

**NATIONAL INSTITUTE OF ENVIRONMENTAL HEALTH SCIENCES (NIEHS)
FRAMING THE NIEHS AGENDA ON CLIMATE CHANGE**

MEETING REPORT

APRIL 16, 2008

WELCOME AND OPENING COMMENTS

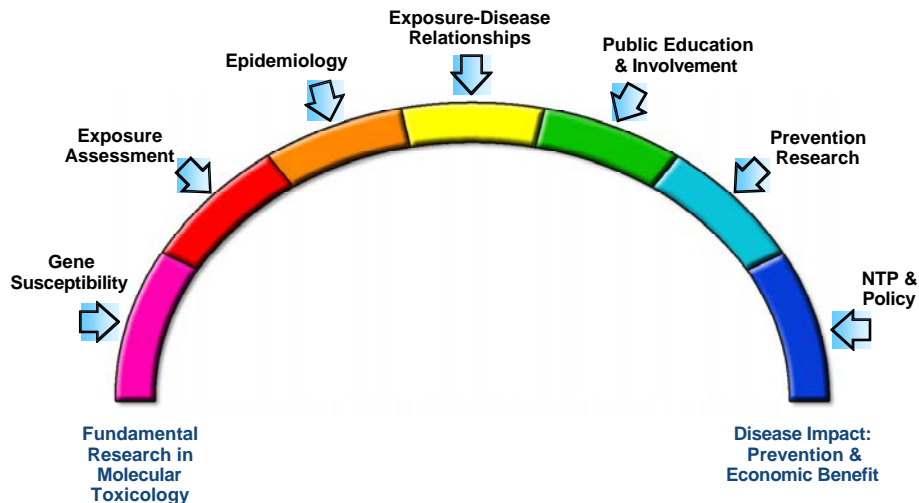
Samuel Wilson, M.D.

Acting Director, NIEHS and NTP

Dr. Samuel Wilson began by reviewing the NIEHS mission: To reduce the burden of human illness and disability by understanding how the environment influences the development and progression of disease. “We know that a cleaner environment equals better human health. At NIEHS, we link environmental protection to better human health,” said Dr. Wilson. “I am reminded that former Congressman Paul G. Rogers, an environmental health champion, often has said that environmental laws are health laws,” continued Wilson.

Unlike most NIH Institutes and Centers, NIEHS works on “the front end of disease” by studying the environmental triggers of disease. The NIEHS portfolio covers a spectrum of activities (see below) ranging from fundamental research to disease impact.

Framing the NIEHS Agenda on Climate Change



Dr. Wilson challenged participants to think about the human health implications of climate change in a fresh new way. He suggested that participants determine the ‘sweet spots’ or ways NIEHS can add value to the conversation on global climate change issues.

NIEHS BEFORE AND AFTER CLIMATE CHANGE: SETTING THE STAGE

Dr. Sharon Hrynkow, Associate Director, NIEHS

Dr. Hrynkow reviewed key milestones in the history of NIEHS involvement in the global climate change issue. Since the early 1990s NIEHS staff and grantees have worked with the Intergovernmental Panel on Climate Change (IPCC) [Information on IPCC activities and reports are available at <http://www.ipcc.ch/>].

In 1995 NIEHS co-sponsored a National Academy of Sciences (NAS) study on health impacts of climate change. Over 300 people, including Vice President Gore attended. Focus areas included: heat stress, skin cancer, immune suppression, vector and non-vector borne diseases, water and air quality, weather disasters and rising sea levels, and social and demographic dislocations. Recommendations for action on climate change and ozone depletion included:

- Global surveillance and response.
- Disease prevention (related to remote sensing data and strengthening public health infrastructure).
- Education for health professionals to include global environmental health, and worker safety related to sun exposure.
- International cooperation.
- Research and Development needs: create interdisciplinary program that would undertake pilot efforts on: (1) infectious and other diseases, (2) mechanisms of susceptibility, and (3) global change drivers.
- Public outreach.

Part of the federal response to the growing awareness of climate change was to establish the federal coordinating entity – Climate Change Science Program (CCSP). CCSP includes a number of agencies with large physical science portfolios, including the National Science Foundation; the National Oceanic and Atmospheric Administration (NOAA); the National Aeronautics and Space Administration (NASA); U.S. Department of Defense (DoD); U.S. Department of Energy (DOE). NIEHS represents the Department of Health and Human Services on the CCSP and as such reports annually on DHHS efforts related to climate change. By and large, the major investment reported to CCSP has been in terms of efforts related to UV-B radiation and related health impacts (skin cancer, cataracts). NIEHS reports on the order of \$14 million in investment using the current CCSP definition. The question was raised as to whether the definition and related items reported to CCSP should be broadened to reflect a more comprehensive investment. It was noted that using another set of lenses, such as asthma or other respiratory diseases, health effects from production and use of alternative fuels, and health consequences from loss of biodiversity, NIEHS investments could be on the order of \$100M. Dr. Hrynkow was quick to note, however, that that figure was likely an overestimate since not all grants captured in those categories would be linked to climate change impacts. “Truth likely lies somewhere in between,” she added. The need for clear definitions and tracking instruments was clear.

The 2010 priorities for CCSP do reflect a broader set of health implications, including to understand investments and strategies aimed how people will prepare for and respond to global environmental change. Specific focus will be placed on decision-support tools related to adaptation (what information is most useful and at what stage), and calls for interdisciplinary research. Specifically, the CCSP has prioritized:

- Research linking ecosystem changes and health outcomes.
- Research to better understand and forecast how climate change affects morbidity and mortality in the US and globally.
- Development of a climate change and human health risk assessment to better quantify and predict health outcomes on a regional scale. Emphasis on development of tools related to decision support.
- Exploring the concept of healthy communities (green/smart/sustainable) as an adaptive framework to protect from the impacts of climate change.

Other NIEHS Venues for Climate Change Input and Discourse

In addition to the CCSP, NIEHS supports the Institute of Medicine (IOM) Roundtable on Environmental Health Sciences, Research and Medicine as one vehicle to identify issues of priority and concern. In September 2007, NIEHS and its partners supported a Roundtable event on Climate Change and Health, then in November 2007, NIEHS and its partners supported (and helped organize) another Roundtable event on Transport Fuel and Health. The IOM Roundtable will continue to be an important vehicle to exchange information and ideas on climate change for NIEHS.

NIEHS was invited to participate in a planning meeting to start preparation for a new National Academy of Sciences study and Summit on Climate Change. Information from the present activity will help inform NIEHS commentary and approach to the NAS planning process.

In addition, NIEHS has begun a dialogue on climate change and energy issues with counterparts at the World Health Organization. The Director-General of WHO made a major address on climate change on the NIH campus in December and her leadership on the issue of climate change in particular was applauded. As a result, WHO has elevated the issue of climate change within its own infrastructure and has made this a priority for this

year's World Health Assembly and for World Health Day. Dr. Hrynkow and her colleagues are working with WHO and with DHHS counterparts to explore priorities and opportunities for cooperation.

Scientific understanding on climate change has contributed to a sense of urgency in a range of communities. The IPCC 4th Report (available at <http://ipcc-wg1.ucar.edu/wg1/wg1-report.html>) concludes that climate change is not only real but that it is changing at faster rates than projected even 6 years ago. As the health community works to address climate change, Dr. Hrynkow challenged the participants to consider:

- The under-recognition of the environmental health implications of climate change. Examples were given of how infectious disease spread springs to mind when considering health impacts from climate change.
- The incomplete understanding of the health impacts of climate change. As one example, it was noted that ground-level ozone is expected to rise with warmer temperatures. Is there a knowledge base for how this will change by region and if so, what would the consequences be for human health?

NIEHS has a unique role to play in climate change discussions, given its mission, longstanding interest, firm foundation of relevant research and training, and ability to partner with many groups. However, NIEHS does not have a targeted Climate Change Program. Instead NIEHS has a body of research investment that demonstrates state-of-the-art expertise in the range of health endpoints that are likely to be affected by climate change, and that could be deployed to understand those changes as necessary.

Goals For the Meeting

- Provide updates on current NIEHS efforts related to climate change.
- Gain views on key issues and opportunities that would strengthen NIEHS efforts on climate change.
 - Are there other venues in which NIEHS should be involved?
 - Are there issues that should receive more emphasis, e.g. energy-climate/health?
- In a flat budget scenario, what should NIEHS' identity be on climate change? Should we focus on raising awareness of environmental health and climate change, or go further?

“The Climate Change train is leaving the station...we have a window of opportunity. If we frame our issue appropriately we will be able to enhance the discourse,” stated Hrynkow.

INITIAL PERSPECTIVES – Two participants were invited to make brief comments on the opening presentations and on the goals for the day's work.

Dr. Jonathan Patz, Professor and Director, Global Environmental Health Center for Sustainability and the Global Environment (SAGE), University of Wisconsin

What do we do with the number (166,000 deaths per year) due to global warming? There is an urgent need to bring a health impact assessment framework to global climate change that considers benefits and risks, ethics, vulnerable populations, and co-benefits. To move the global climate change agenda forward, Dr. Patz stressed the need for:

- Increased involvement from NIH and CDC in global climate change research.
- More international research.

- More integrated research (instead of focus on specific agents or exposures).
- Anticipating future risks through use of new energy technology.
- A new research base to support the connections between energy and transportation policies.

Dr. Rita Colwell, Distinguished University Professor, University of Maryland and Johns Hopkins University

Vibrio cholera offers lessons to climate change researchers. With warming temperatures, it is more of an international issue than ever. Interdisciplinary approaches, employing social sciences, behavioral and molecular, are needed to develop and deploy effective interventions. And, multifactorial challenges must be taken into account as the pathogen interacts with its vector and with the broader environment.

To move the global climate change agenda forward, Dr. Colwell suggested:

- Developing preemptive medicine.
- Including NOAA in discussions.
- Developing a holistic and integrated program to replace the last 100 years of reductionism.
- Increasing research on biocomplexity with an interdisciplinary focus on problems that includes the interpersonal dimension.

There was general agreement of the need for creating a lexicon vocabulary to improve communication among diverse groups. Differing notions of climate change, global change, impacts of climate change on health and so on were discussed. Several participants suggested that NIH should lead efforts to address climate change in the context of global change (land use change) with health as the integrator. Global climate change efforts require a systems approach with multiple organizations working together. These issues cannot be addressed by focusing on disconnected agents of disease.

It was further suggested that the term Global Change (which includes climate change) be used to frame the issue instead of Global Climate Change. Such a concept would include land use change, not climate change, as having the biggest impact on the world's ecosystem. Several participants noted the merits of such an approach.

The notion of climate change and health conjures up an infectious disease agenda. Participants urged NIEHS to broaden the definition and to ensure that environmental health considerations, including respiratory disease and other chronic conditions of import in the NIEHS portfolio, are integral to future climate change and health activities.

SESSION 1: NIEHS ACTIVITIES ON EXPOSURES VIA AIR

Dr. Christopher J. Portier, Associate Director, Office of Risk Assessment Research, NIEHS

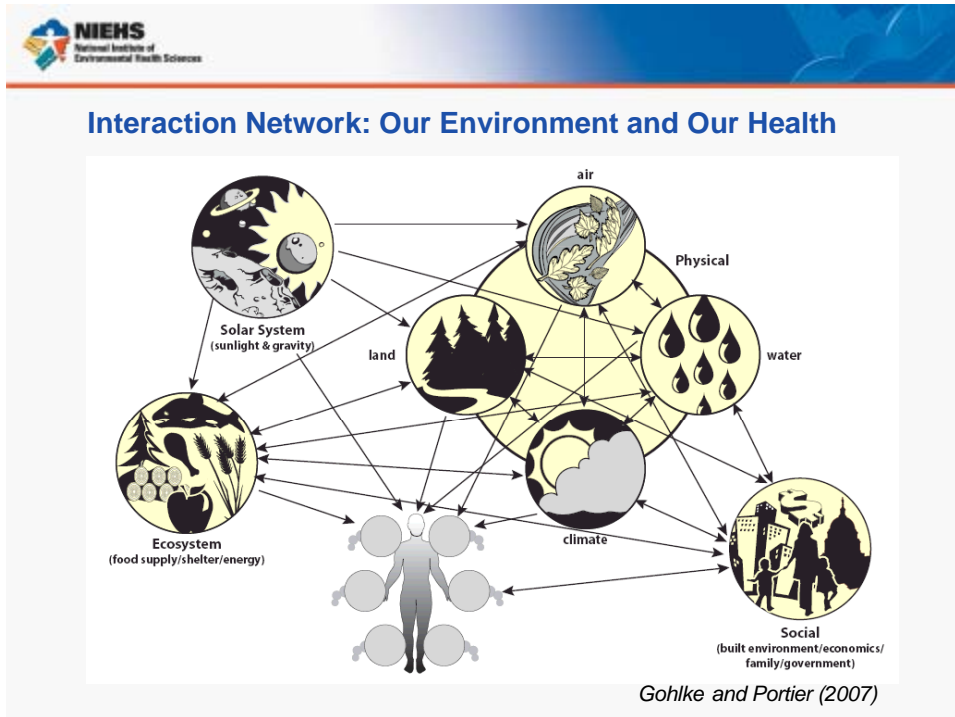
With Moderated Discussion led by Dr. Portier and Dr. Joel Schwartz, Professor of Environmental Epidemiology, Harvard School of Public Health

Dr. Portier reviewed the NIEHS portfolio on airborne pollutants and climate change. It covers a broad spectrum of research from epidemiology, to genetic/protein measurement, to basic biochemistry and includes four interconnected areas:

- Health implications such as cancer, asthma, heart disease, et cetera.

- Pollutants- such as changes ozone levels.
- Mechanism/Basic Research- changes in oxidative stress, inflammation, and immune system functioning.
- Climate Change.

The interdependence of environment and health was emphasized (see below).



For example, a Boston study found that obesity increased the negative effects of ozone on lung function. The value of international cooperation in understanding the links between environmental conditions and human health endpoints was noted.

Discussion Question: How will climate change impact air quality, and how could NIEHS efforts be enhanced, if appropriate, to address challenges on the horizon?

Dr. Schwartz noted that current research supports the direct effects of temperature on mortality and morbidity. He pointed out a critical gap: most research has not controlled for seasonal changes. “Researchers do not understand what actually goes on with temperature fluctuations. We know that what goes on differs between Miami and Minneapolis but we don’t understand why,” concluded Dr. Schwartz.

Participants suggested that NIEHS efforts could be enhanced by:

- Looking at carbon capture and storage issues – how will these strategies impact human health, if at all.
- Researching more about biofuels – what are the combustion products of new fuels, and what do we know about their impact on human health? What are the risks to workers during development of new fuels, and distribution?
- Working to ensure that research advances are communicated to policy makers.

- Creating more evidence based best practices.
- Continuing to build a strong basic science base to inform clinical decisions.
- Working with EPA to study pollutant concentrations related to climate. Climatologists and health researchers must come together. Atmospheric chemistry will be key – do we have the capacity to engage?
- Developing white paper with request for funding to launch a program for global climate/health.
- Creating more training grants, increasing PhDs in climate change field, and publishing more journal articles on global climate change.
- Focusing more on biodiversity and how losses of species will impact human health.
- Creating a millennium environmental health assessment.

Participants further identified the following gaps and under-researched areas:

- Understanding the health implications of secondary aerosols.
- Role of ozone and carbon dioxide in health.
- Biomass combustion— additional knowledge needed on health effects of burning wood.
- Interactions between temperature and air pollutants – how will mixtures of pollutants change with increasing temperatures, and will temperature rises impact exposures to individuals?
- Linkages between changes in agriculture and health. How will temperature impact crop diversity, and thereby human health?
- Lack of research on effects of ozone on agriculture: Does climate change affect vegetation?
- Expand research program on aldehydes given the link between combustion of ethanol and resulting aldehydes
- Add thermal regulation to NIEHS portfolio.
- Ensure that susceptible/vulnerable populations are included in all activities related to climate change and health implications.

Working Together: Create Partnerships to Further Global Climate Change and Health Agenda

- Participants agreed that NIEHS could enhance its efforts by working with agencies such as the Environmental Protection Agency (EPA), National Oceanic and Atmospheric Administration (NOAA), Department of Homeland Security (DHS), U.S. Department of State, United States Agency for International Development (USAID), and the National Governor’s Association (NGA), among others. It was suggested that NIEHS develop a broad consortium of federal agencies to build a national effort to focus on the diversity of global climate change and health. One way to do this would be to use a systems approach, encompassing the interests and objectives of many, and that includes powerful modeling tools that incorporate health.
- It was suggested also that the “S” in NIEHS be redefined to close the gap between NIH and NSF because many important issues fall into this gap.
- One participant asked how outside organizations could help NIH further the global climate change agenda. “Encourage NIH Institutes and Centers to participate in forums to raise public visibility and awareness of climate change issues,” responded Dr. Lang.

LUNCHTIME PRESENTATION: DR. JULIA GOHLKE “ENERGY AND HUMAN HEALTH”

Dr. Julia Gohlke proposed that our approach in addressing the energy impacts on human health has been too narrow. “We do not look at the whole picture. Instead we just focus on a certain part,” she noted. To solve this problem she offered a framework for a systems approach to human health research that includes:

- Social component (interaction within our species including family/government/built environment/economics)
- Ecosystem component(interactions with all other species on earth including agricultural systems, infectious disease, forest resources)
- Physical components (interactions with nonliving aspects of the earth such as water, air, mineral)

A range of energy sources were discussed within the broader framework: solar, batteries, wind, coal, and biofuels. There are unanswered questions about how each, if fully deployed, would impact human health. Among the key questions were:

- What are the human health research challenges for sustainable and safe utilization of 36 billion gallons of biofuel by 2022, as stipulated in the Renewable Fuels Mandate?
- What are the most promising alternative energy technologies in which potential human health implications have not been fully evaluated?
- How can the NIEHS knowledge base in areas of toxicology and gene-environmental interaction research be mined to address health effects of energy systems?
- How can environmental health scientists better capture interactions between social, ecological, and physiological components of health?

There was a broad consensus about the need for NIEHS to consider a linked agenda of climate change and energy. In terms of an identity, the NIEHS agenda on climate change should reflect priority on understanding energy and health.

During the discussion period, Dr. Richard Jackson urged participants to avoid ‘chasing after today,’ because technology changes quickly. Some of our current biofuels will probably be short lived. The biofuels that will really take off are still to be determined. For example, cars of the future will be unrecognizable (such as zero carbon footprint car prototype at Michigan). Participants identified other important questions and issues:

- As new energy technologies arrive we need to know: Are their genetic polymorphisms that show increased susceptibility to environmentally mediated diseases?
- What primary and secondary pollutants will result from fuel changes?
- If we look at energy stabilization wedges as a response to climate change, a life cycle analysis of both primary and secondary effects are critical, but what do we need to study in the health field? Currently these wedges are decided based on technological feasibility.

NIEHS efforts could be enhanced by:

- Adding energy and energy efficiency as a research focus area.
- Calculating the true costs of climate change more aggressively. For example, the real cost of gasoline is \$15/gallon.

- Bringing a life cycle analysis to bioenergy that includes economics and social aspects.
- Looking at the question of energy efficiency, which includes options for making buildings more efficient.
- Sending a policy package to the next administration about the co-benefits of increasing building efficiency.
- Looking at mitigation options beyond energy. Look at their effect on global change.

Dr. Pai-Yei Whung from the EPA offered an additional view. She pointed out that ethanol cannot be used in the existing pipelines for gasoline distribution because it is water-soluble. She added that the agriculture community is focusing on an in-between generation of biofuels as a way of meeting multiple needs.

SESSIONS 2 AND 3: NIEHS ACTIVITIES ON EXPOSURES VIA WATER AND NIEHS ACTIVITIES ON SOIL AND ECOLOGICAL IMPACTS ON HUMAN HEALTH, and CO-MODERATED DISCUSSIONS

Dr. Dennis Lang, Acting Director, Division of Extramural Research and Training, NIEHS; Co-moderated discussions with Dr. Rita Colwell, Distinguished University Professor, University of Maryland and Johns Hopkins University; and Dr. Richard Jackson, Director, Graham Environmental Sustainability Institute, University of Michigan.

Dr. Lang provided an overview of NIEHS activities on exposures via water and soil. He described global warming's effects on water supply and quality:

- Increased sea level
- Increased sea temp
- Effects on ocean ecology
- Altered water courses
- Altered salinity
- Altered estuaries, marsh lands, creation of new ones
- Shifting/increasing desertification
- Alterations in farming practices/productivity

The NIEHS water-related research portfolio includes the following relevant activities:

- Superfund Basic Research Program
 - Hydrogeology of ground water contaminants
 - Site remediation
 - Fate and transport of ground water contaminants
 - Mixtures
 - Expertise in both biologic sciences and engineering
- Superfund Worker Education and Training
 - Katrina, WTC, bird flu, bioterrorism, radiation, chemical spills, first responder training
 - Ocean's and Human Health (with NSF)
 - Marine toxins
 - Monitoring

- Arsenic and other metals in ground water
- Heavy metal concentration in aquatic food chain
- Water pollution indicators/human health
- Endocrine disrupting chemicals in water
- Agricultural fertilizers/pesticides - run off

The Superfund Worker Education and Training Program was discussed as an example of how basic research can translate to on-the-job needs of local and national governments. This program was key in the days following 9-11 and Katrina.

Discussion points focused on clean water particularly in light of concerns over desertification and conflict. Water quality and quantity will be key. For NIEHS, a prototype ocean observation buoy system is being supported to help scientists monitor water quality by identifying individual pathogens and toxins.

The integration and collaboration that takes place among NIEHS programs and partners provides a gateway to a diverse collection of environmental health research relevant data from multiple investigators and agencies (EPA, ATSDR, DOE). These partnerships could form the basis of new efforts related to climate change and health.

NIEHS Research on Soil Relevant to Climate Change

Dr. Lang reviewed the effects of global warming on soil quality and productivity: An increased demand on land productivity has led to increased deforestation; use of fertilizer and pesticides; desertification; and need for irrigation. The amount of crops grown for food and biofuels has also changed. The NIEHS soil related research portfolio includes:

- Superfund Basic Research Program
 - Geochemistry of soil/sediments contaminants
 - Biologic and engineering consortia
 - Fate and transport of soil contaminants
 - Complex mixtures
 - Site remediation – voc reclamation
 - Phytoremediation
- Superfund Worker Education and Training
- Pesticides
- Heavy metals
- Toxins
- Microbial metabolism (engineering improvements)

Discussion Questions: How will climate change impact water quality (oceans, coastal, fresh water) and soil conditions and how could NIEHS efforts be enhanced to address challenges on the horizon?

Increasing efforts to use reclaimed water suggests a research opportunity on that issue. It was again noted that quantity of water, not necessarily quality, was the real issue and offered that NIEHS should be looking at both.

In terms of framing the agenda, it was noted that NIEHS should consider deforestation as a health issue, given the role the forests play viz-a-viz clean air. A discussion on policy research included examination of existing legislation to determine if regulations governing clean air, water and soil (for example, as related to Superfund clean-up sites) were relevant to today's situation. Should key pieces of legislation be re-written?

In terms of water, Ms. Kimble noted that efficiency in water usage should be a main goal. What are the behavioral strategies that will allow us to motivate more efficient usage? Pricing of water was another area of interest. In the US, disinfection products are on the rise. What are the by-products of their usage, and how will these change in the environment with warming temperatures? Overall, water was described as the "sleeper" issue in the US assessment on climate change.

OPEN DISCUSSION ON KEY ISSUES AND RELATIVE PRIORITIES

Dr. Margaret Hamburg, Senior Scientist, Nuclear Threat Initiative/Global Health and Security Initiative and Dr. Hrynkow led an open discussion on key issues and priorities. Dr. Hamburg urged participants to capitalize on the broadening awareness of climate change among the public and policy makers. "The link between global climate change and health is not obvious to many and must be communicated to decision makers," asserted Hamburg. Dr. Hamburg summarized the following research approaches and strategies to move the global climate change agenda forward:

- Integrated approach to research (not just focused on individual strategies).
- International perspective is critical in any US strategy on climate change.
- Applied research component (practice applications/ behavioral/community/ and population based approach).
- Focus on how to measure health impacts
- Raise awareness among the public, policy makers, and scientific community about global climate change issues.
- Creation of partnerships would allow funds to go further.

On a very practical note, Dr. Hamburg offered that NIEHS should ensure that critical issues are identified and communicated to decision makers so that when the funding becomes available some of it will go to NIEHS.

Dr. Hrynkow led a short discussion on the issue of vulnerable populations, noting that those with poor access to health care suffer disproportionately in any health care situation, including disasters that might arise due to climate change. During the visit to NIH of the Director-General, WHO, women were cited as bearing the greatest burden from climate change. To meet the Millennium Development Goals, and particularly those related to equity, vulnerable populations must be given priority.

Physicians for Human Rights put the climate change discussion in the context of a broader human rights agenda. In framing its agenda, NIEHS was urged to consider environmental justice programs in the climate change context and to consider the right to health as part of future efforts. Systems thinking is invaluable in moving the agenda, as well understood from lessons learned from the AIDS pandemic.

Other groups vulnerable to climate change impacts include subsistence farmers, economically disenfranchised, those without healthcare, and genetically and medically susceptible groups (obesity, heart failure, diabetes

among other conditions). The unborn is another vulnerable group because exposures during gestation and in early life often have prolonged health effects.

The disparity of the health effects of temperature extremes by race was discussed. A recent report by Schwartz et al. shows that the percent increase of deaths during heat waves is 3 times higher in blacks compared to whites, and higher in women compared to men, correcting for all other factors.

WHO's Burden of Disease assessment with Climate Change as a risk factor shows no gender disparity, however. Instead, the burden of impact due to climate change will be borne by children under the age of five. Definitions used by various groups suggests that further studies would shed light on impacts by group.

While the DALY (Disability Adjusted Life Year) has been a useful metric to quantify and project trends for the global burden of disease, the group felt that a new metric would be useful to quantify factors not included in the DALY and that would allow a fuller discussion of the impact of climate change. NIEHS could be one group that could lead the development of such a metric. In developing a new metric, NIEHS should consider both direct and indirect health impacts.

WRAP-UP AND CONCLUDING COMMENTS - Dr. Hrynkow

Lessons learned from the day's work and possible action steps for NIEHS:

NIEHS has a unique voice on climate change issues and should use it to elevate awareness of the environmental health dimensions of climate change.

One of the challenges facing NIEHS as well as other agencies is how to define existing efforts related to climate change and health. Development of meaningful definitions and tracking instruments is critical.

Many research questions remain in terms of the impact of climate change on human health. These range from basic questions about how temperature and humidity affect individual air pollutants; how temperature impacts human physiology beyond heat stress indicators; how the development and use of new energy sources will impact human health; and how behavioral changes can lead to efficiencies in water and power usage, thereby reducing demand, to name just a few. Some of these questions might be appropriate for NIEHS to consider down the line.

Modeling of climate change impacts on health is a critical and urgent gap area. Related, the creation of a systems framework through which risk and analysis of mitigation and adaptation strategies could be assessed from the health perspective would be useful. Both will require the development of metrics that will more effectively allow understanding of impacts on individuals, communities and societies of a range of climate change mitigation and adaptation options.

NIEHS should expand partnerships with other NIH components, federal agencies, multilateral groups, including WHO, and international counterparts to leverage expertise and funding toward common priorities.