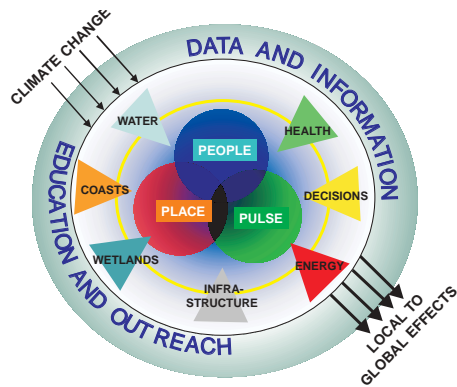


PART 3

CONCLUSIONS



CHAPTER 10

ADAPTATIONS AND POLICY RECOMMENDATIONS

Climate is changing in the New York Metropolitan Region. Over the past 100 years, temperature in the region has warmed nearly 2°F; however, it is very difficult to determine the causes of the observed climate trends.

The rate and amount of temperature rise is projected to increase over the 21st century due to anthropogenic greenhouse warming. Substantial uncertainties about climate change remain, including the rate and magnitude of projected regional changes. Gradual changes may be punctuated by changes in climate extremes.

The use of a range of plausible scenarios enabled the Metro East Coast Assessment researchers to project possible impacts created by climate variability and change as well as to evaluate the MEC Region’s responses. An assessment exercise such as the Metro East Coast study is useful in developing preparedness for extreme climate events in the present as well as readiness for a changing climate.

PEOPLE, PLACE, AND PULSE

Climate change will fundamentally affect the people, place, and pulse of the Metro East Coast Region. Coastal areas and communities appear to be among the most vulnerable sites in the region, due to the potential for changing sea levels and more frequent flooding from storm surges. Although it is impossible to know if and when the area will experience a catastrophic storm and flooding event, projections show that severe storm recurrence periods are likely to shorten (Chapter 3 *Sea-Level Rise and Coasts*). Shoreline homes, airports, railway tunnels and roads, operating and derelict industrial facilities (including hazardous waste sites), and ecosystems are at risk of flooding ever more repeatedly (Chapter 4 *Infrastructure*). Coastal wetlands, such as the Jamaica Bay salt marshes, may show the earliest and most manifest evidence of loss associated with sea-level rise (Chapter 5 *Wetlands*). Given limited potential for retreat inland, the remaining fringe of coastal wetlands may decline, causing a ripple of other ecological effects, including the loss of critical bird and aquatic habitats.

The Metro East Coast Assessment found that the New York City water supply system—the largest in the study region and one of the largest in the world—should be able to respond to the expected increases in annual temperature and their effects on the water supply via evaporative demand as well as greater variability in rainfall, at least in the near term (Chapter 6 *Water Supply*). Responses to projected salt-water intrusion and the longer term need further study. The direction of change in the total amount of precipitation remains an uncertainty. The MEC Water Supply Sector team has called for the evaluation of enhanced intra- and inter-regional water distribution protocols, which could potentially include mutual aid agreements with the Delaware River water system.

Inequity and spatial and demographic unevenness of climate change impacts are found among the region’s public health risks (Chapter 7 *Public Health*). There is likely to be increased exposure to heat stress conditions, greater potential for water-borne or vector-related disease outbreaks, and higher concentrations of secondary air pollutants, resulting in higher frequency of respiratory ailments and attacks. Populations currently at risk, including the poor, immuno-compromised, elderly, and very young, will be the most vulnerable.

Electric energy demand and health effects will interact under conditions of climate change because of the connections between climate warming, increased energy demand, electricity blackouts or brownouts, and resulting heat stress (Chapter 8 *Energy Demand*). Heat stress may become especially problematic for the elderly urban poor if electricity outages, exacerbated by heightened demand for air conditioning in hotter conditions, occur more frequently in the future.

Although climate change will dampen the winter demand for energy, this will be offset by an estimated increase in summer electricity demand. Summer demand could be especially strong during summer heat waves as illustrated in the set of four successive heat waves that hit the region from late June through early August, 1999. The temperature rose to more than 90°F for 27 days during the

period. The climate change scenarios project that the average number of days exceeding 90°F (13 days in the current climate) will increase by 2-3 times by the 2050s. The peak electrical demand recorded in the region occurred on July 6, 1999. Brownouts and an extended blackout occurred in the primarily minority neighborhoods of upper Manhattan and the South Bronx. These events might foreshadow future extreme events.

The Metro East Coast Assessment found that climate change impacts in the region will be simultaneous, multi-dimensional, and interactive. Heightened frequencies of storm-surges will damage major infrastructure juxtaposed to already threatened coastal wetlands; health impacts cannot be separated from the impacts of augmented heat waves on energy demand. Drinking water supplies during droughts may be negatively affected by saltwater intrusion in the Hudson River estuary.

Finally, the Assessment concluded that climate change impacts will not be limited by the region's boundaries. Global cities, such as New York, are important hubs for international capital and labor flows. A major climate-related disruption of New York Stock Exchange activities, for example, would have reverberating impacts on financial markets around the world.

ADAPTATIONS TO CLIMATE CHANGE

Adaptations and adjustments may include physical modifications to infrastructure (e.g., higher seawalls and raised airport runways); changes in decision-making practices (e.g., increased use of management strategies with overlapping jurisdictions and longer timeframes); and far-reaching societal shifts (e.g., disinvestments in highly vulnerable coastal sites and increased support for at-risk populations of the poor and elderly). These new responses, in turn, will interact with the ongoing processes of ecological and societal transition in the region.

Management institutions and agencies with responsibility for the coastal zone in the Metro East Coast Region need to incorporate the potential for changing climate conditions in their current decision-making. Options for reducing the increased coastal storm-surge hazards and risks to regional infrastructure include short and medium-term protective engineering and insurance measures and longer-term land-use planning. Adaptation strategies to protect the region's coastal wetlands include facilitating the inward migration of shore marshes by establishment of buffer zones.

Projections of sea-level rise and increasing storm-surge hazards brought forward in this Assessment are relevant to decisions regarding clean-up of toxic waste sites, wetland restoration projects, wastewater treatment plants, and

transportation corridors. These projections also need to be taken into account in appropriate and realistic ways during current and future preparation of new flood maps and frequency estimates, response protocols, coastal building code regulations, beach renourishment time-tables, and insurance policy mandates. Such activities will be necessary to protect the region's human, physical, and ecological assets.

For energy demand, the emphasis in adapting to climate change should be on improved energy efficiency, particularly to reduce summer peak electricity loads, and enhanced passive cooling in buildings and communities. Local lines that distribute electricity to customers need to be upgraded, and the adequacy of transmission lines to bring more power into the metropolitan area should be assured.

POLICY RECOMMENDATIONS

How can environmental managers in the region respond to the potential challenges and opportunities of climate change, and how can they bring the issue into their everyday decision-making processes? Decision-makers are being challenged to be pro-active with respect to potential climate change and variability, responsive to potential environmental changes on longer time horizons, and flexible in the face of increased uncertainty (Chapter 9 *Institutional Decision-Making*).

Policy recommendations were made in each of the sector studies of the Metro East Coast Assessment. The Sea-Level Rise and Coasts, Infrastructure, and Wetlands sectors recommend that the implications of sea-level rise associated with climate change be taken into account in the designation of coastal hazard zones, adaptation of setback requirements, rolling easements, and limits to development in coastal zones. The Water Supply Sector recommends that a study be conducted of possible climate change adaptations first with specialists from the relevant agencies within the Metro East Coast Region and then with experts from the Delaware Basin and New Jersey. For the Public Health Sector, climate change projections should be incorporated into future policy decisions regarding public health issues. Policies are needed that incorporate climate change impacts into ground-level ozone mitigation. The "weatherization" program that exists to save energy costs in housing for low-income people could be extended to provide summer cooling in urban areas as well as winter heating.

At the regional level, climate variability and change could be associated with several initiatives. These include education and outreach programs, enhanced methods for defining and entraining potential climate change impacts into planning decisions, and increased inter-agency com-

munication and cooperation. Current major capital reinvestment activities and structural shifts in management regimes in the Metro East Coast Region provide excellent pathways for integration of climate change adaptation into stakeholders' decision-making practices.

Climate Awareness Program

As an education and outreach component, a regional Climate Awareness Program would be effective to inform both decision-makers and the general public about the nature of current climate processes, lessons learned in responding to climate extremes, and future climate change. Enhanced training of weather forecasters in the region about the climate change issue along with climate awareness websites or other easily accessible sources of updated information would facilitate this process. In conjunction with the Metro East Coast Regional Assessment, CIESIN (Center for International Earth Science Information Network) is developing a Climate Awareness website for the region with the Columbia Earth Institute of Columbia University. (See http://metroeast_climate.ciesin.columbia.edu for the Assessment website).

Climate Impact Indicators

Through our communication with stakeholders in the course of the Metropolitan East Coast Regional Assessment, we learned that the impact of potential climate change has to be put into the discourse of everyday decision-making processes. Rates of possible sea-level rise, and temperature and precipitation shifts are relatively remote to the average decision-maker and region resident. Impacts must be put into contexts that are meaningful. The development of a set of cost-based, urban-focused climate change impact indicators would make a significant contribution. For example, what will sea-level rise mean in terms of increased costs of beach renourishment and what will temperature increases mean to acute asthma sufferers.

Inter-Agency Climate Task Force

Increased intra-sectoral and inter-sectoral communication among agencies and institutions also would greatly increase the response capacity of local decision-makers to potential climate change impacts. This kind of enhanced communication would allow decision-makers to identify potential problems and define common solutions. Examples of the general utility of within-sector interactions already are present in the MEC Region. SENYIWSAC (Southeastern New York Intergovernmental Water Supply Advisory Council) is a volunteer, non-regulatory group of water supply managers that communicate on common problems and planning initiatives. Regional air traffic control protocols for the region's three major airports and numerous smaller airports are another example.

Inter-sectoral working groups are fewer. Such groups are critical for addressing the multidimensional impacts that cut across sector lines. In the Metro East Coast Region, this type of interaction is especially important given the highly integrative nature of the urban environment problems such as the links between public health and energy demand, and the links between the ecological and infrastructural components of the coastal environment. Interagency task forces developed as part of regional environmental management activities, such as the Florida Everglades and Chesapeake Bay, can serve as valuable examples of how to develop climate change-related groups in the MEC Region.

RESEARCH NEEDS

Each of the sector studies of the Metro East Coast Assessment identified specific gaps in knowledge and the research needed to fill those gaps. Research needs identified for the Sea-Level Rise and Coasts Sector include improving the resolution of topographic data in order to better assess risks of higher storm surges and refining the calculation of potential changes in saltwater intrusion in the Hudson River. Data needs of the Infrastructure Sector are a detailed catalog of historic storm damages, accurate inventories of major infrastructure systems and components, and evaluation of infrastructure and network fragility. Future research in the Wetlands Sector focuses on determining the dynamic processes that are contributing to current marsh losses. This involves the study of marsh geomorphology, structure, and ecology, as well as continuing research on the influence of current rates of sea-level rise on the region's coastal wetlands. The role of other anthropogenic influences such as dredging and sediment transfer, and water pollution needs to be defined. Research is needed on marsh accretion rates, on how storm-wave action and freezes influence salt-marsh geomorphology and on biogeophysical interactions between salt-marsh flora and geologic and climatic conditions.

Research needs for the Water Supply Sector include detailed assessments of adaptation options, with engineering, economic and environmental factors relevant to the benefits and costs of adaptations and their optimum scheduling over time. Also needed is a better understanding of the likely effects in direction and amount of climate change on each element of demand and supply in the region's systems, especially calculations of potential changes in water demand in urban and suburban areas. For the Public Health Sector, additional scenarios of ozone health impacts are needed that include alternative assumptions about the demographic make-up of the MEC

Region in future years and differential risk coefficients for different demographic groups. Another important research direction for the Public Health Sector is the study of the independent and interactive impacts of heat stress in conjunction with air pollution. The Energy Demand Sector should expand to include potential impacts on supply as well as demand.

THE CLIMATE CHANGE CHALLENGE

The complex nature of potential climate change impacts in urban regions poses tremendous challenges to urban environment managers to respond cooperatively, flexibly, and with far longer decision-making timeframes than currently practiced. Given the already fragmented nature of urban environments and jurisdictions, the political and social responses to the global climate issue in cities should begin at once. Transforming the urban management paradigm to better prepare for climate change will safeguard against negative feedbacks in the Metro East Coast Region and around the world.

In summary, the Assessment illustrates that the future environmental conditions of the Metro East Coast Region will be much more dynamic than in the recent past. The highly sophisticated environmental management and response strategies that evolved during the 20th century in the region were based largely on the idea that the ecological and environmental baselines were static, although ranging within the conditions of dynamic equilibrium. Under this premise, local environmental change was seen as being brought about largely through direct human action.

Global climate change forces a fundamental reassessment of these assumptions. In the 21st century, the baselines will change and local decision-makers will have limited ability to control the pace of this transformation. The gases already emitted into the global atmosphere are projected to cause some degree of warming and environmental change regardless of the implementation of any comprehensive policy designed to reduce greenhouse gas emissions (the root cause of projected climate change). For the citizens and stakeholders of the Metro East Coast Region, the challenge will be to adapt to and mitigate climate change simultaneously and equitably.