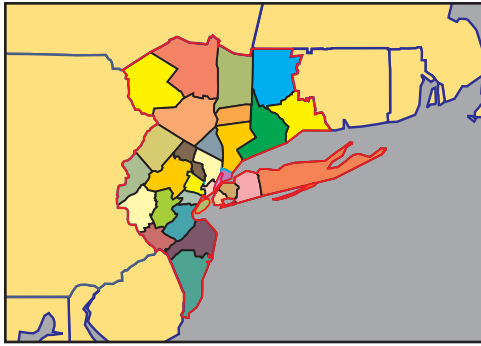


PART 1

INTRODUCTION

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CHAPTER 1

ASSESSING THE METROPOLITAN EAST COAST REGION

The Metropolitan East Coast (MEC) Assessment is one of the regional components of the National Assessment of the Potential Consequences of Climate Variability and Change for the United States. The goal of each regional assessment is to understand the impacts of climate variability and change on the physical systems and human activities of a specific area of the United States. Key to the process is the identification of sectors that are vulnerable to the additional stresses that increased climate variability and change will introduce and the potential for adaptation strategies to cope with them.

The Global Change Research Act of 1990 created the U.S. Global Change Research Program (GCRP) in order that the nation analyze and evaluate global climate change. The U.S. GCRP initiated the National Assessment in 1997. The National Assessment process involves examination of potential impacts of climate change at a regional level as well as a sectoral level across the United States, synthesizing the results into a final Assessment Report (National Assessment and Synthesis Team, 2001).

For the regional assessments, the GCRP divided the United States into regions, each of which was charged with engaging researchers and stakeholders from a variety of sectors and disciplines in the exploration of the current and future impacts of climate on the region. The Metropolitan East Coast Assessment is the primary assessment activity that focuses specifically on the impacts of climate change and variability in an urban area. Understanding climate impacts in urban areas is becoming increasingly important, since human populations are more concentrated in cities, and the number and size of cities are growing.

The U.S. GCRP provided a template to guide the regional assessments, consisting of topic areas (e.g., current stresses, potential impacts, and coping mechanisms). However, each of the regions developed its assessment independently, focusing on different sectors of activity, involving stakeholders in unique ways, and creating a variety of products for scientific, technical, and general audiences.

The first step for the Metro East Coast Assessment was a two-day workshop hosted by and held at the Columbia University Earth Institute. The *Metro East Coast Climate Impacts Assessment Workshop* on March 23–24, 1998, brought regional stakeholders, government representatives, scholars, non-governmental organizations (NGOs), and members of the general public together to explore the creation of an integrated regional assessment of climate impacts. The charge to the workshop was to develop a network of stakeholders, to initiate assessment of vulnerabilities and opportunities, and to recommend future steps to develop partnerships among stakeholders, researchers, and the federal government regarding climate variability and change.

Four questions from the National Assessment provided the foundation for the workshop:

1. Independent of climate, what are the dominant stresses and issues currently of concern to stakeholders in the region?
2. How might greater climatic variability or climate change increase or decrease those stresses?
3. What kinds of information do we need to help us think about climate change and climate variability in the region?
4. Given our current knowledge, what coping mechanisms might be taken to minimize stresses and at the same time address the climate change issue?

The goal of the initiating workshop was to promote discussion between researchers and stakeholders in order to develop a method of research that focuses on relevance and utility. Through the workshop proceedings, specific areas of research were identified as the most important foci of a regional assessment in the New York metropolitan area: Coastal Resources, Infrastructure, Water Resources, Public Health, and Institutional Decision-Making.

Since the initial workshop, the research foci have evolved to include: Sea-Level Rise and Coasts, Infrastructure, Wetlands, Water Supply, Public Health, Energy Demand, and Institutional Decision-Making. Researchers

Stakeholder Involvement

The assessment mandate from the U.S. GCRP emphasized the involvement of key stakeholders at the regional level. The MEC Assessment has defined stakeholders as: institutions whose activities are and will be impacted by present and future climate variability and change, and thus have a stake in being involved in research of potential climate impacts. Through a research partnership that involves collaboration, ongoing feedback, and product review, the MEC Assessment hopes to make its research relevant and useful in decision-making across sectors of activity in the New York Metropolitan Region.

Each of the MEC Assessment's seven sectors collaborates with representatives from one or more stakeholder institutions. Table 1-1 illustrates the stakeholder institutions that are involved in the Assessment process.

The stakeholder representatives have been involved in the Metropolitan East Coast Assessment since its inception. Key to the success of the relationships between the researchers and the stakeholders is regularly scheduled outreach. Every other month, the MEC team met at the offices of a stakeholder to present the Assessment and its findings and to discuss the areas in which the stakeholders' activities and the Assessment's foci interface. During outreach meetings, several questions help to frame the discussions:

1. Which activities of the stakeholder agency are most relevant to the issue of climate change?
2. What are the time-frames of stakeholders' decision-making horizons?
3. Is the potential for climate change taken into account explicitly in any decision-making processes?

TABLE 1-1
Stakeholder Partners*

| Sector | Partner |
|---------------------|--|
| Coasts | New York District of U.S. Army Corps of Engineers |
| Infrastructure | Federal Emergency Management Agency, Region II The Port Authority of New York and New Jersey |
| Wetlands | National Park Service, Gateway National Recreation Area New York State Department of Environmental Conservation |
| Water Supply | Southeastern New York Intergovernmental Water Supply Advisory Council |
| Public Health | New York City Department of Health |
| Energy Demand | New York State Energy Research and Development Authority |
| Meta-Stakeholder | U.S. Environmental Protection Agency Region 2 |
| General Stakeholder | Regional Plan Association |

*Stakeholders are institutions whose activities are and will be impacted by present and future climate variability and change, and thus have a stake in being involved in research of potential impacts. Although stakeholders are an integral part of the research process, the findings that result from this research do not necessarily represent the opinions or policy positions of the stakeholder institutions.

4. What information (relevant to any aspect of climate impacts) can the MEC Assessment provide to the stakeholder? Are there data that MEC researchers can collect that would be of use to the stakeholder?
5. Does the stakeholder have data that would be useful to the MEC team?
6. How can we make the information that we create useful, relevant and specific to the stakeholder?

Data and Information

As part of the Regional Assessment, the Center for International Earth Science Information Network (CIESIN) developed and managed the Metro East Coast Assessment Geographic Information System (GIS) and website (http://metroeast_climate.ciesin.columbia.edu). The Assessment also included the development of educational modules and materials. CIESIN created an educational module related to climate variability and change in the Metro East Coast region. See Appendix MEC Region 1 for a description of the data, information, and educational activities developed for the MEC Assessment.

METROPOLITAN EAST COAST REGION

The New York Metropolitan Region is one of the most important urban areas in the world. It is characterized by great physical and demographic diversity. The largest financial trading market of the world controls the economic heartbeat of the region. The general economy is mostly based on service industries, which depend on modern, sophisticated means of communication and transportation. Approximately \$10 trillion of stock and bonds were exchanged in New York in 1999 (Warf 2000) The gross regional product (GRP) is estimated at approximately \$1 trillion.

The activities of this urban conglomeration place tremendous pressure on the regional land and water resources. Approximately 30% of the land area have been fully converted to urban uses. The regional water demand is 1,500 mgd, which presents decision-makers with increasing concerns about the quality and quantity of the regional water supply.

A complex web of formal and informal processes that involve the public, nonprofit, and private sectors governs the MEC Region's institutional framework for land use and development. The overarching considerations of environmental protection, health, and safety often intertwine. Institutional adaptation and flexibility must arise in order for links to form that will allow integrated decision-making regarding climate change.

With close to 1,500 miles (2,413.5 kilometers) of coastline, the region's development has been intimately

connected to the ocean. For example, four of the five New York City boroughs are located on islands. Infrastructure has emerged to adapt to this situation. More than 2,200 bridges and a system of tunnels that carries rails and roads connect them with each other and the mainland. The region maintains a versatile, high-volume transportation system by air, roads, and rails (above and below ground), as well as on the water. These and other essential infrastructure elements are often used to capacity.

People

The Metropolitan East Coast Region has a rich demographic history and is ever evolving. Its population grew dramatically throughout the latter part of the 19th century, largely through massive immigration from Europe. While the region remained mostly rural through the mid-part of the 20th century, several large urban concentrations developed. Predominant among the urban centers on the eastern seaboard was New York City, which held by far the largest percentage of the region's population. In 1950, the City made up 56.6% of the region's 13.9 million people. Other significant urban concentrations included Newark, NJ; Jersey City, NJ; Yonkers, NY; and Bridgeport, CT, among other sites.

Since 1950, the population growth of the region has lagged behind that of other metropolitan areas in the United States. Even so, the population continued to increase and reached 21.5 million by 2000. By that time, New York City lost some of its dominance in the region. Population decentralization was an important demographic trend during this period. The city, by 2000, made up only 37.2% of the region's population. Rapid suburbanization and associated white flight fostered a dramatically changed physical and social landscape. The rate of per capita land demand increased steadily during this period. Land conversion increasingly took place on more vulnerable land including flood-prone areas and coastal locations. Coastal development was particularly intense along the Atlantic Ocean coasts of New Jersey and Long Island.

These shifts have been associated with changes in regional employment patterns. Employment growth in the older urban counties has been very slow (and in many cases has shown absolute declines), while employment growth in the outer suburban counties has been very strong. For example, urban counties lost 307,000 jobs from 1970 to 1995; suburban counties gained 2,018,400 (U.S. Bureau of Economic Analysis, U.S. Census of Population).

Both of these shifts have meant a significant change in the overall level of wealth in the region. While some neighborhoods in New York City, particularly in Manhattan, remain extremely wealthy, the out-migration of the middle and upper middle class from older, urban areas along

with a relocation of jobs has meant increasing spatial inequity within the region with respect to income levels. As of 1995 census estimates, almost 24% of the population lived below the poverty level in New York City. The population living below poverty level in Connecticut was about 8%, and in New Jersey it was nearly 9%. Nearly 16% of New York State's total population (including the City) lived under the poverty level, according to 1995 census data. For a large percentage of the region's population, the high poverty levels correspond with lower access to adequate health care and other social services.

Another important characteristic of the region is the racial and ethnic diversity of the population. While the New York metropolitan region has always been defined as a region of immigrants, the recent period of increased international migration has meant a further diversification of the population. Many areas, both urban and suburban, have significant ethnic, African-American, and Hispanic populations. In New York City, non-Latino whites now make up less than 50% of population. Recent estimates note that 40% of the population in the City is foreign-born. The region also has large populations of elderly and immuno-compromised people, particularly people living with HIV/AIDS.

Place

The New York Metropolitan Region has a very diverse landscape. It is dominated by water. Several large waterways and water bodies—the Newark Bay/Hackensack Meadowlands, the Hudson River, East River and Long Island Sound, Peconic Bay, Jamaica Bay, the Arthur Kill, and the Raritan River estuary—cut deeply into the land area.

Three physiographic regions are present: the coastal plain, the piedmont, and the Appalachian highlands. Given its coastal location, much of the land area is at relatively low elevation. A limited amount of land (~1.0%) is below 10 feet (3 meters) in elevation. This land includes some of the most heavily developed areas and regionally important infrastructure, such as lower Manhattan and portions of the three major regional airports.

The ecology of the region has been tremendously modified and it is now a heavily human-dominated landscape. Some exurban areas, such as extreme eastern Long Island, northwestern New Jersey, and parts of Connecticut and upstate New York, more distant from New York City, still maintain extensive wildlife habitat and ecological function. The ecological function of the more settled part of the region is low. However, the few remaining larger-scale (i.e., greater than 1,250 acres or 500 hectares) habitat sites—for example the Hackensack Meadowlands and the Great Swamp in New Jersey and Jamaica Bay in New York—provide habitat for aquatic species and critical stopovers for migratory bird species.

Vulnerable habitats in the region have been heavily degraded. The vast majority of the region's wetlands have been lost. Buffer areas around wetlands or rivers typically are not present. In many areas, smaller rivers and streams have been filled, channelized, or diverted into culverts. Surface water and groundwater supplies, particularly in the more heavily urbanized areas, have been compromised and typically exceed federal water pollution standards. In the region, there are more than 100,000 leaking underground fuel tanks, spill sites, or former industrial sites included on the federal government's register of known or potential toxic sites (Yaro and Hiss, 1996). Many are located in lowland locations where coastal wetlands were used as landfill sites. There are 131 active Superfund hazardous waste sites in the region.

The built environment comprises the most prominent feature of the region. As of 2000, the region maintained 8.3 million housing units, and current estimates include approximately 2,000 miles (3,218 kilometers) of major highway, and 1,250 miles (2,011 kilometers) of railway (U.S. Census, 2000). Much of the built environment in New York City itself and adjacent older urban and suburban areas pre-dates 1950. Maintenance of the infrastructure and buildings is a massive and continuing process. In the outlying counties, the majority of the construction is more recent. Currently, the greatest amount of new construction is taking place in these outlying areas. Revitalization and redevelopment is taking place in selected areas in the older urban core, such as the Hudson River waterfront area in New Jersey.

Pulse

The region is highly dynamic. Complex socio-economic systems form the basis of the region's pulse. The region is organized around high-volume inflows as well as outflows and intraregional flows. As a largely urban site almost all of the food supply has to be imported into the region, and increasingly much of the solid and hazardous waste is exported out. In the case of the New York City water supply, fresh water is also brought into the region. Energy is imported into the region via the Northeast and Mid-Atlantic grid.

Population migration has been a significant component of the region's pulse. In the past three decades, more than 3 million people have migrated into the region. As a major port, the region is tied to the world through shipping. In 1999, over 40 million tons of bulk cargo passed through the ports of New York, Newark and Elizabeth (Port Authority of New York and New Jersey 2000).

Another important component of the region's pulse is the financial services industry. The MEC region is one of the most important financial and business centers in the world. Forty-three percent (861 billion) of all stock shares

traded in the United States are traded on the New York Stock Exchange. New York is also the world's largest advertising center, with transactions of \$37.7 billion in 1998 (Warf, 2000).

Local decisions and transactions that take place in the region everyday have important implications for locations throughout the world. Furthermore, any significant disruption to the communication and transportation systems can have dire economic consequences, not only locally, but also nationally and globally. An assessment of potential climate change impacts must take into account the possibility that future extreme weather events in the MEC region could disrupt these activities.

CURRENT AND FUTURE STRESSES

The region faces several stresses, besides climate change, that limit its current and future viability. The Regional Plan Association, a leading metropolitan regional planning organization, has labeled it as a "region at risk" (Yaro and Hiss 1996). The stresses facing the region include the need for maintaining continued economic growth, inequity among the region's residents, aging and inadequate infrastructure, and threats to environmental quality.

Throughout the latter part of the 20th century, the region experienced a dramatic shift in economic activity. The metropolitan area's manufacturing sector declined significantly, while the service sector grew. Hundreds of thousands of manufacturing jobs were lost. From 1970 to 1994, the manufacturing jobs as a percent of total employment declined from roughly 26% to 12% (Conn., NJ, and NY Depts of Labor). This trend is expected to continue over the next two decades. The service sector employment is expected to continue to show the most dramatic increase.

While the New York Metropolitan Region will remain a global economic and cultural center, its position will be under increased pressure resulting from the further development of a mobile, electronic-based economy, which could promote the decentralization of economic activity from more expensive, older urban areas. A poorly trained workforce is another factor that might encourage regional stagnation and decline.

The economic bifurcation or "hourglass economy" with increasing numbers of both high- and low-income jobs, with a dwindling middle class has created a situation of growing inequity in the MEC Region. This is similar to other urbanized populations in the United States, which are becoming more divided as the gap emerges between high wage-high skill and low wage-low skill residents.

Large disadvantaged underclass populations are present in degraded communities throughout older urban centers in the region. These areas of poverty have persisted even

during the current era of unprecedented prosperity and will likely continue into the future. Meanwhile, rapid income growth has taken place in the outer suburban counties. Income decentralization is expected to continue into the future, although recent redevelopment in selected urban areas might temper this movement.

The spatial restructuring of the region has helped reveal another stress—the lack of appropriate infrastructure. The tremendous infrastructure that has been developed is now aging, in need of significant redevelopment, inadequate to handle the current demand, or otherwise under threat. For example, the regional water supply systems will have to adapt to the changing patterns of development. The integrity of the New York City water quality is being challenged by increasing development around its upstate New York water supply areas, while in northwestern New Jersey new water supplies need to be developed as populations in the area grow. The energy supply infrastructure also needs to be upgraded. Recent increases in regional energy demand have resulted in proposed new power plants and new distribution systems.

The region also continues to face many challenges that threaten regional ecosystem function, environmental conditions, and daily quality-of-life. The most critical environmental issues for the region include air and water pollution, and suburban sprawl. The regional air quality still exceeds federal mandates for several pollutants. Surface and ground water supplies, and coastal waters face constant threat. Recent years have seen much of the remaining open space and farmland present at the distant edges of the region become sites for significant land speculation and conversion. These sites include northwestern New Jersey, the farthest eastern edges of the North and South Forks of Long Island, the lower Hudson River Valley, and southwestern Connecticut.

DECISION-MAKING IN A CHANGING CLIMATE

The MEC Assessment poses the questions: how can the people of the New York Metropolitan Region start to respond to the potential challenges and opportunities of climate change, and how can we bring the issue into our everyday decision-making processes? To respond to these challenges, the Metropolitan East Coast Assessment seeks to create a partnership with regional stakeholders and researchers, educators, and the general public to improve the city's responses to climate extremes today and prepare for a changing climate in the future.

The integration of stakeholders into the research process has promoted an awareness and understanding of climate impacts research in the stakeholder community. By work-

ing closely with the researchers, the representatives from the stakeholder agencies have been able to incorporate their specific data and concerns into the climate impact research of the Assessment, with the result that climate variability and change may begin to be considered in the decision-making processes of the involved stakeholders.

The ongoing involvement of stakeholders in the MEC Assessment has been beneficial in strengthening the research process and results and in building a regional network of interests around the discussion of climate impacts. The representatives from stakeholder agencies have been able to forge working relationships with each other around the concerns of climate impacts. Interagency interactions, along with interdisciplinary interactions, have emerged as one of the prime by-products of the process. Just as climate impacts cannot be successfully addressed by a single academic discipline, institutional responses to potential climate change cannot occur independently. Climate impacts cross sectors and necessitate integrated institutional attention.

The Metropolitan East Coast study, along with the other regional components of the National Assessment, is a necessary first step in building a decision-making community that is informed about potential impacts of climate change and variability and that has the tools to act in preparation and response to these potential impacts. In order to build further upon the Metro East Coast Assessment there must be continuing commitment to focus on the issue of climate impacts on the New York Metropolitan Region and other urban environments.

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