term. He acknowledged that meeting this challenge will be tremendously difficult.

Goldwyn kicked off his comments with the following key points:

- Energy is a national security challenge;
- Energy independence is a myth – we can't drill our way or invent our way to be independent in a total interconnected global economy;
- Oil dependence/national security and the carbon emissions climate problems are connected BUT require different solutions;
- There are no quick solutions and we need to start now;
- We need to lead at home – we're a huge part of the

consumption and we have no credibility overseas if we're not taking care of our own business; and

- Over the next 20-30 years we need a new foreign policy approach with resource producers.

Mr. Goldwyn quickly overturned DC-speak about “energy security,” reminding us that for most countries and people in the world, energy security is first and foremost about survival. It is also about power, autonomy, the ability to get resources to run your economy, and being able to set foreign policy without coercion. It's also about the avoidance of economic and environmental injury. He reminded the audience that countries' behavior related to energy and oil deeply impacts all foreign interactions. The ability of the U.S. to form critical coalitions and influence foreign policy is tied to ours and other's oil supply routes. For example, he pointed out that China's stance toward genocide in Sudan is impacted by their oil dependence, as is Europe's stance towards Russia on a range of issues, and our ability to take on Iran. Our loss of global influence is partly due to situations like the one in Venezuela, where we don't matter anymore because President Chavez has tons of his own money from oil to exert influence.

He also spoke about the erosion of the oil market, with resource rich countries trying to lock up supply for political and nationalist reasons. He touched upon erosion of the collective energy security system, which we built up in 1975 after the Arab oil embargo, when 65-70% of the world's major consumers got together to have technology and strategic reserves. Now, with only about 40% of major consumers involved, with neither China nor India involved, we don't have collective energy security. Turning to the U.S., he reminded us that dependence on oil is primarily about transportation – planes, trains and automobiles – and national security, in addition to climate implication. In contrast, electricity generation issues are mainly about coal and climate change. They are different, overlapping energy issues. However, for every problem, there are existing technological solutions, and the major issue is that we haven't been able to deploy them on a commercial scale.

Mr. Goldwyn gave the audience a major reality check by acknowledging that we are doing “really, really poorly” at solving our energy problems. United States politics have defeated demand management for energy use and most of the

necessary technologies are years away from being deployed at the necessary scale. He is also dismayed by our progress trying to build a consensus to get reciprocal access to resources and technologies. “Given the overwhelming and intractable nature of these problems, what can we do?” he asked, and offered the following solutions:

Lead at Home:

- First and foremost, adopt a serious cap and trade policy that addresses mobile and stationary sources;
- National technology program to address our real problems and remove bottlenecks;
- Invest in infrastructure;
- Modernize our strategic energy reserves; and
- Promote energy efficiency and conservation across the board.

New Foreign Policy Approach for the long-term:

- Start practicing diplomacy again, especially to promote stability and conflict resolution;
- Modernize our collective energy security system, bringing in China and India;
- Promote reform and transparency in energy markets;
- Promote free market energy and use the power of consumers and reciprocity; and
- Use energy as a tool of soft power and bring electricity to the masses.

In closing, these huge problems are not money or technology problems, but primarily a leadership problem. In addition, the population must be educated enough about the realities so we build a social consensus to change it. Finally, “it's about having a President of the United States who will stand up and tell people you're going to pay more for energy but you're going to be safer and there is no other way.”

Ann Florini was the third panelist to speak on the topic of energy. She is the Director of the Centre on Asia and Globalisation at the Lee Kuan Yew School of Public Policy at the National University of Singapore, with interests across

the board in international relations, environment and development. She co-chairs the International Task Force on Transparency at Columbia. Her forthcoming book is called *The Coming Democracy and Rules for a New World*. Using the lens of global governance, she discussed four major, interconnected problems – energy security, climate change, development, and human rights.

Dr. Florini began by recalling comments by the then-head of the International Energy Agency in 2006, in which he diagnosed the energy problem as being one of energy policy that is not consistent with reality. She agreed with this assessment, noting that if you project forward current policies, the world will need about \$22 trillion in new investments to meet its energy needs, with that investment going towards unstable governments. A World Bank study showed that there is an ominous correlation between stability and oil resources, with the most oil rich countries “a real mess...the more oil you have the worse you are governed.” Connected to, but distinct from, the energy security problem is the need to be carbon constrained. Among the panelists, she was the first to focus attention on governance adaptation challenges, asking: “What are we going to do when there’s 100 million Bangladeshi refugees?”

Dr. Florini then focused attention on economic development, a topic that does not always get brought into discussions about energy policies. “Lack of access to energy resources is another way of defining poverty. If you don’t have access to basic energy resources, you are by definition poor and there’s an awful lot of people who by that definition are extraordinarily poor.” A “lot” may even be an understatement; 2.5 billion people rely on traditional bio-waste for energy, and 1.6 billion lack any access to electricity services, and live their lives with no electricity ever. In addition, the vast majority of major human rights violations in the corporate sector are associated with extractive industries. No other sector has as enormous and intrusive a social and environmental footprint, and at local levels in poor countries there’s no effective public institutions in place, so there’s an authority vacuum.

So, “we have four big sets of problems, energy security, climate change, development, and human rights. Stacked

up against that – what do we have to have in place in the way of institutions, organizations, tools, and measures to deal with this whole complex of issues? What does it all add up to?” Starting with the United States, Dr. Florini seconded Mr. Goldwyn’s statements about the problems with our national energy policies, but also noted that we are not alone, as most countries’ energy policies are not consistent with reality. We need much better national policies, and could get much faster and sustained growth in renewable energy if we had very different national policies.

Another critical actor and piece of the puzzle is the International Energy Agency (IEA), which is not a global body, but is instead limited to the members of the OECD, and was set up to solve the problem of energy market stability after the first oil shock in the 1970s. It set up a stockpiling and sharing system that is insufficient now, with erosion of the collective energy security system because most of the demand is from countries outside of the IEA. In addition, IEA does not deal much with development issues and does not deal at all with human rights issues. The G8 was begun around the same time as the IEA for similar reasons, but pays attention to energy issues only when oil prices are high and rarely makes meaningful commitments. The World Bank, on the other hand, is increasingly being pushed as an important source for clean energy funding across the developing world. Key problems, however, include that developing countries don’t trust the World Bank to represent their interests and the Bank lacks historical credibility prioritizing clean energy and continues to fund lots of fossil-based energy. Although there are many, many other global energy efforts, these are all happening only on a small scale.

“So then the question is, where next? How do we deal with this situation of massive problems, no institutional space within which to deal with these problems and the need to come up with something like \$22 trillion in new investment and figure out where it’s going to go?” There are a couple of ways we could proceed:

- **Build on existing initiatives** – do things like try to entice Russia into the energy charter treaty, expand the International Energy Agency’s current outreach efforts with India and China, and shift the Doha round negotiations to focus more on energy and the

needs of energy for development.

- **Aim for a much more coherent framework** – one that brings together these issues across very different parts of governments and very different types of experts so that you have energy security, climate change, development and human rights all being talked about as part of one big complex of problems.

Dr. Florini sees more hope in the second approach, recalling a famous message from President Eisenhower that one way to deal with a really big problem is to make it much bigger. The reason you make it bigger is because then you can have trade-offs across issue areas, which is exactly the way good trade negotiations are supposed to work. In bringing together sets of difficult issues, you open up room to negotiate when things otherwise appear to be zero-sum games on their own.

The final speaker on the energy panel was Carol Dumaine, Deputy Director for Energy and Environmental Security, Office of Intelligence and Counterintelligence, in the U.S. Department of Energy. Moderator Socolow introduced her as someone “seeking new modalities for the organization of information, who studies how scenarios are used . . . she’s an inventor.”

Ms. Dumaine’s background is as an intelligence analyst at the CIA, and she has come to the Department of Energy to apply some of those approaches to energy and environment taken together, not peeled apart as they usually are. She sees the significant need to apply strategic intelligence (that is, strategic warning and foresight) to develop situational awareness of how the future could unfold in different ways and how that could affect national security. She reminded the audience that “uncommon challenges require uncommon solutions.”

She began by discussing the need for increased intelligence in this arena, leveraging publicly available information. As she described it, “intelligence is about distinguishing what we know from what we don’t know and informing policy makers in a timely way about what they need to know so that they can make better decisions. Strategic intelligence is basically about increasing our readiness today for the unexpected.” No matter what field we’re in, we rarely have 100% certainty (“and if you do, you should question it”), and thus need to know how to act under conditions of uncertainty. “Decision makers today need

to have enhanced insights into the underlying dynamics of how energy, environment, and security interrelate and they also need to know how the context, the global context, can affect national security.”

She briefly recalled the efforts of a panel of retired high-level military leaders who produced a report called “Climate Change and National Security.” Going into the report, most of them were agnostic, but came out believing that climate change is a national security issue. Within the history of U.S. intelligence efforts, however, viewing energy and climate as ripe areas for application would seem out-of-bounds from generally-held assumptions that critical threats arise from human actors. Ms. Dumaine, however, sees energy as squarely within the bounds of intelligence efforts, which, from a larger optic, are about foreknowledge of what could happen.

In the 10 months that she has been at DOE, they’ve held three major workshops to involve experts from a wide variety of backgrounds. This experience has confirmed the observations of Professors Pacala and Socolow that “because of our backgrounds, we generally don’t know how to deal with irreducible challenges,” because “analysis by definition is about reducing things into parts and studying the parts and putting them back together.” The workshops also helped them learn that these problems stretch far beyond traditional national security issues, and may require an ecosystem-like approach to use distinct forms of expertise jointly to mirror the very complex problems. This group is basically trying to evolve a global knowledge ecosystem that is inclusive of different sectors – government, business and NGOs – to take a systems approach to what is viewed as a systems problem.

The work they’ve been doing has also demonstrated that governments “really do lack a capacity for aggregating all of this, distilling it in a way that busy policy makers or leaders of businesses, reinsurance industries and others, can use to make decisions for the future.” The strands of focus through this process include:

- Identify the emergent security issues;
- Link up the scientists with academics and business people;
- Emphasize methods for strategic foresight and

warning; and

- Learn from business inroads in open innovation.

Ms. Dumaine believes that understanding some of the most elusive problems is actually something we can get at only through new cooperative and collaborative arrangements and they're actually quite vital to our national and global security. As an example of where greater collaborative insights are needed is in preparedness for low probability/high impact scenarios, which is one of many areas that can be usefully informed by a better knowledge ecosystem with diverse capabilities.

In summary, her approach is to work towards "unclassified leveraging of global ingenuity and expertise, understanding that we're dealing with complex systems not typically handled well by traditional analysis and prioritizing questions which need to be asked and understanding how the national concerns interrelate with global drivers and impacts." Instead of amassing individual knowledge, we need to get better at looking across and trying to identify uncommon approaches and will need different ways to work together, including futures thinking and horizon scanning.

Eco-Friendly Development

Moderator: Kelly K. Caylor, Assistant Professor, Civil and Environmental Engineering, Princeton University

Panelists: Julius E. Coles, MPA '66, President, Africare

Elfatih A. B. Eltahir, Professor, Civil and Environmental Engineering, Massachusetts Institute of Technology

Joshua R. Ginsberg, '88, Vice-president for Conservation Operation, Wildlife Conservation Society

Sponsor: Princeton Environmental Institute

Panel Moderator Kelly Caylor, of Princeton University's Civil and Environmental Engineering department, began by saying that the panel would address three separate subjects that should be much more interrelated in terms of how we think about development of dry land ecosystems and the shared, similar environmental challenges across the developing world. His own focus is the maintenance of ecosystem services and Africa. Professor Caylor then related themes about African ecosystems and hydrological

dynamics based on his research and that of Professor Elfatih Eltahir of the Massachusetts Institute of Technology. Dr. Eltahir was scheduled to speak on the panel, but unfortunately was not able to attend due to an unforeseen emergency.

Hydrological dynamics in Africa present development and environmental challenges. Professor Caylor and others are taking a geographical, map-based perspective to understand how vegetation and climate interact and answer eco-hydrology questions about the sustainability of African landscapes. Looking first at population projections across the globe and Africa, he focused audience attention on the significant growth expected to occur in sub-Saharan Africa. Water resource distribution is one of the most important aspects of this work. Although there is actually quite a lot of rainfall in many areas, the way that rainfall gets translated into available water resources in terms of both quality and quantity of surface water available for populations is very stark. Drought related deaths are hugely and disproportionately represented in Africa, as are malaria deaths. Both are related to the distribution of water.

As Professor Caylor showed via maps, forest cover losses in Africa are outpacing even classical Amazon deforestation, and much of this is due to the continued use of "traditional biofuels," charcoal production for household fuels. Development in Africa and elsewhere requires water; industry is the dominant user of water in developed countries, and it is very hard to separate real economic development from intensification of water use in the industrial sector. Agriculture is the dominant user in developing countries, and those and domestic needs can't be reduced easily to divert water for industries uses. He sees some opportunities, such as increasing the use of hydroelectric power in Africa, but overall the problem is very challenging.

Professor Caylor then focused on how landscapes interact with water, which is the focus of his research. Showing classic landscape development trajectories from a 2005 Science paper, from pre-settlement to industrialization, he highlighted the transition from subsistence agriculture to industrialized agriculture, or, where there is insufficient water, to very degraded landscapes, with low economic and low non-human value. Without sufficient water, it is very difficult to shift to intensive agricultural production. Intermittency of water availability, with huge differences in soil water from year to year,

and persistent moisture deficits are critical problems in Africa. Neither of these problems are easily adaptable to the traditional ways that we manage landscapes. Advances in the use of remote sensing data to monitor and predict soil moisture and drought will give researchers at Princeton and elsewhere a better idea of how climate change is going to impact these landscapes. This type of data allows us to see that in all classes of drought and in almost all regions of Africa, the incidences of drought and the severity are increasing.

He then showed the audience data about the significant interaction between vegetation and rainfall. With reforestation or the like, climate feeds off of the vegetation and rainfall spikes up with the vegetation in an initial pulse, an increase in rainfall that deteriorates over time. Most notably, he showed that with land degradation beyond a certain point, we cannot return to equilibrium rainfall levels. In this way, the African situation is fundamentally different than ecosystems in northeastern U.S. and elsewhere in which you allow land to come back, and it does, versus unrecoverable shifts in vegetation and climate.

In closing, Professor Caylor reemphasized the inseparable connections and interactions between the economy and the physical environment, especially water, as we think about development in many parts of Africa and elsewhere. Of note, much of his work is in Botswana, where the national currency is literally called *pula*, the Setswana word for “rain.”

In opening up the floor to panelists, Professor Caylor posed the question to them, and to the audience: “how do you separate the economic and social development from the environmental situation that a lot of these countries find themselves in and the situations that we don’t yet even understand that they might be experiencing in the future?”

Julius Coles, the President of Africare, spoke after Professor Caylor. An MPA alumnus, Coles has worked with USAID in Senegal, Swaziland, Vietnam, Liberia, and elsewhere and was in the Foreign Service. In 2007 he received the James Madison award from Princeton University. He thanked Professor Caylor for showing maps, charts and demography figures that demonstrate the difficulty of the African environmental situation and the impact that it’s having on the people and on the economic development of the continent as a whole.

Mr. Coles has spent 46 years working on Africa. He began his talk by discussing the positive economic growth signal of some 5.4% over the past five years across African countries, summarized in the 2007 Africa Economic Outlook, a publication of the African Development Bank. This stands in major contrast to slightly positive or negative growth for 30-40 years after independence, and represents a phenomenal change in the situation and sense that it is not a continually hopeless situation. He pointed out that in some countries, sound economic policies, good management, and leadership have brought about a phenomenal change on the African continent, but also acknowledged that a lot of that growth is due to metal resources and the exploitation of oil and other fossil fuels that are abundant there. Despite the positive signal, Africa continues to be the poorest region in the world.

Experts in the field and the United Nations have acknowledged that Africa is not going to make 2015 millennium development goals. What does this mean?

Mr. Coles thinks it speaks both to how optimistic people were about what could be achieved and how unrealistic these goals were in terms of how they were established. Going forward, they have to be adjusted more realistically. Focusing on poverty in Africa, some 600 million people live on less than \$2 a day. Some 210 million people live on less than \$1 a day. He shared these statistics to give the audience a sense of how serious poverty is on the African continent. Speaking to sustainable development, Mr. Coles noted that most people believe that something has to be done to lessen the heavy reliance on natural resources or suffer major adverse impacts for decades to come. Unfortunately, according to United Nations Economic Mission for Africa indicators of overall sustainability encompassing economic, environmental and institutional dimensions, African economies are less sustainable today than they were 25 years ago.

“Why is this the case?” Coles asked, and offered several causes:

- Extreme poverty, the most significant development challenge confronting Africa;
- Complex linkage between poverty in Africa and the environment;
- Natural resource based African economies;

- Population growth rates;
- Rapid urbanization; and
- Rapid deforestation.

Put simply, today's pressing survival needs place significant demands on the environment, from Tanzanian ecosystems, to Kilimanjaro, to the Serengeti.

Another major problem, as mentioned in the Energy Panel, is the very poor environmental performance of extractive industries. Mr. Coles mentioned exploitation by U.S. companies and looming, increasing exploitation by Chinese companies in this context. Overall, achieving growth through sustainable development is daunting for a continent so dependent on its natural resources. Current patterns of extraction of non-renewable resources such as gold, diamonds, and crude oil have had a huge negative impact on the environment. In Nigeria alone, oil spills and gas fires have polluted the environment considerably for more than 50 years. He emphasized that Africa cannot afford the current approach to resource extraction and cannot achieve sustainable development if rates of oil and mineral extraction continue.

Africa's population growth rate – 2.5% per year in sub-Saharan Africa compared to 1.2% in Latin America and Asia – could double Africa's population in 30 years, placing additional stress on Africa's ecosystems. Food and water supply challenges and environmental degradation are often related to high population growth rates. Rapid urbanization is another core problem that needs to be addressed, and is impacted heavily by rapid rural to urban migration. Huge portions of urban populations live in unsustainable, slum conditions, with only 43% having access to pipe water. Waste disposal is a major challenge.

Rapid deforestation is another daunting problem. The continent lost 53 million acres of forest and woodlands from 1990-2000, a very significant portion of the roughly 650 million acres across the continent, and accounting for 56% of global forest loss. Protection of soils, the recycling of nutrients and the regulation of the quality and flow of water are all threatened by rapid deforestation.

Finally, Mr. Coles mentioned the major challenge posed by climatic variability and the expectation that Africa will suffer more from effects of climate change than any region in the world, with greatly increasing drought and desertification. Severe water scarcities are expected by 2025, and agricultural production could drop by 25%. He believes that climate needs to be a higher priority, and that African governments should be more involved in global agreements.

What are potential solutions to these interrelated problems?

- Strengthening Africa's capacity to implement multilateral environmental agreements and participate more fully in their drafting – being a signatory is not enough. Mr. Coles also believes that international institutions need to devote more resources to training and implementation;
- Assistance to improve the effectiveness of environmental institutions and the legislative bases and administrative procedures for environmental management, which are limited by lack of resources;
- Build additional national level capacity to carry out environmental assessments, strategically looking across larger picture of impacts; and
- African governments need to engage the private sector effectively to provide business solutions to environmental challenges and leverage the technology and knowledge available.

In closing, Mr. Coles stated that he believes that long-term sustainable development in Africa is possible, but that it will take a long time before it is possible to achieve.

The final speaker on the panel was Joshua Ginsberg, the vice president for conservation operations with the Wildlife Conservation Society (WCS). He received his Ph.D. from Princeton and has spent 15 years as a biologist and conservationist working in Africa. He has also held faculty positions at Oxford University and the University College in London.

Complementing the large-scale vision for Africa that Mr. Coles presented, Dr. Ginsberg focused his presentation on smaller scale examples that provide hope that development and environmental issues can be addressed together. He noted that

many discussions about sustainable development are polarized – that is, they either claim that there are truly “win-win solutions” or that things are impossible, with water declining, productivity declining, greater civil conflict, and resources conflicts. He sought to present a realistic view of some of the work on the ground.

The human footprint in Africa, measured by overlays of roads, villages and human access is unequivocally getting stronger, with greater breadth and depth of influence. Dr. Ginsberg stressed that development is critical, both to raise people out of poverty and to allow for conservation. He showed OECD and World Bank data that reveal that overseas direct investment has just begun to outpace development assistance, growing particularly rapidly over the past 3-4 years, with most still in resource extraction fields. He spoke of a “thin silver lining” – direct investment in conservation or focused on development through conservation is about 100 million to \$150 million a year. Because this is such a small slice of overall investment dollars in the region, conservationists need to work through other avenues as well. “We really don’t have much choice. If we’re going to do this, we’re going to have to work both with development and with industry.”

He sees major opportunities for conservationists to work productively with development organizations and U.S. industries, but then noted that working with Chinese industry on these issues is much, much harder, and conservation is definitely not a priority. “Conservation and development have been placed in opposition for about 30 years and that conflict between those two activities I think is in some ways an intellectual problem,” Ginsberg said. The traditional approach to trying to do conservation and development together has been a “donut and hole approach,” with stringent protection in a center zone surrounded by a buffer zone with some level of management serving as a guard between the protected zone and the “rest of the world.” In theory, this was a nice idea, but in practice, rarely worked, with high pressure on buffer zones spilling over into protection areas. Unfortunately, early outcomes are unclear, because this approach started in the ‘70s, before the shift in NGO/foundation focus to greater monitoring and evaluation to measure whether programs actually work.

Dr. Ginsberg then talked about the “second sort of major phase” in the ‘80s with “integrated conservation and development programs” (ICDP), which attempted to do development and conservation in the same place at same time. This work made the naïve and simplistic assumption that if we did good development we would get good conservation. On the positive side, many ICDP projects were successful at meeting their development targets and goals, as measured through evaluations by the World Bank and World Wildlife Fund. The conservation targets, however, were less well defined and often were sacrificed. For example, one project in Uganda, facing a reduced budget, cut conservation activities first and protected core development work.

Currently, Dr. Ginsberg believes we are in the “living landscapes” phase of approaching development and conservation together, using biological and human landscape mapping. With this approach, there is more of an equal partnership between development and conservation. It involves data driven prioritization – layering information about conservation and human needs over each other to highlight conflict areas. This reduces the need to manage the entire system, and allows us to focus on the areas where there are competing human and wildlife needs. It allows us to consider road development, hunting, and agricultural areas and impacts within a larger landscape view, and to manage at a landscape scale.

Dr. Ginsberg spent the rest of his presentation describing specific examples, focusing on certification programs that add value to products and can contribute to “living landscape” approaches. The first example he shared is from the northern Congo, where a logging company, Congolaise Industrielle Dubois, approached WCS to do something to change the dynamics of wildlife conservation and forestry. They started a program in the mid-90s to manage wildlife in the landscape of a production forest, avoiding the situation where building logging roads leads to wildlife destruction and market chains that move bush meat out of the area. The approach WCS took was to have the logging company take responsibility for management in their concession area. However, the original project did not account for a very small population of indigenous people, pygmies, who used the land and moved around on a semi nomadic basis, and this was a real problem.

Congolaise Industrielle Dubois did so well in terms of added value for their timber that they decided to go for forest stewardship council (FSC) certification, which requires that indigenous and local people are brought into the document making process, that the impacts are mitigated and that generally the program is done in a way that has minimal impacts on local people and indigenous people. In 2002, Greenpeace slammed CIB on their approach, but by 2007 there was enough change that certification was granted. This was not a perfect situation, there was learning that needed to happen, with poor engagement but strong conservation results leading to an external certification process that forced them to integrate people into the picture. The project continues to be the best managed industrial forest activity in central Africa.

The second specific example is just one of many developing and marketing products that are more wildlife friendly, the Elephant Pepper Company, an independent organization that has a close relationship to the Tabasco Company. The approach is to reduce elephant crop raiding around protected areas by adding in buffer crops of chili peppers, which elephants avoid, making it unnecessary to shoot them down for crop raiding. The result is reduced impact and reduced mortality of elephants while producing an economically attractive and more secure crop. In Zambia, WCS is working with other organizations to expand this idea to other crops and localize the marketing. The idea is to produce certified and branded products (called It's Wild in Zambia) for consumption in Zambia, reducing the supply chain, developing cooperatives, and reducing the impact on wildlife.

Dr. Ginsberg also mentioned a river conservation project with significant co-benefits – across wildlife populations, fisheries, power generation, and preservation of agricultural potential and hunting territory. Improving the situation through the commercial and small-holder side of things to conserve river flows is important for development and for conservation purposes.

Finally, Dr. Ginsberg spoke about carbon trading and markets in the context of northeastern Madagascar forests. A very large block of forest, containing nine million metric

tons of marketable carbon, has been turned into a carbon reserve. To meet the challenge of marketing that carbon, protecting biodiversity, and delivering benefits equitably, WCS is working to develop distribution for “triple-certified carbon” associated with ecosystem management and sustainable development. In this particular example, in Madagascar, 50% of the revenue is going to go to local communities, and is managed by a capable local financial management and development NGO. The biodiversity benefits are very significant, as well as local benefits, but this is not always possible or as clear with these projects.

In closing, Dr. Ginsberg emphasized that establishing transparent and effective distribution and management of income is the key to successful sustainable development, recognizing that the very poorest people in the world live closest to and off of the land. With these programs, revenues coming in from avoided deforestation, etc. should remain local rather than going to heads of government. This requires capacity building built into the programs and projects, and addressing tenure rights and local income needs. As such, WCS works to help local people get land tenure, which is critical for local communities and indigenous communities and gives them the right to start managing the land themselves.

Antibiotic Resistance: When Drugs Don't Kill the Bugs

*Moderator: Anthony D. So, MD, MPA *86, Director, Program on Global Health and Technology Access, Terry Sanford Institute of Public Policy, Duke University*

*Panelists: Maria C. Freire, Ph.D., President, Albert and Mary Lasker Foundation
Stuart B. Levy, MD, Director, Center for Adaptation Genetics and Drug Resistance; Professor of Molecular Biology and Microbiology and of Medicine, Tufts University School of Medicine; President, Alliance for the Prudent Use of Antibiotics*

*David B. Wallinga, MD, MPA *94, Director, Food and Health Program, Institute for Agriculture and Trade Policy*

Sponsors: Center for Health and Wellbeing; Woodrow Wilson School of Public and International Affairs

Panel Four of the Colloquium brought together four distinguished speakers who have addressed the complex problem of antibiotic resistance through different avenues.

The panel moderator, Dr. Anthony So, is Director of the Program on Global Health and Technology Access at the Terry Sanford Institute of Public Policy, Duke University. He leads a

program that supports research, policy meetings and teaching on issues of global health, and is the strategic policy unit for ReAct, an international coalition for action on antibiotic resistance. Previously, Dr. So served as Associate Director of the Rockefeller Foundation's health equity program. He has also served as a senior advisor to the Administrator at the Agency for Health Care Policy and Research within the U.S. Department of Health and Human Services, and supported Secretary Donna Shalala when she co-chaired a presidential advisory commission focused on improving the quality of health care for all Americans.

Dr. So kicked off the panel on antibiotic resistance – “When Drugs Don't Kill the Bugs” – by offering a few remarks to place this global challenge in a policy framework. In his Nobel Prize acceptance speech for penicillin in 1945, Alexander Fleming sounded one note of warning, on the potential danger of underdosing. He observed that it's not difficult to make microbes resistant to penicillin in the laboratory by exposing them to concentrations not sufficient to kill them. In the decades since the 1940s, his comments have proved prophetic.

Antibiotic resistance is an issue that grabs an occasional front page headline, as when Andrew Speaker, suspected of carrying drug resistant tuberculosis, boarded a passenger plane to Italy, or when a school child succumbs to methacillin resistant staph aureus (MRSA). Antibiotic resistance is more widespread than most realize, and claims victims under the flag of a dozen diseases or more. The Journal of the American Medical Association (JAMA) reported in 2005 that MRSA killed more people in the U.S. that year than HIV.

Dr. So emphasized that antibiotic resistance is a global problem. Last year a Tanzanian study found that mortality rates in hospitalized children, linked to antimicrobial resistance, was double that of malaria. Yet this problem does not receive the sort of attention that AIDS and malaria get, despite the significant impacts. Using a map, he retraced the worldwide spread of penicillin resistant streptococcus pneumonia clone 23F, illustrating that in addition to being a global problem, it is a problem of globalization. In public policy terms, he explained that preserving the effectiveness of antibiotics poses a classic public goods problem, with tradeoffs between individual versus collective interest decisions. For instance, clinicians may

prescribe a broader spectrum antibiotic or a combination of antibiotics so as not to miss a resistant strain when treating a patient. This has consequences at the community level, reducing the availability of effective antibiotics, but seems to be in the best interest of the patient.

There are similar tensions that play out also among the individual and collective behaviors of other stakeholders. Another important factor in the story are drug companies. To recoup research and development costs and profits the company will aggressively market a broad antibiotic to secure a larger market, even if its uptake will accelerate development of resistance and diminish eventual effectiveness. Insurance companies are yet another player, paying for hospitalizations extended by resistant infection rather than pay for infection control at the hospital lest there be free riding by other insurers. These diverse incentives raise the important policy question: “What public sector interventions might realign individual and collective actions by these stakeholders to combat antibiotic resistance?”

Before introducing the panel, Dr. So also briefly focused on both the supply and demand side problems related to antibiotics. On the supply side, very few new antibacterial classes have surfaced in recent decades, with a significant hiatus since the 1960s and only a couple of new bright lights in recent years. Major research-intensive pharmaceutical firms are not investing in antibiotic discovery and development. Because antibiotics are typically used for short, limited time periods to actually cure disease, and have low profit margins, in contrast to chronic disease treatments, there is less incentive for drug companies. Even with complementary technologies and approaches available, Dr. So sees a need to accelerate the development of new antibacterials, which will require public sector intervention, such as push incentives that pay for research and development inputs and reduce the level of private sector investment involved. On the demand side, the policy thinking has been to reduce risk to drug companies by guaranteeing greater returns, through advance purchase commitments or other pool approaches that pay for outputs of research and development.

As a final framing point, he stressed that there is a lot of opportunity to make a difference in this field, and he shared

his hope that the panel will help to inspire some in the audience to work on this important challenge.

The first speaker, Dr. Stuart Levy, is Professor of Molecular Biology, Microbiology and Medicine, and Director of the Center of Adaptation Genetics and Drug Resistance at Tufts University. He is also the President and inspirational force behind the Alliance for the Prudent Use of Antibiotics, the leading organization in bringing awareness to policy makers about this issue. Among his scientific and other professional achievements, Professor Levy wrote the issue's classic book, *The Antibiotic Paradox, How Miracle Drugs are Destroying the Miracle*.

Dr. Levy began by stressing the international nature of the problem, and very real threat of multidrug resistance because resistance doesn't limit itself to just bacteria but parasites and viruses, creating "a black cloud on the ability to treat common diseases." In the United States, when resistance strikes, we usually have backup drugs, but that isn't true everywhere, and for any of these diseases there are strains that are resistant to not just one but to multiple different drugs. The current problem is not what Alexander Fleming warned – resistance to penicillin, but resistance to penicillin and tetracycline and other antibiotics all in one organism.

Another problem that Fleming did not anticipate is that this issue would not just limit itself to where antibiotics are used most, in hospitals. Antibiotics are now spread all over the community and all over the U.S. in many different ways. To illustrate this point, Dr. Levy recounted what happened with the antibiotic Cipro, used during the Anthrax scare. Despite being a drug used only for really serious illnesses, ABC news did a query and found that 2% of American households had somehow gotten hold of Cipro and had it in their medicine chests. Even *Glamour* magazine did an expose of sorts, having a young journalist go on the web and say that she had a urinary tract infection and in short order was able to get a 60 day supply of Cipro, the recommended dosage for an anthrax attack.

"How do resistance problems happen?," Dr. Levy asked. First, you need the antibiotic, which kills off everything that's susceptible and allows bugs that are resistant to stay

and with them coming together you have a resistance problem, but a contained one. Second, resistance becomes a clinical problem when bugs spread, and a patient does not respond to treatment. This second step becomes fairly easy when strains are moving around hospitals, communities, and moving among people in homes. The latest statistics say we produce 35 million pounds of antibiotics in the U.S. A pound is 450 grams and we hardly use a gram to treat a patient, which gives us a sense of how much extra antibiotics are out there. A large proportion is used in animals, but also in certain parts of the country. In Louisiana, Washington, and Florida, fruit trees are being sprayed with antibiotics, some the same as the ones that we use in people, to control infection of the trees. In addition, antibiotics are doled out more than needed in hospitals and homes all over the country, as with the Cipro mania story.

There's another side to antibiotic resistance and that is that the resistance genes don't stay put in the organism they are once there. "It's like a dog being able to transfer something to a cat or a pig to a cow." Extra chromosomal units called plasmids carry resistance genes on something called a transposon, and these pieces of DNA can move from strains that are different and then they can jump onto the chromosome and become a part of normal bacterial genes, converting that bacteria to a resistant organism. "Given all these pathways for getting around, is there any reason we should wonder why resistance has been created so quickly?"

Public awareness is incredibly important, Dr. Levy stressed, because of how we use antibiotics and how we store them and how we believe they are all powerful. If we use antibiotics in human or plant agriculture, or animals, they just don't disappear after we use them. They go into municipal supplies, and out into natural water. Levy believes that this environmental, ecological feature is important, and thinks that most of resistance is occurring outside of human bodies. The Alliance for the Prudent Use of Antibiotics is studying the kinds of resistances that exist in bacteria that are not causing infections worldwide, as these are reservoirs of antibiotic resistance that then can be transferred to bacteria that are of consequence to health.

Finally, Dr. Levy addressed the "germophobic" movement underway in the U.S. and now worldwide that has led to antibiotics being added to soaps, cleaning agents, plastics,

toothbrushes, etc. Clever marketing people started putting antibacterial into everything, for no sensible reason. Levy left the audience with the message that we really have to make peace with microbes, rather than continue to believe we can sterilize ourselves against them, which only causes us harm and increases the development and spread of resistance.

The second speaker, Dr. Maria Freire, serves as President of the Albert and Mary Lasker Foundation, and was formerly the CEO of the Global Alliance for Tuberculosis (TB) Drug Development, a not-for-profit, public-private partnership created to develop new, faster acting anti-TB medicines that are affordable and accessible to patients worldwide. Prior to that she was Director of the Office of Technology Transfer at the National Institute for Health (NIH). She is a biophysicist by training, with post-graduate training in immunology and virology and has been the recipient of a Fulbright fellowship as well as two U.S. Congressional Science Fellowships.

Dr. Freire focused all of her comments on the case study of tuberculosis. First, she gave some background on the numbers for tuberculosis infections and resistance. Second, she shared the results of an experiment done by the Alliance to address the problem. Third, she discussed the consequence of those actions from a global perspective.

Tuberculosis kills one person every 20 seconds, about 1.6 million people every year, while eight to nine million get infected all over again. It is the biggest killer of women of child bearing age in the world. Fully a third of the world is infected with the latent form of tuberculosis. A final scary number is that the economic bill for the tuberculosis epidemic is \$16 billion. Antibiotics do work to combat TB, and they're relatively inexpensive. So, what's the problem and why do so many people die? The cost of the treatment is primarily in the way we have to deliver it to avoid drug resistance, and we've been relatively unsuccessful.

We treat TB through what is called directly observed treatment, which the World Health Organization recommends. Those infected are asked to take antibiotics for six to nine months, taking a combination of four drugs for the first two months and then taking intermittent treatment for the following four months. One of the first things Dr. Freire did when she became CEO of the Alliance was to go back to Peru (where she is from).

Peru is an endemic country for tuberculosis. She watched people take their treatment, a combination of 11 pills that you have to take in one sitting at a facility away from your home. She realized that it is an unnatural thing to do. That's the cost of TB; it's a social cost, an economic cost. Importantly, people stop taking the antibiotics, creating an entirely man-made epidemic of multi-drug resistance to TB. Now we have extremely drug resistant tuberculosis (XDRTB).

About two years ago, we discovered that there were people infected with TB that died within two weeks of diagnosis. We didn't understand at first. It was a combination of the TB and HIV co-infection and it was essentially a new strain of tuberculosis that was resistant to essentially everything that we had. We were running out of weapons. XDRTB has pretty much been identified all over the world. We're talking about a big epidemic, we're talking about big numbers and we're talking about a set of problems in which we have no more weapons.

The good news is that in the year 2000, a group of very clever people, about 60 people, got together in Capetown, South Africa and said, we have to do something about this. This was 2000, and XDRTB was first described in 2005 or 2006, so we were a little ahead of the game. We created a new organization – a not-for-profit pharmaceutical – to figure out how to work on making new antibiotics for tuberculosis for which there is no market, because there was no real return for the investment by the drug companies.

The Global Alliance for TB Drug Development is a product development partnership, a subset of the public private partnerships, in this case with the goal of developing TB drug candidates and novel regimens for treatment. The Alliance also aimed to bring other people into the discovery and development of TB antibiotics, including attracting those who had left the field, while making sure that the product was going to be affordable, was going to be accessible to the people who needed it, and was going to be adopted in the field. That's the vision. And why are these criteria important? Tuberculosis is a disease of poverty. And so we have to insure that in the economies where there is no coverage for this that people can take the drugs.

Dr. Freire showed a slide of the mountains of pills that we ask people to take for TB. Their vision is that at the end there will be a blister pack in which you would actually have fixed dose combinations of antibiotics that you can give people that they would be able to take, while avoiding having the drugs flying all over. The organization is also aiming for a treatment that is two months or less, that can be effective against multidrug resistance and extensively drug resistant tuberculosis that can be co-administered with antiretroviral drugs. Dr. Freire is fully confident that the group will achieve the two month treatment, but less sure when they'll be able to tackle latent forms of TB.

The premise of the Alliance was to go into all these pharmaceutical companies that have all these antibiotics sitting on the shelf, just pluck them, and use the resources that we would get from governments and Foundations (Rockefeller, Gates) and then move them, and outsource the development. What happened, however, is that those drugs weren't there - we just couldn't find them. So we made it our business to scout the world. We went to China, we went to Korea, we went to Switzerland, we went to India, we went to New Zealand. We scouted the world for every possible antibiotic that we could bring into our pipeline. We went through scientific and technical reviews, due diligence, and negotiations with the owners of the intellectual property until we finally made deals.

The way the Alliance was organized allowed them to be very nimble in negotiating with pharmaceutical companies, with governments, and with different research groups, building up to their current portfolio, with two drugs that are currently in clinical trials and a whole host of other compounds coming through the pipeline. To convince companies to let them take over antibiotics that they weren't otherwise going to move or put money behind, they had to be very strategic, and convincing about their ability to move the drug through the process. In one case, they created an interesting agreement in which they committed to moving the compound forward or giving the company the money if they couldn't. They then beat every deadline and milestone, and within three years had that compound starting clinical trials.

In addition to being proud of their ability to move the drugs through the process, Dr. Freire is proud that, in using our resources, we created an infrastructure for others to go into tuberculosis and tackle the pipeline problem, resulting in a significant current global pipeline. What the Alliance and other discovery groups look for are drugs by function, aiming to have antibiotics that will attack the TB bacillus from different angles, in combination. In the process, they are not only creating new antibiotics but the new combinations that are going to be powerful because they're going to be intelligently designed to tackle different targets.

Dr. Freire wrapped up her presentation by emphasizing that we really need innovation in this space. The dearth of innovation and research is something we really do need to move forward on, and in terms of collaboration we will need all the resources. We have to act and think comprehensively because it may be a pharmaceutical company that has the best drug for one aspect but they can't go it alone, but nobody else can either so we do need to think about this in a cohesive and holistic way. Directing her comments at students in the room, Dr. Freire also emphasized the need for talented people in this exciting field, to tackle disease in a different way, at a great grand scale, and creating a novel mechanism to do that. Financial and technical competence and contribution in particular will be critical.

The third panelist was Dr. David Wallinga, a physician and Director of the Food and Health Program at the Institute for Agriculture and Trade Policy, an NGO. He applies a systems perspective to the intersection of public health, agriculture, food and environment. Most relevant to the panel, Dr. Wallinga has focused on the ecological health impacts of inappropriate use of antibiotics in livestock and poultry, and played an influential role in the Keep Antibiotics Working Coalition. He has also served on the board of scientific counselors to the CDC's National Center for Environmental Health, and previously served on the science advisory board of the EPA.

Dr. Wallinga began by reiterating the point that Dr. Levy made - that antibiotic resistance is not just a grand challenge but an ecological challenge as well, in part because bacteria are promiscuous and will freely swap DNA even with bacteria that look nothing like them. Dr. Wallinga stressed that resistance is also an ecological problem because the bacteria, the antibiotics,

and the genes are dispersed throughout our environment, from hospitals to households to water systems to farms. The movement of material creates policy tensions, in this case a tragedy of the commons. Keeping antibiotics effective for treating human illness is in the common good, but unfortunately any use of antibiotics can contribute to undermining that effectiveness, with antibiotic use anywhere potentially impacting the effectiveness of another antibiotic use.

While Dr. Freire has focused on the supply side of the equation, Dr. Wallinga has focused on reducing use on the demand side. He believes that until we reduce antibiotic overuse, we're not going to be able to address the essential ecological nature of the problem. In particular, he has focused on reducing the use of antibiotics in agricultural applications. Why agriculture? Why is this important to focus on? There is some scientific consensus that antibiotic and antimicrobial use in food animals is contributing in a significant way to the overall problem of creating resistant organisms that are transmitted to people.

To give the audience a sense of how this happens, Dr. Wallinga described how antibiotic use on farms can lead to selection for resistant bugs that can end up in the food chain and contaminate the meat that we buy in the supermarket. While this is the most direct form of transmission from the farm to humans, there are other ways. For instance, 75% of antibiotics given to animals ends up in their manure, which is often reapplied to agricultural land to grow food. In this way, the antibiotics also end up in the waterways adjacent to the land, some of which are upstream from the water intakes for our municipal water systems.

Another reason Dr. Wallinga focuses on agricultural use is that the volume is huge, somewhere on the order of 20 to 30 million pounds a year. How are these antibiotics used? When animals get sick, we understandably want to be able to treat them with effective antibiotics. However, by far the majority of the use is for animals that aren't clinically sick, but are being raised in very crowded and often indoor facilities that make them more prone to disease. The methods used are also concerning from a resistance standpoint, because they're used in feeders and drinking water to dose groups of animals, not individual animals. With routine use at concentrations too low to kill the bacteria but potentially enough to select for the most resistant bacteria in the animal, we fully expect the development

of resistant strains. Based on Union of Concerned Scientists estimates, about 70% of all the antimicrobials or antibiotics used in the U.S. are being given to beef cattle, poultry and swine in their feed.

These are antibiotics we are all familiar with. About half of them belong to classes like the penicillins, the tetracyclines, or erythromycin-like antibiotics. These are familiar names and have important human uses as well. The FDA approved the use of these drugs in animal feed decades ago, when we knew much less about the nature of antibiotic resistance, and without testing them for safety on those grounds. In addition to poor dose control, which can select for resistance bacteria, there is very poor infection control within indoor, very crowded, and rarely cleaned environments. Finally, there are no ecologic controls and lots of potential for bacteria to spread from the farm environment into human environments

Dr. Wallinga posed the question: "Is this really necessary?" U.S. certified organic production specifically prohibits antibiotic use, and in Europe even conventional production has phased out the use of antibiotics routinely in animal feed. The best case study is Denmark, the largest pork exporter in the world, which in 1998 and 1999 phased out the use of antibiotics in feed completely. The World Health Organization and Danish scientists studies the impacts and found reduced human risks without any impact on food safety, consumer prices and very little impact on producers. However, the switch required a change in practices, including cleaning out barns more often and giving animals more space, and there is major resistance to making these changes in the U.S. Large scale industrial animal producers in the U.S. are using the antibiotics because they are an integral part of the production system as it stands today.

So, "what are the policy levers for decreasing demand for antibiotics in agriculture?" Direct education is one route, but the coalition working on this is also investigating the possibility of passing stricter regulation of antibiotics and changing the market. The greatest impact Dr. Wallinga has seen so far has been in changing the market. For instance, they work with large institutional purchasers like Bon Appetit, which does a lot of the food service management for college campuses. Since 2003, they've actually had a policy on antibiotic use in

food animals. They also work with hospitals on policies for food service contracting so that they preferentially choose companies and vendors supplying meat raised without antibiotics. Also, several years ago McDonald's decided they wanted to decrease the amount of antibiotics used in their chicken production. Tyson is their largest, if not their exclusive, chicken supplier, and they told Tyson: "we want you to do this," and Tyson did it. They reduced their antibiotic use by 93%. Federal legislation would level the playing field and require verification of supplier claims. As such, his group is supporting efforts to pass new regulations in Congress.

Dr. Wallinga ended by asking: "why not just have the FDA do a better job of regulating?" Unfortunately, the FDA's authority is incredibly weak, and they would have a very high hurdle to withdraw their approval for existing antibiotic feed additive, basically having to show an imminent hazard to public health. As a result, those who want to change the system are focused on federal legislation to reduce antibiotic use in agriculture.

Environmental Justice

Moderator: Kimberly K. Smith, Currie C. and Thomas A. Barron Visiting Professor in the Environment and Humanities, Princeton Environmental Institute; Visiting Associate Professor, Center for African American Studies; Associate Professor of Political Science, Carleton College, Northfield, Minnesota

Panelists: Omar Freilla, Director, Green Worker Cooperatives

George S. Hawkins, '83, Director, Department of the Environment, Washington, DC

Martin P. Johnson, '81, President and Chief Executive Officer, Isles, Inc.

Sponsors: Policy Research Institute for the Region (PRIOR); Center for Human Values; Center for African-American Studies

Panel Moderator Kimberly Smith, a Visiting Professor at the Princeton Environmental Institute, introduced the Colloquium's final panel. She also provided a historical perspective on the development of the environmental justice movement. Professor Smith is visiting Princeton from Carleton College in Minnesota, where she teaches constitutional law, judicial process, American political thought, political theory and environmental politics. She is the author of three books, including *African-American Environmental Thought, Foundations*, published in the spring of 2007.

Building on Professor Pacala's introduction to the Colloquium, Professor Smith further delineated the intractable problems the environmental justice movement aims to solve. She agreed that they are very much "grand challenges," requiring creative, outside-of-the-box approaches. She described the environmental justice movement broadly as addressing the environmental problems of impoverished and marginalized communities. The panel focused on urban neighborhoods in particular, as they are plagued by concentrated racialized poverty. In addition to justice issues often being frankly overlooked in national environmental policy debates, standard environmental solutions simply don't work. Solutions must be sensitive to the heightened vulnerability of the poor, the history of racial discrimination, and the pressing need for both economic development and environmental remediation.

Fortunately, the environmental justice movement has made progress in getting their issues on the agenda at all levels of government. Professor Smith told the audience that there has been a steady increase in legislation and regulatory policies, especially at the state level, but also at the federal level, to address problems identified by environmental justice activists. "But there's a sense in the environmental justice community that we're just getting started," she said, "that this movement has the potential to really transform environmental management."

Environmental justice activists today focus on a broad range of issues, from the very local to global in scope. They seek to address some of the toughest and most important questions, including:

- How do we make sustainable development work in the inner cities?
- How can we get a more equitable distribution of resources along with overall reductions in pollution in metropolitan areas?
- How can we integrate environmental and equity goals into our housing, transportation and economic development policies?

The first speaker, Martin P. Johnson, is the founder, President, and Chief Executive Officer of Isles, Inc., a Trenton, New Jersey-based community development organization that has been tackling sustainable development in one of the most

economically depressed and racially segregated cities in the country. For over 25 years, Isles has been developing innovative programs to address the interconnected problems of housing, job training, green space development, pollution and energy efficiency in low income urban neighborhoods.

In contemplating environmental justice “grand challenges,” Mr. Johnson first thinks about the specific challenges in Trenton and similar cities, where environmental hazards are shouldered by those that can least afford to shoulder them. However, these problems are one part of a much larger “grand challenge” to Johnson – the challenge of making our cities work. He believes that “if we can’t find a way to make cities work as a species we’re imperiled, we’re basically in trouble.”

His organization, Isles, was incorporated 27 years ago here on campus by students and a handful of faculty at Princeton to promote development in places outside of the economic mainstream in a way that’s environmentally sound, controlled by those it serves, and meets important economic goals. Isles is organized around five core departments:

- Youth Build Institute, an alternative high school that trains young people in construction trades and other vocations;
- Community Planning and Research group, which works with community groups to develop their own master plans and guide interventions in their neighborhoods;
- Financial self reliance/literacy group, focused on savings accounts, micro-business, micro-lending, and home ownership development;
- Real estate group, which works on energy efficiency in housing, both in older stock and new construction; and
- Environment and community health group, focused on cleaning up environmental hazards, growing food in the city of Trenton (there are no supermarkets), and engaging in broader community health activities.

Isles has had many successes over 27 years, developing hundreds of homes and trainees. Mr. Johnson went on, however, to contextualize their work in the larger demographic trends. He showed a map with population growth and income data,

demonstrating that the county that Trenton is in has grown significantly in size over past decades, while the city of Trenton’s population has shrunk dramatically, bottoming out at about 84,000. Between 1989-1999, there was a significant expansion of poverty and lower income household concentrations into areas around the city. Poverty has deepened and spread outwards, disrespecting the municipal boundaries.

Part of what is happening is that families have left the city of Trenton for better circumstances – many of them people of color, and in the face of increasing white flight from the first ring around the suburbs further away from the city. Mr. Johnson emphasized that this pattern is not unique to the Trenton area. It is also occurring in Camden and other places where flight is happening out of urban areas, and then out of the first and now second and third ring suburbs. In Trenton, the families and children that remain are overwhelmingly poor and overwhelming minority populations. The wealthiest elementary school has 80% of its students now qualifying for free lunch. Trenton segregation levels are so high that they are the third-worst in the country for Latino populations and fifth-worst in the country for African-Americans. Beyond that, Trenton has more students going to school with other poor students than elsewhere in the country by a substantial margin. This concentration of poverty has important implications from an environmental justice perspective. Mr. Johnson then went on to show map data about environment impacts in the area. He showed the heat island effect on land surface temperature, with the very hottest parts of the city also being the area with the highest poverty rates.

The lead poisoning challenge for city children is startlingly poorly measured and treated. Less than 40% of Trenton children are tested, but fully 6% have lead levels of >10 micrograms/deciliter which does major damage to their brains between five and ten years old. However, the state of New Jersey will not intervene until a child is tested twice at 15/deciliter or once at 20. As a result, there is no intervention until it is essentially too late. This is an enormous challenge that Isles and others are just starting to really address. Recently, they tested 420 homes for lead dust levels, and will test 400 additional homes over the next 18 months. The distribution throughout the city is diverse so far, and testing

will allow them to better target efforts, but currently, “it is a big unknown problem.” Trenton’s environmental problems also include 90 Brownfield sites, again mostly in lower income areas.

Another major problem is energy use, with the city of Trenton being a place with lots of energy hogs, because over a third of housing units are sub-standard and use an enormous amount of energy. There is an inverse relationship between household income and energy cost per household – the wealthier you are, the lower the per square foot costs are for energy. This means that the people who can least afford the burden of high energy costs, which have been increasing well beyond inflation, are heavily impacted.

Mr. Johnson also very briefly spoke to environmental justice indicators of impact in Trenton. The air quality in the city is very challenged, with one of the highest rates of deaths related to diesel-based particulate matter. Trenton’s water systems infrastructure challenge is immense, with water pipes under the streets that are 100 plus years old and have lots of lead in their joints, leading to lots of lead coming out of taps even if the water is good coming out of the water treatment facility. Approximately a third of the city has background lead levels that would not allow you to build without remediating the soil, and a lot of kids are playing in dirt that’s filled with lead. Indoor air and health issues also loom large, with Trenton’s asthma burden far more than double the rest of the county’s burden in terms of the population.

The energy cost issue is one that Isles will be focusing on increasingly in the future, with a sixth department in the organization working on energy efficiency – distributed, more environmentally sound energy – and reducing heat island impacts. Isles also wants to help figure out how to make tenure for renters and landowners in Trenton more secure, and deal with the land contamination issue, which segregates communities and weakens connectivity between residents and security of city populations.

Finally, Mr. Johnson talked about the need to ensure that public investments being made in energy efficiency and alternative energy make their way into these neighborhoods.

To truly shift growth to cities, the public sector has to get more of this money and investment into places like Trenton. For structural reasons, very little of it gets there now. He ended with some good news about Trenton and the progress they are making. Isles has gotten to a point where they know a lot about the specific situation, and are prepared to make the additional changes and do the work to move forward. He encouraged those in the audience, living within the extraordinary resources of Princeton University, to help do something about these problems.

The second panel speaker was George Hawkins, who is currently the Director of the Department of the Environment for Washington, DC. He is involved in all dimensions of urban environmental management, from reducing the risks of lead poisoning for children, to dealing with storm water runoff and waste water treatment, to providing energy cost support for low income residents. As Chair of the Mayor’s Green Team, he helps coordinate the District’s sustainability program across more than 40 agencies. Prior to this position, he was the Executive Director of New Jersey Future, a state-wide nonprofit focused on smart growth. Mr. Hawkins framed his insights through a synopsis of what has been going on related to environmental justice in Washington, DC. He has spent his career going back and forth between work in states and cities and “tours of duty in DC.” He first began working in DC in 1979 and has seen it change tremendously over the years, particularly in connection to environmental justice.

As an environmental lawyer, Mr. Hawkins is very aware that the classic notion of environmental justice has been tied to legal issues, and to a core set of issues, including facility siting and cleanup priorities. He sees environmental justice tied to at-risk communities – especially minority and immigrant communities – and to the current distribution of money and power. To help paint a picture of the DC environmental situation, which is tied to the geographical set-up of the city, Mr. Hawkins showed a few maps of the DC area. It is divided into four quadrants, centered on the Capitol, with significant northwest, northeast, and southeast areas and a much smaller southwest quadrant.

Decisions about where to site hazardous waste facilities is a major environmental justice issue. In DC, there are no landfills, which means that all of the trash collected goes to a trash transfer

station first, and is then taken to landfills in other places. So in DC, the question is, “where do you put the trash transfer station?” Further, “where do you put a wastewater treatment plant? Where do you put your cement plant? Where do you put your metal finishing facilities?” Not surprisingly, many people will fight to avoid having these facilities put in their neighborhoods, near where they live. Where are these facilities in DC? Historically and currently, poverty is more concentrated in the three quadrants other than the northwest, which also has lower income pockets.

East of the Anacostia is an extremely poor neighborhood in Washington, DC, which most people have never even seen. This is where you find many of the facilities no one wants – including the largest advanced wastewater treatment plant in the world, a big cement plant, big power plants, and where all of the trash transfer stations in DC were located. When original siting decisions are made for facilities that most people do not want near them, they get placed in neighborhoods with at-risk populations who don't have a lot of money or power to fight the decision. Quite understandably, wealthy neighborhoods fight battles against siting, so within the larger system, the facilities end up populating low income areas with at-risk populations, and then those neighborhoods further decline, and become dumping grounds for the waste treatment plant, the trash transfer station, the wastewater treatment plant, etc., all in one area.

Another classic notion from the movement has been a focus on cleanups. The environmental justice issue is about what gets cleaned up, where, and how funds are distributed. Mr. Hawkins told an illustrative story about a cleanup occurring in northwest Washington, to remove contaminants from an area where mortar shells with arsenic in them were tested during World War I. The area was covered over, and some of the biggest and wealthiest houses in DC were built there. Currently, there is a huge project to find and contain the remnants of these shells. Arsenic is a big problem, but there are all sorts of problems in the rest of DC that warrant similar attention that are not getting cleaned up. This very wealthy northwest site has absorbed something like 25% of all the funds available for these types of cleanups in the USA! As Mr. Hawkins reminded us, the DC story is one of many, a metaphor for any town, anywhere. There is always a part of town with the facilities no one wants, where you also see at-risk youth and populations with less money and less power.

In a global sense, we're shifting manufacturing and other less desirable activities overseas, replicating the same story on a grander scale. The classic notion of environmental justice has expanded in scope outwards.

Mr. Hawkins then shifted his focus to talk more broadly about “why cities?” What happens in cities is vitally important, for the people living in them and for the local and global environment. For instance, taking energy use as a critical example, per capita energy use for transportation and homes is by far the highest for single family suburban homes. Suburban homes built with green technology are somewhat better, but not as good as any residential unit at all in a city. The very best, and most efficient use, is within green cities set up for energy efficiency and with great public transportation. Washington, DC and New York, NY have the best public transport in the U.S. Moving out into suburbs and exurbs – spreading out from the core with all the efficiencies and leaving the city behind – also increases land consumption. What does this mean? Poor urban policies and abandonment of cities are terrible environmental policies. Mr. Hawkins sees the environmental justice movement changing rapidly and dramatically to focus on urban policy issues and problems within the broader regional and global frame. Making cities work is the essential answer, both at the local level, and for the global health of the planet.

Washington, DC is unique place to work on urban policy issues because the District Department of Environment encompasses the city, the county, the state and the feds. They review every development and regulate it all, from lead paint to energy; it is all in one place. The very hopeful bottom-line about DC is that revitalizing the city is working. Twenty-five years ago the city had collapsed and populations in the suburbs were exploding. What has allowed things to improve?

First, those who moved to non-smart growth suburbs discovered that it is really difficult to get around. In these neighborhoods, people and children cannot walk to school, to church, or to stores. In cities, you can get to all these places, they are set up that way, and it is better for people's health and for getting to know your neighbors, etc. In DC, the outskirts got so hard to live in that people starting streaming back into the city, particularly young people. Second, they brought in

a very capable mayor, Tony Williams, and started running the city better. The simple mechanics of picking up the trash, better police response, etc. made it more attractive for people to move back. This is good news. However, it also means that the lowest income residents of DC are being displaced, and moving back to the area along the Anacostia River.

Mr. Hawkins is responsible for the Anacostia cleanup plan for the city, and it has become a sought-after area, with new development coming in. There are new problems related to their success revitalizing the area. They're tackling the challenges of affordable housing in the district and getting businesses to come back in. They're dealing with disagreements about a major new development, Poplar Point, over citing, cleanups, and preserving natural areas from development versus creating mixed use economic development. These debates are critical for DC and for cities all over the country as we work to get cities to come back. DC is coming back, with a population of 650,000 people, up from 500,000, and many, many buildings being built. With that success comes the other challenges we need to tackle to ensure cities remain affordable to all populations and to work through the inevitable development trade-offs.

Green-collar jobs are one critical part of the solution, concluded Mr. Hawkins. In DC, there are jobs to be done across so many areas – cleaning up the river, storm water containment, green roofs, photovoltaic installation, all of those jobs. Job programs to train at-risk youth are a natural ladder, one that is doable and not too far out of reach. A first job can be cleaning the river or painting a roof white, the single best energy efficiency project you can do. These jobs and training for them is a critical part of the solution.

The final panel speaker was Omar Friella, who has been named by City Limits magazine as one of the new school of activists most likely to change New York City. He has also earned a number of other awards in recognition of his activism on behalf of communities and the environment. He is the founder and director of Green Worker Cooperatives, an organization dedicated to the creation of worker-owned and environmentally friendly businesses in the South Bronx. He has also served as program director for Sustainable South

Bronx and has worked with the New York City Environmental Justice Alliance. Mr. Friella kicked off his comments with a story about his initial environmental justice work, which illuminated larger shifts that have taken place in the field.

When Mr. Friella first started doing environmental justice work in New York City, about ten years ago, it was for the New York City Environmental Justice Alliance. One of the very first campaigns was a fight against a waste transfer station in the South Bronx called Hunt's Point, which would have handled about 5,200 tons a day of garbage sent up to the Bronx from the rest of New York City. At the time, it was one of a "laundry list of waste facilities that nobody else wanted in their community" that were on the table or had already been built and were up and running. As Mr. Friella recalls – "we were just learning how to fight." One way that they fought was to organize about 700 people to fill up a middle school auditorium for a public hearing. He recounted the words of a regulator from the State Department of Environmental Conservation, who sat on the sidelines during the hearing, and was overheard saying "the city's like a body and every body has a colon to process its waste." To Mr. Friella, that statement embodies not only New York City's policy regarding waste management, but the way that every city, every town, and every county in the country handles what it is that nobody else wants.

If we accept the premise that certain parts of our cities should be expected to take societies waste, we are not going to recognize communities as being inherently equal in terms of their ability and potential. To change the situation, Mr. Friella emphasized that we also need to change our expectations about people, how benefits and burdens are distributed, and get away from the current situation in which low income communities and communities of color are bearing the greatest burdens and receiving very few of the benefits.

The other assumption Mr. Friella emphasized we need to adjust in order to move forward is that "so much consumption is really necessary, a necessary piece of life." Consumption, waste, and environmental injustice go hand in hand. As he put it, if we weren't generating waste then we wouldn't have communities that were being used as the dumping grounds, and if we didn't have the communities being used as dumping grounds, then we wouldn't be generating so much waste. The radical departure

that Mr. Friella makes from these assumptions is that we can move to a point with real environmental justice and get to a point where we're not generating waste.

His main frustration with the mainstream environmental movement is this sidelining of environmental justice and anyone who talks about racial equity and class equity, which is often seen as at the periphery of an environmental issue. He showed pictures of the South Bronx over time, and pointed out the construction and demolition debris, waste transfer stations, and power plants. Power plants in New York are all located in poor neighborhoods, with 95% of them communities of color. Waste transfer stations and even recycling facilities, when they're not operated well, are seen as eyesores, and because they are in poor neighborhoods, they're allowed to operate however they see fit. Surrounding all of these facilities sited in poor parts of New York, there are vast tracts of land and vacant lots in the industrial parts of the city. As Mr. Friella described it, there has been "pretty much a free for all" rather than planned economic development. Warehouses have sprung up and brought incredible amounts of truck traffic. The South Bronx is now known as Asthma Alley, with one of the highest rates of asthma in the country.

Over time, there has been increasing pushback on the part of the community of the South Bronx against being used as a dumping ground. Experience gained over time, which has brought a great level of awareness and understanding, is leveraged to fight back. These communities are now in positions to preempt the latest waste facility advance and ask for the types of development they do want, proactively. Job creation is the other important piece of the puzzle in the South Bronx and similar communities – there's a desperate need for work. Unemployment is extremely high, as high as 27%. Mr. Friella's organization was formed to help answer the question: "what can we actually do to create work in a way that is amenable and in line with our principles?" Green collar jobs in line with the principles of environmental justice is the type of work Mr. Friella and others are developing, work that creates jobs and improves environmental conditions.

Green Worker Cooperatives, formed four years ago, focuses on moving towards zero waste as a job creation strategy, using some of the huge amount of material that we throw away. Instead of a few workers processing and burying the 10,000 tons of

construction and demolition debris New York creates each day, Mr. Friella's organization works on ways to use this waste, adopting a zero waste strategy, and creating new jobs while reducing waste, and on a global scale, keeping resources in circulation, and reducing the need to cut down new trees. They began by creating a worker cooperative, and have expanded their work to help create green businesses that are owned by their workers and that improve environmental conditions. The first cooperative created a building materials reuse store, turning what would have been construction and demolition debris back into sinks, tubs, hardwood flooring, windows, lighting fixtures, and more, "things that you get at a Home Depot, only that they would have been thrown out previously." Urban Ore, established around 1980 in Berkeley, California, was the first store of this type. Rebuilders Source is the first Green Worker Cooperative, the first reuse store for home improvement actually owned by the workers "anywhere on the planet." Rebuilders Source employs five people to handle a ton/day. Instead of just moving trash out, they're working towards sustainability and zero waste. The cooperative's goal is to be profitable and sustainable on its own through this model.

Mr. Friella stressed the critical importance of the worker ownership model, which creates accountability to the community. There's an intrinsic level of accountability that's built into the ownership of one of these enterprises. In addition, the workers are able to retain the wealth they create as owners of the cooperative, and in turn, are likely to spend the money in the community as well. In short, the cooperative operates based on a democratic model that is rare in practice, a model that empowers workers and engages them day-to-day in the enterprise. Mr. Friella recounted all the ways in which people are disempowered in daily life, and explained that this model seeks to counter that, creating opportunities for workers to be the decision-makers. He concluded on an upbeat note, noting that worker cooperatives are expanding in New York and elsewhere around the country, giving more opportunities to a greater number of workers in the process.

Conclusion

Woodrow Wilson School Acting Dean Nolan McCarty closed the 2008 Princeton Colloquium on Public and International Affairs, thanking the speakers, participants, audience, and organizers. He stressed that he hoped that the two days of discussion about these “grand intractable challenges” had provided information and background that would lead to solutions.

The Colloquium’s key message is that these challenges are not just intellectual problems, but also moral imperatives. Emphasized by all is that solutions must be interdisciplinary, a key component built into the Grand Challenges Initiative.

The Executive Summary of the 2008 Princeton Colloquium on Public and International Affairs was written by Rebecca Lutz and edited by Terry B. Murphy. The report is available online as a PDF at <http://www.princeton.edu/~pcpia/2008/2008Report.pdf>

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