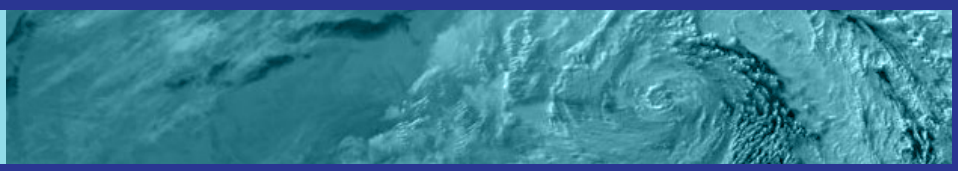
NEW YORK CITY'S RISK LANDSCAPE

COASTAL STORMS



COASTAL EROSION

FLOODING

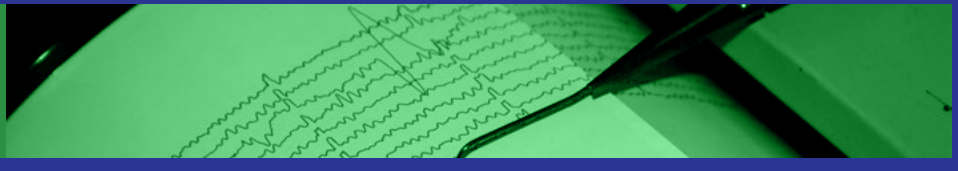
STRONG WINDSTORMS

EXTREME HEAT

WINTER WEATHER

WATER SHORTAGE

EARTHQUAKES



PANDEMIC INFLUENZA

CHAPTER 2
OVERVIEW

RISK AND RESILIENCY

Risk and uncertainty are constants in human life, and New York City has been practicing risk management for centuries. New Yorkers have been identifying, assessing, and prioritizing risks and devising measures to avoid or minimize them. For example:

- In 1657 the Dutch banned thatched roofs in what was then New Amsterdam. This effort to reduce the risk of fire was a precursor of our modern building code.
- Seawalls built to protect the shoreline were originally simple protective structures. They have benefited from the development of coastal engineering insights.
- The 1867 Tenement House Act was the country's first comprehensive housing reform law. The Act's public safety and health measures included an important requirement for fire escapes and 1 outhouse for every 20 occupants.
- In 1899, New York City enacted the first citywide building code. Previous building laws had been enacted by the State.
- The Triangle Shirtwaist Factory fire in 1911 spurred adoption of strict fire safety and labor laws for factories in New York.
- In 1954 the City committed to building a third water tunnel, to permit inspection and repair of the two existing tunnels and to add redundancy. Construction began in 1970 and should end by 2018. The $5 billion project is the largest in city history.
- In 1983, revisions to the NYC Building Code incorporated the FEMA floodplain maps and mandated flood-resistant construction standards for new or substantially improved buildings in order to qualify them for the National Flood Insurance Program.
- In 1995 our first seismic Building Code provisions were adopted.

In present times, our nation's trillion-dollar insurance industry is an immense risk management enterprise. For the insurance industry, the financial sector, engineering, and many other fields, managing risk has always been prevalent, and in the 20th century the practice of risk management has expanded to include sustainability.

In the early 21st century, the goal of resiliency – the capacity to prepare for, respond to, and recover from difficult conditions – converged with the goal of sustainability. The two are inextricably intertwined: an unsustainable way of life makes hazards more severe.

KEY CONCEPTS AND TERMS

The concepts and terms employed in risk management can vary with context. Here are key concepts and terms as used in this Guide:

- **Hazard**: A source of potential danger or an adverse condition that could harm people, our socioeconomic systems, or our built and natural environments.
    - Natural hazard: A hazard that results from conditions in the natural environment, such as flooding. Humans may contribute to or exacerbate the hazard but cannot directly cause it.
    - Non-natural hazard: A hazard directly caused by human activity, such as an intentional or accidental release of hazardous materials.
- **Risk**: The chance that a given hazard could impact people, our socioeconomic systems, or the natural and built environments.
- **Vulnerability**: The extent to which people, our socioeconomic systems, and our built and natural environments are exposed to the impacts of a hazard and are unable to quickly and easily recover.
    - That is, we are vulnerable to flooding, including aging populations that are less able to quickly and easily recovery from a disaster. The risks it carries can extend from damage to beachfront property to disruption of our transit system when subway stations flood.
- **Risk assessment**: The methodical process of (1) identifying hazards, (2) estimating how frequently hazard events could occur (3) identifying who and what is vulnerable to them, and (4) estimating how severe impacts could be.
- **Probability and consequences**: Classically, risk is calculated as the probability of an event (that is, its likelihood, or odds) times its consequences. The odds of a major earthquake in New York City are fairly low; the consequences could be devastating.
- **Uncertainties**: What cannot be understood or foreseen because the complexity of phenomena outstrips our knowledge.
- **Adaptation**: Measures taken to adapt to change; for example, moving beachfront property to higher ground in the face of rising sea level.
- **Mitigation**: Measures that avoid or reduce hazard impacts on people, our socioeconomic systems, and the built and natural environments over the long term. In this Guide, we often refer to them as "risk management strategies"; it is also similar to adaptation.
- **Risk management strategies**: Regulatory controls, plans, policies, programs, projects, initiatives, and anything else that could cost-effectively eliminate, avoid, minimize, or otherwise manage risks. In some contexts, this Guide uses the terms strategies and measures interchangeably.
- **Preparedness**: Actions that strengthen the city's capability to respond to disasters.
- **Resiliency**: The capability of preparing for, responding to, and recovering from difficult conditions; ability to bounce back after change or adversity.

INSIGHT INTO COMPLEX SYSTEMS

New York City is acutely vulnerable to compounded impacts. Embedded in a densely populated, sprawling region, we are dependent on vital energy, telecommunications, transportation, and water and wastewater systems, some of them dependent on each other and all of them aging. Our infrastructure is interconnected. Therefore damage to one system can affect other systems, in turn amplifying the impacts. For example, flooding could shut down a power substation that in turn can cripple communication and transportation systems, disrupting normal life, compromising public safety, and slowing emergency response.

A FUNDAMENTAL SHIFT IN APPROACH

As awareness of the principles of sustainability and resiliency grew, and insight into the interdependencies of complex infrastructure systems deepened, a fundamental shift occurred in the way New York City assesses and manages risk. The piecemeal, response-recovery hazard cycles that had largely prevailed in the past have evolved into a deeply informed, long-term, strategic approach.

Now we view risks as a set within an integrated, citywide risk management framework that has a long-term planning horizon. We draw expertise from a range of disciplines across the public and private sectors.

The result is a robust risk management process that directly serves sustainability and resiliency goals.

A VISION OF A RESILIENT CITY

What would a resilient, sustainable New York City look like? Measures that promote these qualities must be affordable and cost-effective. Here are just a few of a resilient city's features:

- Residents are well informed about potential risks and well prepared to deal with them.

Tightly coupled, complex systems can produce a "domino" effect.

- Resiliency goals are seamlessly integrated into City agencies' planning, budgets, and culture.
- City agencies have deep expertise, and closely coordinate with local, state, and federal stakeholders.
- All parties learn continuously, share what they learn, and modify their plans and practices accordingly.
- The built environment is designed, constructed, and retrofitted to withstand a variety of hazards and to advance sustainability goals.
- Redundancies are designed into complex systems and supply chains so that, if a critical component fails, another can function in its stead.
- The City collaborates closely with external stakeholders to promote sound risk management practices, and to coordinate recovery from emergencies.

While even this brief list is ambitious, New York City is making steady progress.

THINKING HARD ABOUT THE SUBJECT

Risk management is rooted in a cyclical process: identify hazards, assess the risks they pose, devise strategies to manage them, implement the strategies, respond if a hazard event occurs, recover as fully as possible, assess how effective strategies were, and strengthen them to the extent possible. However, real-world events are often more complex than this model suggests.

A series of questions helps illustrate how complex the subject of risk can quickly become. Because some hazards this Guide addresses are quite different from

Risk = Probability ✖ Consequence

each other, certain questions are more applicable to some than to others, and questions may apply in different ways to different hazards. But the questions can provide useful context for the chapters ahead.

"How big is the risk?"

The common definition of risk is the probability of an event times its consequences.

An event that would be catastrophic – a 7.0 magnitude earthquake that causes destruction throughout the city – could be considered a low risk because it is so rare. On the other hand, common events such as extreme heat or snowstorms may not cause significant impacts individually, but when considered cumulatively, they constitute a high risk because they occur so often (at least once during most years). These examples reveal that categorizing the severity of a risk can be somewhat subjective.

How likely is the hazard to occur and how often?

Except for erosion, which is usually a gradual process, the hazards profiled in this Guide occur as discrete events, which makes predictions of their probability crucial. When a hazard event occurs, it is usually measured by its probability or likelihood of occurrence. For example, we can say there is a 1 percent chance that a 100-year flood event will occur in any given year.

Where is the hazard likely to occur? How large an area will be affected?

Whether at night a tornado strikes a deserted City park or a dense residential neighborhood can make a big difference to impacts. The compounding impacts of some hazard events can extend far from the place they occur – for example, power outages. Proximity to the ocean, or low elevation, or soil type, or density of infrastructure are among many factors that affect exposure to risk.

What are the hazard's potential consequences? Who and what are most vulnerable?

Consequences are a function of (1) who and what are impacted, (2) their vulnerabilities. A storm surge can destroy a beachfront bungalow that rests on sand and spare the house next door that sits on concrete pillars. An elderly person is at greater risk of heat stroke than a healthy teenager.

For certain hazards, how much warning time people have affects vulnerability. This is a function of forecasting, City agencies' communication capabilities, and individuals' abilities to receive timely information, and understand it.

Impacts can take these forms:

- Impacts on people: the potential for injury and loss of life, displacement from home, disruption of health and social services, and loss of income – with special consideration of vulnerable populations

- Economic impacts: damage to buildings and infrastructure, disruption of business, loss of revenue, recovery costs

- Disruption of critical systems – energy, telecom, transportation, water, and wastewater – and compounding impacts

- Environmental impacts on air quality, water quality, and ecosystems

How long could impacts last? How long could recovery take?

This is partly a function of the nature of the hazard. For instance, while the effects of the 2014 Polar Vortex can no longer be felt, the city is still recovering from 2012's Hurricane Sandy.

Recovery is also a function of vulnerabilities. People with scant resources whose income is disrupted by a hazard event may not recover quickly.

When thinking about risk, it is helpful to bear in mind these considerations:

- In general, the higher the consequences of an event, the lower the probability, and the higher the probability of an event, the lower the consequences.

- For a given hazard, every single event is unique, often making probability and consequences difficult to predict.

- For any one event, impacts can vary greatly across population groups and geographic areas.

- Cascading effects can vary greatly by hazard, and from event to event for any given hazard.

- The number of variables involved in risk assessments can be huge.

- Risks are dynamic – changing as the environment changes, the world around us changes, and our city continues to evolve.

- The knowledge base that informs risk assessment and risk management continues to grow; the science is still evolving.

- Experts can differ in their assessments.

OUR RISK MANAGEMENT CAPABILITIES

New York City's risk landscape, as sketched in Chapter 3 and explored in Chapter 4, can seem quite perilous. However, our City manages risk on many fronts, every day, in many ways. And Hurricane Sandy mobilized citywide risk management efforts on a scale not seen since the 9/11 attacks. Those efforts informed much of our 2014 hazard mitigation planning.

The yearlong project that produced our 2014 Plan – described in Chapter 5 – was characterized by broad representation from City, State, and federal agencies, regional organizations, the private and nonprofit sectors, academic institutions, community organizations, and citizens. The planning effort was led by New York City Emergency Management and the Department of City Planning in close collaboration with the Mayor's Office of Recovery and Resiliency. What resulted was a comprehensive approach to risk reduction. To assess risk and identify appropriate risk management strategies, the planners pursued a rigorous process of analysis and research, drawing from the historical record, the latest scientific and technical information, various City plans and reports, and consultation with many parties.

MITIGATION PLANNING TEAM

New York City Emergency Management plans and prepares for a broad range of hazards, coordinates emergency response and recovery efforts, educates the public about preparedness, and collects and

disseminates critical information. To accomplish this mission, New York City Emergency Management incorporates a broad mix of disciplines, experience, and perspectives, including planning, emergency response, public health, communications, public policy, geography, and others.

The Department of City Planning is responsible for the City's long-term planning, including land-use and environmental review; preparation of plans and policies; and providing technical assistance and information to government agencies, public officials, and community boards. The Department's expertise on New York City's built, social, and natural environment contributed greatly to development of the *2014 Hazard Mitigation Plan*.

The Office of Recovery and Resiliency developed and implements *A Stronger, More Resilient New York*, a plan to advance Sandy recovery efforts and strengthen resiliency to extreme weather events and climate change. The Office – which reports directly to the Mayor – works closely with NYC Emergency Management, the Department of City Planning, and many other City agencies. Their long list of Partners indicates how comprehensive their approach is. Their teams include architects, economists, engineers, lawyers, marketing and communications experts, planners, policy analysts, and expert advisors. Climate change and adaptation, energy supply, building efficiency and resiliency, carbon emission reductions, transportation, and waste management are among their subjects.

CLEAR ACCOUNTABILITY, CONTINUOUS LEARNING, CLOSE COORDINATION

The *2014 Hazard Mitigation Plan* identifies hundreds of risk management strategies. Because risks range so broadly in nature, responsibility for managing them, responding to hazard events, and promoting resiliency is distributed across – and embedded in – over 40 agencies: it is integral to their missions and integrated into their daily work. They design and implement strategies, evaluate their effectiveness, modify them as appropriate, and investigate best practices applied by other cities, in turn sharing ours with them. This makes for a process of continuous learning, as does the fact that our city is dynamic, and risks and strategies for managing them continue to evolve.

With distribution of responsibility comes the need for close coordination. Our City government is well networked, thanks in part to our aggressive use of digital technologies. We also work closely with New York State and federal agencies, and a host of local, state, and regional stakeholders. In developing the *2014 Hazard Mitigation Plan*, our team met one-on-one with numerous agency representatives to discuss risk management strategies. Significantly, one benefit of this planning process is that it strengthened coordination among the planners.

ANALYTIC AND DECISION-SUPPORT TOOLS

As 21st century risks have become more complex, the tools we apply to assess and manage risks have become more sophisticated.

A prime example is Geographic Information System (GIS) software, an increasingly powerful way to display and explore place-based data. By linking mapping to databases and combining many layers of different kinds of data, GIS enables users to visualize, manipulate, and analyze spatial data. The results can directly inform decision making. Many of the maps in the *2014 Hazard Mitigation Plan* were created with GIS, and some of them appear in this Guide.

Computer modeling is a powerful tool that serves many functions, including weather forecasting and simulating the potential impacts of various hazard events. Loss estimate models are used widely by risk managers for catastrophic modeling to inform decision making and set insurance premiums. NYC Emergency Management ran loss-estimate models developed by FEMA to better understand the economic impacts of hurricanes winds, floods, and earthquakes.

COMMUNICATION TOOLS

Communication is crucial during an emergency in order to promote preparedness and recovery. New York City has a suite of communication tools,

products, and practices. They begin with close interagency communication and range from urgent public alerts to long-term public education, outreach, and awareness campaigns. For example, NYC Emergency Management offers these services:

- Notify NYC alerts subscribers to emergency activity in all five boroughs. Subscribers can receive messages by email, text message, phone, or Twitter. The service, now reaching over a quarter-million subscribers and counting, proves its value every day.

- NYC Emergency Management's Advanced Warning System is designed to alert individuals with special needs to hazardous weather, utility or transportation disruptions, public health emergencies, and incidents requiring evacuation.

- Wireless Emergency Alerts is an emergency notification service that allows authorized government officials to send geographically targeted emergency alerts to enabled mobile devices on the AT&T, Sprint, T-Mobile, and Verizon wireless networks.

- Ready New York is a continuing campaign to encourage New Yorkers to prepare for a variety of emergencies. Its guides are available in print and online in multiple languages and formats. In 2013, NYC Emergency Management presented this program at over 1,000 events across the city.

Social media has become a primary communication tool, and on subjects related to public safety, New York City now has a presence on many social media channels. It facilitates real-time, two-way communication between the City and the public. The City's expansion of Wi-Fi hotspots further strengthens this tool.

COLLABORATION WITH THE PRIVATE SECTOR AND OTHER PARTIES

This Guide necessarily focuses on the role of government. But in hazard events, the roles of community and nongovernmental organizations, the private sector, and citizens become tremendously important as well.

> We are all truly partners on the risk and resiliency frontier.

This was displayed in the wake of Sandy in the sustained outpouring of volunteerism (partially facilitated by social media) – New Yorkers at their very finest. The chapter "Sandy and Its Impacts" in *A Stronger, More Resilient New York* offers a vivid account of the response to one of the most severe natural disaster ever to hit New York.

The close relationships that City agencies cultivate with external parties not only strengthen our ability to respond to hazard events; they inform our planning and strengthen our preparedness. Many parties contributed to our *2014 Hazard Mitigation Plan*. Along with outreach to households, NYC Emergency Management helps the business community prepare for and recover from hazard events through programs like Partners in Preparedness, CorpNet, and Private Asset and Logistics Management Systems

THIS GUIDE'S FOCUS AND ITS SCOPE

The subject of New York City's management of risks is a large one. How can it be made manageable for readers? For reasons of brevity, we limited Chapter 4 to a subset of all hazards addressed in the *2014 Hazard Mitigation Plan* and we updated and expanded some information.

The fact that some hazards are not formally addressed in this Guide does not mean they are not considered to be serious. We urge readers to consult our 2014 Plan for information on hazards not profiled here.

For every $1 invested in hazard mitigation, an average of $4 dollars is saved

Terrorism is not formally treated in this Guide or in the 2014 Plan, because it is beyond their scope: terrorism is an intentional act and managed as a Homeland Security threat, at all levels of government. The consequences of terrorism come in many forms, some of which are not dissimilar to the impacts from the hazards profiled in this Guide. Because of this, some risk management strategies for hazards help protect us against terrorist acts. For example, redundant components of critical systems could help us withstand both a natural disaster and a terrorist attack.

FISCAL CONSTRAINTS AS A RISK FACTOR

The potential for investments in risk management and resiliency is immense, and the nature of risk and our city are continually evolving. The *2014 Hazard Mitigation Plan* devotes a page (page 284) to a list of funding sources that can be tapped for mitigation measures. It is a long list, but that funding is finite.

Moreover, for State and federal funding, every jurisdiction is in a sense in competition with every other. New York City's roster of potential hazards is paralleled by, for example, California's roster, which includes earthquakes, mudslides, flash floods, wildfires, and drought.

The devastation caused by natural disasters over the past several years – Sandy alone is estimated to have caused $19 billion in damages – raises the possibility of future recovery costs breaking the bank.

Thus, a driving principle in devising risk management strategies is cost-effectiveness: How can we get the most from the resources available to us?

Another principle: By reducing risk, investments in risk management measures can reduce the costs of disaster recovery. It is estimated that for every dollar invested in hazard mitigation, an average of four dollars is saved. A July 2014 report by the President's Council of Economic Advisors estimates that delaying climate policy actions by a decade could increase total climate change mitigation costs by about 40 percent. Taking no action would risk substantial economic damage.

Another principle: Every dollar not spent on recovery is a dollar available for something else – another expenditure or a tax reduction. The opportunity costs of disaster recovery expenditures have been substantial.

New York City's ability to manage and adapt to future risks will be significantly shaped by the availability of funding. Protecting our city requires investment in risk management measures, and by reducing risk, that investment protects our budget from recovery costs.

Thus, lack of investment and budget shortfalls become themselves risk factors.

We hope readers will carry these considerations into their appraisal of the following chapters.