Addressing Public Health Impacts from Climate Change using Systems Thinking Action Teams

2010 – 2011

Environmental Public Health Leadership Institute Fellow:

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EXECUTIVE SUMMARY:

Addressing Public Health Impacts of Climate Change:

Changes in climate will impact all systems (biologic, natural resources, economic, and health) across the globe. Planning for adaptation and mitigation are necessary; however, the types of appropriate information on a regional scale need to be understood as a system that is designed to address specific spatial and temporal needs. Climate models may be downscaled to afford the opportunity to integrate health, extreme events, natural resources, and to simulate economic changes that may occur in the future. Knowlton, et al.\(^1\) published articles using air quality projections for areas around NYC in which the ozone levels may change both temporally and spatially (dynamically) to increase health impacts during climate change. During my EPHLI project, there has been interest at U.S. EPA and the Centers for Disease Control to build an integrated environmental model for projecting future changes in local ecologic and human conditions in future climate scenarios. This project will have focus on specific local areas, e.g., Austin, TX and if feasible, the Central Valley of California.

Using the Limits to Success archetype, my focusing question is “how can we analyze future impacts of climate change with integrated environmental and economic models?” The Causal Loop diagram depicts increasing complexity of input as the limiting factor to when we ask and answer questions about human and ecosystem health. It illustrates the need to balance sustainability and economics, to integrate models climate impacts. The Behavior over Time diagram depicts expected timing of changes in variables of atmospheric carbon, energy use, social welfare, and predictions of human population.

This EPHLI project is focused on learning how integrated models ecologic, meteorological, and temperature-related historical data can be used to predict future climate scenarios. For example, by knowing that increases in greenhouse gas emissions are predictable with current rate of growth. If the level of carbon dioxide is reduced slightly or stays the same, earth’s temperature will continue to rise. The health impacts of climate change (e.g. heat stress, extreme weather events, and air quality) will vary with geographic locations of vulnerable human communities. My interest in using systems thinking was noticed by Dr. Thomas Fontaine, Director of the EPA Western Ecology Laboratory. He agreed to host a Systems Thinking Action Team workshop in December 2010. EPA and CDC, Austin city officials, Linda Rudolph from California Department of Public Health, Kim Knowlton from Natural Resources Defense Council, my EPHLI mentor Adele Houghton, and Roelof Boumans attended. Our goal was to determine if we could create a pilot model employing the techniques of the article ‘Modeling the dynamics of the integrated earth system and the value of global ecosystem services using the GUMBO model’\(^2\). Drs. Fontaine, Boumans and Luber will introduce this work at a February 1-2, 2011 Workshop on Using Integrated Models for Decision Making in Climate Change. I will facilitate the breakout sessions afterward.
California is actively engaged in promoting adaptation planning for climate change planning. There are many opportunities to get involved, where it is appropriate to do so. Local planning
agencies in State of California counties are required to develop Climate Action Strategies; Fresno County and San Luis Obispo County engaged scientific and local expertise to tailor these plans. Case studies are listed at the Local Government Commission website (lgc.org). It is up to the local government working with citizens, businesses, and public officials to set priorities for their future. Public involvement is a key component in developing the plan. The Fellow has had the opportunity to participate in stakeholder meetings discussing natural resource and human impacts using geographic spatial analysis. The Fresno report depicts vulnerable ecosystems and threatened communities and included discussions with local government to discuss priority areas to be addressed. A draft report has just been released for Fresno County.

INTRODUCTION / BACKGROUND:

Problem Statement: My issue of concern is how to perform integrated environmental assessments using spatial analysis of future climate scenarios. I became aware of this issue while writing cumulative risk assessment framework and guidelines for EPA to integrate both chemical and non-chemical stressors in multimedia (air, water, soil). In addition, we have Executive Orders to consider vulnerable populations’ impacts from all stressors.

The Fellow sees the need for and lack of available tools to test multi-disciplinary interactions that affect health. Consideration of climate change requires using what we now know about ecological, human, and economic systems and considering how to realistically predict the effects of changing environmental conditions at a regional or local level.

Methodology used: I developed an understanding of how downscaled climate models can perform hypothesis testing, evaluate relationships, and inform governments for local decision-making. There are few published papers in this area so this is a new area for researchers and practitioners who need simple tools for emergency planning in extreme weather events. The Fellow has significant experience in environmental health and human health risk assessment.

For the EPHLI project, the following steps were taken:
(1) Develop an understanding of the information gaps and need to engage leaders in developing the technical pilot of a local climate planning team,

(2) Develop a network of Public Health experts, including EPA and CDC, States of TX and CA, EPHLI Alum, Adele Houghton who works with the Austin, TX Climate Program; use of an economic ecologist modeler who is under contract with EPA ORD to promote understanding of Systems Thinking.

EPA, CDC, TX and CA have complementary interests using a systems thinking approach to health impact analysis. Dr. Thomas Fontaine, Laboratory Director, EPA Western Ecology Division, hosted a two-day workshop December 16-17, 2010 meeting in Austin, TX. We considered the progress that Austin has made on health indicators, and what additional work can be done. We also considered efforts in California, including Central Valley community action plans, and in San Francisco’s assessment of heat-stress vulnerability. Attendees were both from leadership level of CDC and EPA, and from TX and CA, as well as technical staff from EPA R6 and R9. My mentor and I worked separately and jointly on this effort. We discussed use of
systems thinking to gather information to present at the February 2011 workshop in Atlanta. The goal of the workshop is to develop guidance for communities considering adaptation planning for climate change.

Health and environmental scientists need to communicate with one another and the public in ways that are understandable. Health scientists are concerned that most discussions of climate change focus primarily on Earth’s future condition in abstract ways that are difficult to grasp. The group that has formed rather spontaneously with my participation in the key dialogue has the potential of generating innovative ways to explain how, when, and where climate change will impact regional areas of the US.

January 2011 Update: The Austin Systems Thinking Action Team convened in Austin for two days of interaction to begin to develop a Systems Thinking Diagram that includes data sources, models, health concerns, and climate change scenarios. Representatives were selected who were epidemiologists, health scientists, modelers representing US EPA (five ORD and two Regional staff), CDC (three representatives), CA Department of Public Health, several Austin and Texas agencies, and a research scientist from Natural Resources Defense Council, and Roelof Boumans, EPA consultant, and Adele Houghton, EPHLI Mentor to Winona Vichte. This workgroup expressed interest in continuing discussion and collaboration, especially to gain understanding of the multi-factorial questions and data sources needed to define questions, approaches, and future scenarios. Our discussions and progress made by the modeler, as well as input from CDC, Austin, will be accessible to many attendees, who can contribute to our thinking for the future.
Behavior Over Time Graph:
Causal Loop Diagrams and applicable Archetypes:

Addressing Public Health Impacts of Climate Change

Limits to Success

- We need everyone at the table to contribute...
- Climate deniers: Bah, Humbug!

Virtuous Cycle

Propose questions to be addressed using appropriate models.

How can we analyze future impacts of CC using integrated environmental and economic models?

Consider full environmental and economic changes in tandem.

Limiting Process

R

B
The depiction shown above captures key variables that are important to address in an integrated model to consider for climate change.

The Causal Loop diagram (on a previous page) depicts the narrow scope of the original focus question, based solely on questions about weather, ecological, and human impacts in the supporting loop. It looks like we might be able to address some of these questions in a dynamic way. This however, leads to the questions that other disciplines need to be consider before making environmental decisions. There may be shortcuts that help us pin down current knowledge in a way that is simpler for many audiences. It is also necessary to consider cost/benefit analysis, especially when it comes to human health. Looking back to beginning this project, I consider this year’s work only the beginning of new possibilities.
The above figure is from a report prepared by Northeast States for Clean Air Use Management. This shows the complexity of scale and dimensions of integrated modeling. There are many stakeholders and interest groups who contribute to developing the data sources and models that may be used to view scenarios that may occur depending on future scenarios based on energy consumptions, temperature rise, food shortages, water resources, response to flooding, and resources that are in short supply. It is unlikely that we will reach all possible answers; we have limitations on resources and expertise.

Creation of an integrated dynamic model to consider future climate and health scenarios is the vision of my EPHLI Fellowship Project. This project would fit well into the research target that covers all of the ten essential services. We have formed a small Systems Thinking Action Team to identify a future scenario for climate change-related flooding in Travis County, TX. After the December 2010 Austin, TX workshop, Dr. Boumans developed a straw depiction of how ecological, economic, and demographics might be integrated for the plan for flooding in Austin. He is currently developing scenario depictions for the February workshop.

As a risk assessor for the Environmental Protection Agency, we traditionally use one-by-one approaches codified in legal code limiting EPA’s flexibility to deal with regulated substances. The EPA Science Advisory Board prepared several recommendations to recommend changes in risk assessment to integrate the ecological and social concerns into Agency risk assessment.
The conceptual framework is currently a work-in-progress. It is very new and challenging idea, and we hope to make it accessible to Climate Change Planners at local levels. The Team is just forming, presenting the idea to a scientific modeling workshop in a few weeks. Depending on feedback from the workshop, we must consider next steps and possible time line, measures and outputs. The workshop goal is to have a draft white paper and guidebook of tools that will be compiled by science writers assigned to the workshop.

The project has high visibility at EPA’s Office the Science Advisor, Office of Research and Development, and EPA Regional offices. Center’s for Disease Control climate program is already excited about the concept. The concept of Integrated Assessments is part of the IPCC workgroup on Adaption.

10 Essential Environmental Public Health Services:

1. Monitor environmental and health status to identify and solve community environmental health problems
2. Diagnose and investigate environmental health problems and health hazards in the community
3. Inform, educate, and empower people about environmental health issues
4. Mobilize community partnerships and actions to identify and solve environmental health problems
5. Develop policies and plans that support individual and community environmental health efforts
6. Enforce laws and regulations that protect environmental health and ensure safety
7. **Link** people to needed environmental health services and assure the provision of environmental health services when otherwise unavailable

8. **Assure** a competent environmental health workforce

9. **Evaluate** effectiveness, accessibility, and quality of personal and population-based environmental health services

10. **Research** for new insights and innovative solutions to environmental health problems and issues

Successful completion of this Addressing Public Health Impacts project supports the research component (EHS 10) of an innovative way of incorporating health, environmental, and economic models to identify when and where climate impacts will impact a region of the planet. We are trying to create a useful tool that can be applied easily by local planning agencies. This effort reflects EHS #1-5 in that we use monitoring, analysis, and public health information to help formulate public policy regarding preparedness for new health threats. There are no Federal health or environmental laws except the endangerment finding in which the courts ruled that carbon dioxide is an air pollutant under the Clean Air Act. Federal EPA intends to use this in order to regulate GHGs. Political will is in question.

In addition: We plan to engage local communities to assist them in taking both mitigation and adaptation steps to address climate change. We are trying to inform, educate, and empower professionals to understand that climate change requires better understanding of earth sciences, health sciences, and economics to plan for the future (ES #6).

If the results are useful to Global Climate research, it is possible to apply similar thinking to address global health concerns.

**National Goals Supported**

The Addressing Public Health using Systems Thinking Action Teams addresses the improve **air quality goal**. If air quality is improved, there will be reductions in the proportion of persons exposed to air that does not meet the health-based standards for ozone. As temperatures rise, ozone is projected to increase in areas that are in non-attainment as well as in new areas. Air quality information is published in newspapers every day. Ozone is not directly emitted but it is formed as a reactive byproduct of fossil fuel combustion. It contributes to smog formation. Hot weather increases the overall production; it affects both cardiovascular and respiratory systems and can cause death or aggravation of chronic disease.

Describe how your project supports any or all of these national goals or initiatives.

Strategy to Revitalize Environmental Public Health Services This project is clearly related to the need for **research and tools** to simulate impacts of climate change from increasing temperatures, poor air quality, flooding among others.

**Competency Project: Recommendation for Core Competencies for Local Environmental Health Practitioners**

**Research:** The capacity to identify and compile relevant information to solve a problem and the knowledge of where to go to obtain the relevant information.
**Data Analysis and Interpretation**: The capacities to analyze data, recognize meaningful test results, interpret results, and present the results in a meaningful way to different types of audiences.

**Evaluation**: The capacity to evaluate the effectiveness or performance of procedures, interventions, and programs.

This project has all of the above core competencies. I discovered the need to integrate data sources, develop new ways of data analysis to interpret different scenarios that affect public health. Since this approach is fairly new, and the learning will continue into the next century, it will require care and feeding in order to see how well it informs those who must plan cities, counties, states, regions, and countries.

Much information is available on the web, but we have not made inroads getting the urgent need to protect health and livability of communities worldwide. This is the time to provide core competencies to local health practitioners.
Project Logic Model:

Goal: Improve Understanding of relationship of health impacts of Climate Change (Using Regional Models)
Winona Vickey, EPHLI Cohort 6 (January 4, 2011)

Resources/Inputs:
- Funding
  - EPA
  - In-kind
  - CDC
- Literature resources
- Climate Action Planning
- CDC grantees

Activities:
- Program Design and Development
  - Use S-T to integrate health/economic models
  - Engage appropriate scientists
  - Define regional impacts
  - Use downscaling models
  - Define agenda goals
  - Refine project goals
  - Participate in modeling workshops
- Training
  - Use OSA/RAF for key steps
  - Engage regional staff to work on Regional needs
  - Define tools & analytic approach
- Teamwork and Collaborative Projects
  - Visioning by S-T Action Team
  - Develop thematic health indicators
  - What data is available
  - What data do we need?
  - What competencies do we need?
  - Explore new uses for regional models for other media
  - How to use information in Risk Assessment Guidance for CC
  - Consider IPCC plans for integrated modeling

Outputs: TIER I
- Workplan
  - S-T Workshops: Austin, Atlanta
  - Continue Austin STAT model development with tools for Climate Leaders in State government
  - Engage CA stakeholders
  - Continue discussions with CDC Climate Director to increase visibility of this effort at IPCC adaptation meeting in Japan
  - Review next steps after Atlanta meeting with CDC and Austin STAT
- Workplan
  - Develop White Paper and Hands-on Guide for Local Planners @ Workshop
  - Engage CC grantees in San Francisco and AZ as they work on specific vulnerabilities to heat
- Workplan
  - 3 collaborative projects
  - # of participants involved in collaborative projects
  - # and focus of projects

Short & Long Term Outcomes, Impacts
- Learning
  - Increased capacity of EPA, CDC, to assist S/T to present community based d-un tools
  - Improved delivery of scientific basis of CC+H information
  - Increased collaboration between partners
  - Improved integration of research to practice
  - Increased ability to assess leadership training needs
  - Learning needs are correlated to core PH competencies
  - Increased matching of learning needs with training curriculum being offered
- Behavior
  - Increased leadership capacity of PH leaders
  - Behavior changes in PH leaders
  - Improve real-world applications of many disciplines to inform practical solutions
- Results
  - More efficient and effective public health system
  - Improved health of populations

2010-2011 Fellow Project
National Environmental Public Health Leadership Institute
PROJECT OBJECTIVES / DESCRIPTION / DELIVERABLES:

Program Goal: Develop perspective on whether it is possible to develop a simple model to address specific public health and environmental issues on a local scale using a technique that can be run on the desktop. The goal is to develop shared understanding between science-based observational data (such as changes in temperature, increased likelihood of flooding) and specific health-based impacts that have been influenced by some of the historical data and projected scenarios.

Health Problem: Morbidity and mortality in populations most at risk for long-term changes in ecosystem services, necessary to human well-being. Define populations at risk and those that need their priority be addressed in the planning process.

Outcome Objective: Examine likely areas that can be addressed through several pilots. Determine if the model predictions can be used to build adaptation plans that are spatial in nature.

Determinant: Availability of models from variety of sources than can be used in assessing climate change impacts to ecosystems, public health, energy supply and economic development.

Impact Objective: Consideration of spatial and temporal dynamics in climate predictions.

Contributing Factors: Guidance and expertise of Austin Systems Thinking Action Team to provide expertise in human health indicators and appropriate variables using modeling software.

Process Objectives: Take the opportunity to work towards an integrated assessment tool capable of informing future local and regional planners.

METHODOLOGY:

EVENTS / ACTIVITIES

1. Select climate and energy speakers for the monthly seminar series sponsored by EPA Region 9’s Regional Science Council. Host guest speaker and conduct a round table discussion after the presentation.

2. Attend California Climate Action meetings Topics have included health impact assessment from adopting cap-and-trade policy in CA, Environmental justice health and welfare effects expected in climate change.

3. Attended Fresno stakeholder workshop—Building a Sustainable and Vibrant future for Fresno County, CA. Working with Local Council of Government to evaluate the final report.


5. Helped frame the agenda for December 16-17, 2010 Systems Thinking Action Team workshop attended by EPA Laboratory Directors, CDC Senior Leadership, other EPA and CDC scientists, Austin, TX climate program leaders, Executive
Director of CA Department of Public Health, National Resources Defense Council scientist, myself, Adele Houghton, and EPA funded developer of the integrated model.

RESULTS:

1. Fellow has developed a pilot integrated modeling approach to add health impacts into Regional Climate Models.
2. Workshop report will be completed.
3. Continue discussions with CDC and EPA ORD on improving pilot model effort.
4. Plan follow-up activities if project is continuing to receive technical support.
5. Develop a training module to be available to local planners.

CONCLUSIONS:

Atmospheric CO2 levels are rising so quickly that increases in temperature are certain even if we stopped all GHG production now. Warming trends may release carbon stored in melting tundra which is many times that we see now. News headlines regarding unavoidable climate change are challenged by those who favor economic growth at all costs.

Public health practitioners can create a more literate informed public. Environmental scientists can get their information interpreted through important caring public health professionals. The Fellow believes that there are many opportunities to educate each other. The amount of climate change science material available through the Internet grows every day. How can we build a message to leaders that the urgency to talk and plan is now.
Changing Not Changing

### Benefits
- Protecting the needs for survival in changing environment. Building our capacity for emergency preparedness. Reduce use of fossil fuel. Improve CO2 levels, reduce temperature rise. Live more simply with less waste. Avoid mass migration and starvation when crops fail. Ecosystems will cope better (such as coral reefs, reduced desertification, and sea level rise).
- Why worry? God has a plan. It is a conspiracy of scientists and atheists….. There will be less cost in protecting ourselves. I won’t live long enough to see the drastic changes in 30 to 40 years. I don’t have children or other family to protect.

### Costs
- Humans can reduce their emissions, but it is going to cost all of us. Less if we start now and develop our own adaptation plans. We need to work collaboratively to start a movement that starts with protecting public health.
- World population @ 7 billion; carrying capacity of natural systems will not support. All life needs to have an area that serves their nutritional and temperature tolerance. Humans will not survive if body temperature is >105 F. The costs of damage that will occur if nothing is done are extraordinarily high.

Table 1: Cost Benefit Analysis of Change – No Change

### LEADERSHIP DEVELOPMENT OPPORTUNITIES:

**Winona Victery**

During the year 2011, I felt like a sponge absorbing so many things. I knew my MBTI—it changed a little bit, I knew nothing about the Public Health Essential Services, or anything about systems thinking. My change style indicator of ‘originator’ helped me see how I need to slow down and write out my key thoughts before going into a meeting. This experience of training, mentoring, and problem formulation and execution allowed me realize the importance of natural resources, economic growth patterns intersect with health outcomes. This time has been an opportunity to develop the creative processes and networking to engage both EPA and CDC in ongoing work. The workshop in Austin allowed for equal opportunity for each Austin Team member to think out loud and have an ecological economist begin incorporating a pilot model to include areas of concern in Climate Change in local communities. The initial pilot model is just beginning to take shape; it is much more complex than I can explain or run. The upcoming
National Workshop should give us needed discussion on the ability to use this method for further work.

I acknowledge the colleagues who contributed directly to making this vision come to the real world. To each one of you, thank you. Many other people have given their time and thinking on the project. It is my personal goal to keep my vision alive by moving forward in Addressing the Public Health Impacts of Climate Change. It is essential that we build understanding on this serious threat to both the ecological and human well-being. Our economic future requires adjustments in consumption, land use, human population and basic social structure if temperatures continue to increase.

I have had a number of ‘aha moments’ over the course of the year, yielding additional issues for reflection, reading, and discussion. If I work to satisfy needs of others in planning a project, I am more likely to incorporate their needs into my work. We all have a different view of our goals, some are very detail-oriented, step-by-step, while I tend to skip over this and move into pie-in-the-sky future. It has helped me recognize these traits in others and in myself.
ABOUT THE EPHLI FELLOW

Winona Victery has a diverse educational and professional career. Through the EPHLI Fellowship, Winona benefited from understanding of my personal style, change style, and the coaching and mentoring, conflict management. She is helping to plan a systems approach to examine ecosystem and human condition when facing decisions related to climate change. EPA and CDC have initiated a Systems Thinking Action Plan for Austin, TX and if possible the Central Valley of California. The collaborators formed a STAT (Systems Thinking Action Team) to develop a flexible model to include extreme weather events in local areas to the ecosystems and the potential for health impacts.

Winona received the B.S. degree at Rice University in Biology, M.S. in Endocrinology (Reproductive Physiology) from University of Wisconsin-Madison, and her Ph.D. in Physiology at the University of Michigan-Ann Arbor. Winona spent almost 30 years in the research field for medically-related programs. Her primary research is in the field of lead exposure on physiologic functions, such as cardiovascular, endocrine, and renal systems. Research was at the U of M, NIEHS, and EPA. Toxicology became the primary focus and she received a Board certification by the American Board of Toxicology. She joined EPA in 1986 at the National Center for Environmental Assessment in Research Triangle Park, NC. Her role was to develop risk assessment evaluations of hazardous air pollutants for chemicals such as chromium, cadmium, and other compounds.

In 1989, on a whim, she applied for and was selected to be an Office of Research and Development Regional Scientist for EPA Region 9 office in San Francisco. The detail was for two years developing regional clients for the Office of Research and Development. Her position has continued in various forms for over 20 years funded by the EPA Regional Office. She serves on internal climate change workgroups, national risk assessment and science policy workgroups, and she interacts with universities and organizations that are related to the biological and chemical stressors for human and ecological health. Her service has been acknowledged by three Bronze Medals and a Silver Medal. She has worked with the LAX Airport to plan a source apportionment and air quality research project that is still ongoing after more than 10 years.

She has volunteered at the International Wild Bird Research and Rehabilitation Center, located near her home in Cordelia, CA. These are all aquatic birds, many oil-exposed from other wildlife rehabilitation agencies. Winona lives in Green Valley just 40 miles NE of San Francisco.
REFERENCES
