

Human Health Sector Report

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INTRODUCTION

Human health concerns related to climate change were discussed by seven individuals representing a mix of backgrounds, including: academic environmental research (4), environmental health research (1), state air quality authority (1), and federal Earth-system science management (1). A medical/environmental health researcher (Paul Epstein of Harvard University) provided a position paper to the workshop as a basic resource, and he will be part of the review of this report.

The group was struck by the current lack of substantial information and attention to health effects of climate change. The workshop position paper provided an excellent introduction to several issues of general concern, such as the increased incidence of injuries from extreme weather, etc., as well as those stresses which are more specific to the Northeast (Eastern equine encephalitis, Lyme disease, harmful marine algal blooms, etc.).

It was noted that, in general, the Northeast region may be particularly vulnerable to climate change because high latitudes are expected to see the largest relative changes in temperature, and are the locus of the greatest loss of stratospheric ozone and resultant increase in solar UVB radiation. In addition, current atmospheric transport tends to converge on the Northeast, delivering atmospheric air masses and their constituent contaminants from a number of urbanized sites throughout North America.

Following the format of the "four questions," discussions identified a number of potential direct and indirect effects of climate change on human health. The issues/effects were quite parallel with those presented in the *IPCC Second Assessment: Climate Change* (1995).

Potential direct effects include higher maximum temperatures and more frequent and longer duration high temperature events, creating unprecedented heat stress on vulnerable populations. Such problems may be exacerbated in a region unaccustomed to prolonged high temperatures.

Increased incidence of severe storms would affect large numbers of people, particularly in the Northeast with its dense population concentrated in coastal areas. If efforts to reverse the loss of stratospheric ozone through control of CFCs do not succeed, increased levels of UVB radiation have the potential to cause diseases of the skin and eyes.

Continued reductions in air and water quality are a major potential source of human health problems. Among the issues of particular concern in the Northeast is enhancement of tropospheric ozone, which could result from a number of factors either alone or in combination. These include:

- higher air temperatures,
- increased burdens of ozone or its precursors in remote source regions (e.g., the industrial Midwest and mid-Atlantic), and
- increased local production due to changing energy production requirements or automobile use.

These changes have the potential to reduce impacts as well, through alteration of the current converging atmospheric dynamics, or increases in cloud cover during summer. For similar reasons, changes in particulate material burdens may impact health in the region under some scenarios of climate change.

Water quality issues of particular concern are excess nitrogen and sulfur compounds in surface and ground waters, resulting from:

- continued atmospheric deposition on Northeastern soils which may be saturated with respect to these materials, and
- direct terrestrial application in the form of fertilizers or excessive animal waste.

Nutrient loading into water supplies, whether from terrestrial runoff or direct input, increases the incidence of harmful algal blooms (HABs) and possibly water-borne infectious diseases such as cholera.

Again, these stresses may be either exacerbated or mitigated by changes in climate and atmospheric

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dynamics—both locally and in remote locations. Increased incidence of flooding, either coastal or inland, has the potential to adversely affect sanitation of drinking water supplies by increasing the levels of pathogens such as *cryptosporidium* and *giardia*.

There is some evidence that the incidence of harmful algal blooms is increasing as, for example, in the first observations of the Canadian red tide species *Alexandrium tamarense* moving into New England waters in 1972. The incidence and distribution of a variety of harmful blooms, and their effect on humans, is the subject of ongoing research in New England and elsewhere along the Atlantic Coast.

Least understood, but potentially of great importance, are health concerns related to diseases which are mediated by living vectors or hosts. Microbial, insect, and other life forms are sensitive to local climate, and even subtle changes may have a major impact on the incidence of particular diseases. An example is Eastern equine encephalitis, which is carried by mosquitoes whose populations are enhanced by mild winters and wet springs/summers. Other vectors such as ticks, which carry *Erlichiosis*, Lyme disease, *Babesiosis*, and Powatten disease, are also amplified by mild winters and wetter conditions. A host of other diseases may be impacted by climate change, either directly or through changes in the number and distribution of vectors/hosts. In many cases the magnitude, or even direction, of change induced by particular climate effects are unknown as, for example, Lyme disease, which has several insect and animal hosts each of which will respond differently to climate.

Potential direct effects of climate change include loss of life from flood, drought, and heat waves. A basic indicator of climate change is an increased incidence of extreme weather patterns, thus floods should become more common, leading to increased stress, injury, and death. Droughts also negatively affect water quality and food supplies. Heat waves and higher minimum night-time temperatures (TMINS), can increase mortality among the old and poor, especially in inner cities.

It is clear that the health effects of climate change are both uncertain, and potentially quite large. Studies which combine expertise in climate, environmental science, and biomedical disciplines have begun quite recently, and are restricted to a few specific issues. This is an area which calls for a major enhancement of current research, including the recruitment of expertise and accumulations of

data from fields which have not previously been engaged in climate change research.

One theme of the Regional Climate Change Impacts Workshops is the engagement of stakeholders from outside the academic and government research communities in both dialogue and planning for the future. Everyone has a stake in potential health effects of climate change, and it is time that careful and focused research is supported in this area. Health concerns, if found to be relevant and pervasive, have the potential to motivate—as no other factor can—the general interest and commitment to mitigation strategies.

SIGNIFICANT FINDINGS

- Direct health effects of increased temperature can be expected, and may be exacerbated in the Northeast by the relative lack of experience and adaptive mechanisms, which are present in areas more accustomed to high temperature episodes.
- Climate effects are linked with other environmental health concerns, such as contamination of air and water, by a variety of mechanisms: e.g., higher temperatures increasing the demand for emission-producing power generation, or changes in precipitation affecting pollutant or pathogen loads in surface waters.
- There is evidence of increasing incidence of harmful algal blooms in Northeastern coastal areas, and interactions of blooms with climate factors require further study.
- Very complex relationships exist between climate and vector-borne disease, and factors which may increase or reduce the activity of particular vectors and diseases require extensive study.
- The magnitude of some climate changes such as increased temperature, as well as effects of depleted stratospheric ozone on UV radiation, are likely to be greater at the relatively high latitudes of the Northeast than in some other areas of the country.

- Much more effort is required to assemble the multiple, cross-disciplinary research teams and data sets required to study the health effects of climate change.

THE FOUR QUESTIONS ADDRESSED

1. What are the current concerns and stresses facing regional stakeholders in the human health sector?

Air quality

- Respiratory disorders
- Asthma
- Allergies

Water quality

- Toxins in water
- Gastrointestinal disorders
- Endocrine disruption?
- Immune suppression?

Diseases/Pathogens

- Eastern equine encephalitis
- Lyme disease
- Water-borne diseases (*cryptosporidium*, *giardia*)
- Food-borne (*E. coli*)

Harmful Algal Blooms

- Paralytic shellfish poisoning
- Diarrhetic shellfish poisoning
- Amnesic shellfish poisoning
- *Vibrio* infections

2. How will climate variability and climate change modify the current concerns and stresses related to human health in the region?

Direct Effects of Climate Change

- Increased UV Radiation can lead to skin cancer, cataracts, immune suppression.
- Higher temperatures for longer duration (e.g., heat waves) can lead to heat stress and mortality.
- Extreme weather events (e.g., floods) can lead to direct injury and death.
- Psychological disorders can increase due to stress from all of the above.

Indirect Effects of Climate Change

- Air quality is affected by increases in ozone and particulate matter due to increasing temperatures, changing weather patterns, and/or changing transport from remote sources will increase respiratory diseases and disorders such as asthma and allergies.
- Changes in seasonal patterns, precipitation, temperature, and species distribution and abundance might increase respiratory problems and allergies due to mold spores and pollen.
- Water quality is likely to degrade due to increases in precipitation and changes in atmospheric chemistry that may increase acid (SO_4) and nutrient (NO_x) deposition onto soils and water. Extreme weather events, such as floods, often destroy infrastructure, leading to contamination of water supplies and heightened levels of pathogens (for example, *cryptosporidium*, *giardia*, *E. coli*) in recreational waters (lakes and oceans). Higher fecal coliform levels in bays and estuaries can also contaminate shellfish, leading to shellfish bed closings to prevent transmission of Hepatitis A, Shigella, Norwalk-like virus, gastroenteritis, *Vibrio parahaemolyticus*, and non-O1 Cholera.
- Changes in species distribution and abundance can lead to increased use of pesticides, herbicides and/or fertilizer, which wash into groundwater and into rivers and estuaries. Many of these chemicals are directly harmful to human and animal health, as well as acting as hormone mimickers that can cause endocrine disruption (leading to developmental difficulties, immune suppression, and reproductive cancers and anomalies).
- Vector-borne diseases such as Eastern equine encephalitis and Lyme disease are enhanced under warmer winters and wetter weather.
- Increasing nutrient deposition from air and water, increasing sea surface temperatures, changing seasonal and climatic patterns can increase harmful algal blooms and algal toxicity, increasing the likelihood of paralytic shellfish poisoning, diarrhetic shellfish poisoning, and amnesic shellfish poisoning.
- Changing climate patterns can encourage the movement/survival of other pathogens and disease vectors, leading to diseases new to the region (e.g., cholera, malaria, hantavirus).

3. What information and data are needed by human health researchers and care providers to fully understand and address climate-related issues?

- Information on environmental processes (issues and trends)
- Historical epidemiological data (baseline information)³
- On-going epidemiological data (research)

4. What types of strategies and approaches are available for coping with, or mitigating, climate change stresses for this sector?

- There is a need to increase the monitoring of:
 - ⇒ air quality
 - ⇒ water quality
 - ⇒ UVB levels
 - ⇒ vector-borne disease
 - ⇒ water-borne disease
 - ⇒ harmful algal blooms
- Document any links shown by the data between the above issues and climate change.
- Human health issues, properly documented, can motivate commitment and action to mitigation strategies by individuals, industry, and government.⁴

³ There may be an issue of restricted data availability that must be addressed at the Federal level.

⁴ It was unclear how or if we should include human-caused changes in landscape, etc. (i.e., development) as an agent or process affecting human health concerns. It is clearly relevant, but is it a legitimate element of climate or global change?