



Public Policy Forum

Hazard & Risk Assessment for New York State: Estimating Probability and Severity

**Presented by
Ernest Sternberg and Graduate Students in
Urban and Regional Planning, University at Buffalo**

December 11, 2006

Tom Gais:

I'm co-director of the Rockefeller Institute and I'm very happy to welcome you today for a discussion of "What Dangers Do We Face?" This is a presentation by several graduate students. I will allow Ernie Sternberg to give a more complete introduction about the students and the circumstances around the presentation.

Ernest Sternberg holds a Ph.D. in city and regional planning from Cornell University. Currently he is professor of urban and regional planning at the University at Buffalo and president of Protect New York, an academic and professional society devoted to research and education to safeguard New York from terrorism and disaster. His current research is on the ethics of complex decisionmaking about disasters, whether terrorism, natural, or technological hazards. Lately, some of his work has been focused on hospital evacuations and disasters. What's interesting about Ernie, and I'll say more about this later, is a strong capacity to do a lot of interdisciplinary work. He's done work on cultural facilities and economic development, urban design, tourism, high technology, and industrial policy, all kinds of issues that cut across urban issues, economics, sociology, etc.

Especially important to this Institute, though long past, is that Ernie was the last of the Institute's visiting fellows in 1987 and 1988, when he did work on government research policy and industrial development. The more important matter is that in recent years, he's been working with us here at the Institute, as well as people throughout the SUNY system, in putting together an organization called "Protect New York." It is an academic society formed across field of research and campuses by academic faculty from the State University of New York.

Ernie, working with Brian Stenson and the rest of us here at the Institute, put together a series of meetings and conferences on the issue of homeland security questions as they apply to New York State, along with the expertise of the many people in the State University of New York, as well as some of the other universities here in New York. I should also mention that they do have a web site I can recommend: www.protectnewyork.org. So, without any further discussion, here's Ernie Sternberg.

Ernie Sternberg:

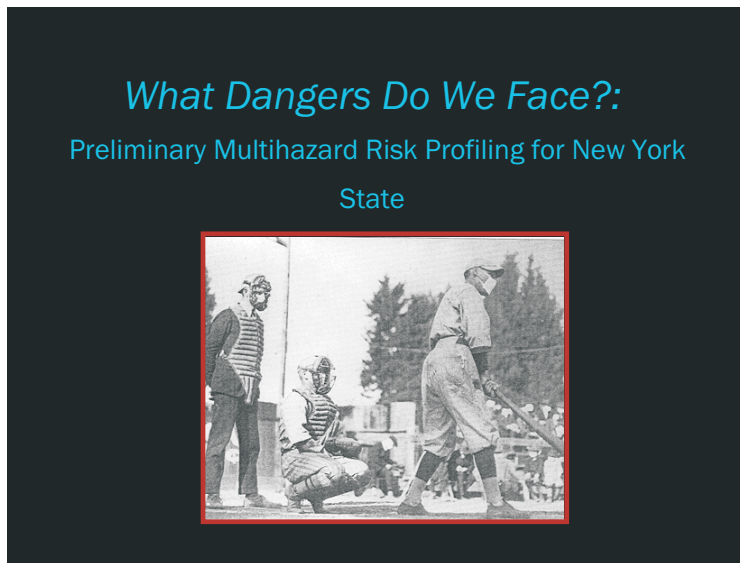
It is notable that I was the *last* of the visiting fellows, I don't know why that was. And by the way, Protect New York does accept all kinds of members, including those who are not themselves academic faculty, but who are interested in research and education.

This is a graduate student project that is being presented today through the Department of Urban and Regional Planning of the State University of New York at Buffalo. As part of our graduation requirement for the master's of urban planning, our students are required to take part in a major class studio, or workshop, in which they take on a significant policy or planning project with a real audience or a real client, a public client; in fact, there are three going on this semester and ours today is just one of them. One of the others is looking at second home ownership and tourism in Cattaraugus County. Another one is looking at the role of the Niagara Falls airport in economic development in the Niagara Falls area.

What we have here is our own project conducted by eight students since last September. We are sponsored for our trip to Albany by the Multidisciplinary Center for Extreme Event Research (MCEER). It was formerly known as Earthquake Engineering Research. MCEER has allowed us to come here and to publish of our final report, which will be ready sometime in 2008.

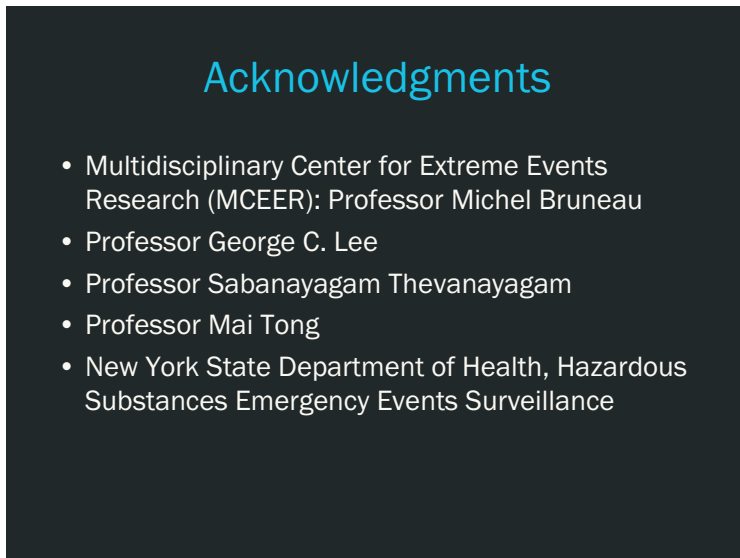
This whole project will be presented by our students. Our moderator will be Elea Mihou, and I don't expect to be a further part of this conversation, until the discussion way towards the end.

Elea Mihou:



Good afternoon and welcome. What you're looking at now is a photograph of New York City baseball players who needed to wear face masks during the games at the time of the 1918 Spanish flu outbreak in the United States. After our presentation, there will be question and answer session, where we can have an engaging and interactive discussion. We really want to

hear your feedback about our research, so we ask that you please hold all of your comments until the end.



This is a list of our acknowledgments. The seniors you're going to be hearing from have put in more than 900 collective research hours. This was made possible through support and assistance from a variety of people, and we also want to give a special thank you to the Rockefeller Institute for hosting us.

Who we are



UB Candidates for the Masters of Urban Planning Degree:

Lindsay Allen
Melissa Fratello
Julie Gotham
Hao Huang
Elea Mihou
Jody Pollot
Pavan Yadav
Carol Yamarino

Under supervision from:

Dr. Ernest Sternberg
Professor of Urban & Regional Planning UB

Hazard Types

- Severe Winter Storms
- Ice Storms
- Severe Thunderstorms
- Wind Storms
- Tornadoes
- Floods
- Heat Wave
- Airplane Crashes
- Fires
- Hazardous Materials
- Structural Failures
- Pandemic Flu
- Terrorism

New York State faces a range of hazards, from natural hazards like tornados, floods, and snow storms, to technological hazards, such as hazardous material transport, plane crashes, and fires, to sea surge, earthquakes, pandemic outbreaks, and terrorism. While some of these hazard types are ancient, some are reflections of a new and changing era. They all, however, are

significant to planners and policymakers alike, because they are reflections of changing populations, changing technologies, changing building codes, and much more. And in spite of their many differences, they share a theme of being major threats to human life that can cause dramatic economic loss and change environmental, psychological, cultural, and social landscapes of entire regions, states, or nations forever.

As we face these potential threats, we have asked ourselves how we assess the hazards of the past against new and changing realities from climate changes to sea level rises, new global mobility, and much more. But even with limited information, decisions still must be made. Money is still allocated; training still takes place; and equipment is still purchased. And not preparing is putting human life and community stability at risk. Ultimately, our

purpose here is to suggest improvement and direction to provide a more advanced way of comparing multihazard risks.

We work on this research with many of the same limitations that a municipality faces. We have limited time, information, resources, and data access. Our purpose ultimately is to provide a process. We believe that when further advanced, this can inform policy and save lives.

We'll be covering hazard types ranging from natural, technological, and terrorism, as well as others. We are not looking at a few other types, such as nuclear meltdown or other pandemic outbreaks beyond flu. We felt that these were sufficient to cover immediate threats, and also due to the availability of other data.

In this work, we don't expect to replace the political process. We understand that funding, distribution, and policies are political processes. They involve and require compromise and political negotiation. We hope that our work can be used to inform policy by providing more information.

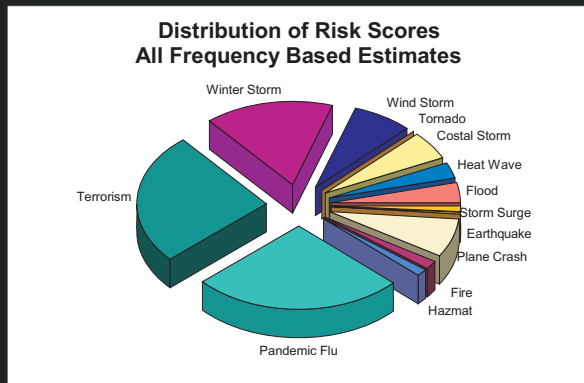


Our geographical scope was the entire State of New York. We understand that not all hazard types will occur equally or at all throughout the state; for example, a sea surge is a different kind of reality for New York City than it is for Albany. So, this is not intended to be applied directly to locality. We suggest that municipalities use this process to

apply to their own cities, towns, or regions, and not just directly take a statewide study.

Our findings, while we feel they set the stage for planning practices and policymaking, economic development, and hazard communication, are only preliminary. They were pursued with limited resources, time, and access to significant data sources. We were not able to assemble expert estimates on all hazard types and, therefore, many of our hazard types

Findings



could have underestimated. We feel, though, that we are advancing a process, a process of data collection and analysis that could be advanced and done better with additional resources. Now I'll turn it over to my colleague, Melissa Fratello, to explain our methodology.

Melissa Fratello:

Thank you, Elea. Hello everyone, I'll be introducing our approach to risk assessment. This study endeavors to impact conventional methods in hazard assessment by offering a dynamic, multihazard profile that provides more detail for policymakers.

A hazard, as defined within our study, is a precondition that creates the possibility for disaster. A disaster is an event of sudden onset, concentrated in time and location resulting in mass destruction, disruption, and/or casualties.

Based on a survey of existing multihazard problems, we have found that categories often are loosely defined or scaled in such a way that makes it difficult to assess real threat or

Conventional Hazard Assessment

Hazard	Hazard Severity + Location + Frequency/Probability	Vulnerability Natural + Manmade + Systems	Total Risk Hazard Risk + Vulnerability + Capability	Page
Drought	Moderate	Low	Low	5
Earthquake	Moderate	High	Moderate -> High	8
Epidemic	Low -> Mod Severity Low -> Mod Probability	Low -> High Impact	Low	12
Flooding	Bear & Evans Cr. = high Sammamish R. = low L. Sammamish = low	Low Low Low	Moderate Low Low	15
Hazardous Materials	Low -> High	Low	Low -> Moderate	20
Heat Wave	Low	Moderate	Low	22
Landslide	High	Moderate	Moderate -> High	24
Terrorism	Low -> Moderate	Low -> Moderate (Depends on target)	Moderate	27
Wildfire	Low -> Moderate (Seasonal)	Low -> Moderate (Depends on if drought)	Low -> Moderate	29
Winter Storm	High	Low	Moderate	33

likelihood. It also is often difficult to determine the basis for risk categorization, such as in this example.

This is a risk analysis from a town in Colorado, and in this example I was not able to find the criteria for risk categorization or priority.

Conventional Hazard Assessment

TORNADO: 288.5, Moderately High Hazard	
<u>Potential Impact:</u> Large Region	<u>Cascade Effects:</u> Highly Likely
<u>Frequency:</u> Infrequent Event	<u>Onset:</u> No Warning
<u>Hazard Duration:</u> Less Than One Day	<u>Recovery Time:</u> More Than Two Weeks
<u>Impact:</u>	
<ul style="list-style-type: none"> • Serious injury or death is likely in large numbers. • Severe damage to private property. • Severe structural damage to public facilities. 	
TRANSPORTATION ACCIDENT: 282.0, Moderately High Hazard	
<u>Potential Impact:</u> Large Region	<u>Cascade Effects:</u> Some Potential
<u>Frequency:</u> Regular Event	<u>Onset:</u> No Warning
<u>Hazard Duration:</u> One Day	<u>Recovery Time:</u> One to Two Days
<u>Impact:</u>	
<ul style="list-style-type: none"> • Serious injury or death to extremely large numbers. • Moderate damage to private property. • Moderate structural damage to public facilities. 	

Conventional Hazard Assessment

The Group rated the 25 hazards as follows:

Hazardous Materials in Transit	316.3
Flood	305.5
Severe Storms	295.5
Earthquake	292.0
Ice Storm	290.8
Hazardous Material at Fixed Sites	290.3
Tornado	288.5
Transportation Accident	282.0
Winter Storm (Severe)	251.5
Fire	236.8
Oil Spill	231.8
Power Failure	230.8
Explosion	205.8
Structural Collapse	204.2
Extreme Temperatures	196.2

Our Approach: RISK =

1. Annual Historic Frequency X Magnitude
2. Expert (or Model) Annual Probability Estimate X Magnitude

Reasons for improvement also include loosely defined categories of likelihood, severity, and impact. This is a hazard analysis from the town of Amherst, New York that was created utilizing HAZNY software. As you can see, much of the terminology is not specific, and instead is open-ended. Hazards of magnitude are often qualitative or on simple point scales that do not express enormous differences in damage.

Here we have the Amherst results from the HAZNY process. You can see here that the final risk scores are on an arbitrary point scale and do not range very much between hazards.

In our approach, risk is calculated by gathering data of historic frequency and multiplying that value by the events categorized magnitude value. Serious magnitude is given a value of 1; Severe a 10; Disastrous I of 100; Disastrous II of 1,000; and Catastrophic of 10,000.

Frequency

- Data sources vary per hazard
- Sample sizes range from 11 years of events (Weather Events) to 306 years (Pandemic Flu)



In some of our hazard studies, we have found expert evidence of future likelihood and applied a separate formula of annual probability multiplied again by the extent of magnitude value.

I'd like to point out here that option to use frequency data rather than probabilities, because when using probability

of at least one event per year, events of lesser magnitude that occur very frequently on an annual basis are not accurately represented.

To give a more specific example, there have been 37 fire events categorized as Serious since 1990. This results in a probability of at least one per year of 0.68, and a risk score in the Serious category of 0.68. Whereas, when using average frequency, risk score in the serious category is 2.18. This result would be the best representation of events that happen frequently on an annual basis, yet do not result in greater amounts of damage.

Data were gathered from several sources. Sample sizes range, as well, with frequently occurring hazards, such as weather events or fires having smaller sample sizes typically, and rare occurrences, such as pandemic flu or earthquake having much larger sample sizes.

Examples of data sources include the United States Geological Survey (USGS), the Center for Disease Control (CDC), National Fire Protection Association (NFPA), and the Memorial Institute for the Prevention of Terrorism (MIPT) Knowledge Base, among others.

Magnitude is categorized by the amount of damage incurred by the events, or in the case of expert estimates, the amount predicted to occur given the severity of an event. We have assigned specific criteria to each category: first by the number of casualties, then taking into consideration other effects, including injuries and displacements, and destruction costs or disruption, which we calculate as the number of people affected times the number of days of the event. And with qualitative effects, in some cases, we also took into consideration shock trauma or long-term environmental effects.

Categorizing Magnitude

Magnitude Category	Casualties	Injury and/or Displacement	Destruction Cost	Disruption (People X Days)	Magnitude Score
Serious	0-9	50-500	5-50million	1,000s	1
Severe	10s	500-5,000	50-500million	10,000s	10
Disastrous I	100s	5,000-50,000	500million-5billion	100,000s	100
Disastrous II	1,000s	50,000-500,000	5-50billion	1 Millions	1000
Catastrophic	10,000s	500,000-5million	50-500billion	10 Millions	10000

*Qualitative Effects are also taken into consideration when assessing magnitude

We have not at this point been able to construct a standard for categorizing events, as the data within hazard categories very often is inconsistent and is often qualitative or lacks better detail and exact numbers.

Magnitude Examples



The photos shown here are examples of how certain events have fallen into our magnitude categories. Several fires have been categorized as Serious. We have had heat waves that have been categorized as Severe, plane crashes as Disastrous I. And here we have a picture of 9/11, which we have categorized as Disastrous II, with Hurricane Katrina and the Spanish Flu of 1918 examples of Catastrophic events.

Formulating Risk Example: Pandemic Influenza

Pandemic Influenza: Annual Frequency and Risk Score, 1700-2006						
Category	Serious	Severe	Disaster I	Disaster II	Catastrophic	Total
Factor	x1	x10	x100	x1000	x10000	
# of events over 306 years	0	0	0	12	1	13
avg freq per year	0	0	0	0.0392	0.0033	0.0425
Frequency Based Risk Score	0	0	0	39	33	72

The process we followed to formulate risk is, again, the average frequency, which is computed by dividing the total number of events of a given magnitude by the total number of years in the sample. This average frequency is then multiplied by the magnitude value, either 1 for Serious, 10 for Severe, 100 for Disastrous

I, 1,000 for Disastrous II, and 10,000 for Catastrophic to reveal the final risk score for each hazard.

And at this point, I want to turn the presentation over to Jody Pollot who will discuss extreme weather events.

Jody Pollot:

We're going to go over the following: winter storm events, other severe storms, tornados, coastal storms, heat waves, and flooding.

Winter Storm Events



- Synoptic weather
 - Alberta Clippers
 - Nor'easters
- Lake Effect Snow
- Blizzards
- Ice Storms
 - Classified Separately

I am first going to talk about winter storm events. There are many different types of winter weather that affect New York State, as can be seen on the slide. New York State climate is affected by the Great Lakes and the Atlantic Ocean; therefore, weather events ideally should be classified on an individual basis to provide the most accurate results.

For this analysis, we chose not to do this, but it should be pursued at a later date. We separated winter storms from ice storms, as ice storms typically cause different types of damage.

This is an example of a Disastrous I storm (see next page). The ice storm of 1998 affected a wide area, including northern New York; specifically, the Adirondack region, New York, New England, and Quebec. Six New York State counties were declared disaster areas by FEMA. Throughout the region, 1.4 million people were without power.

Overall economic loss was estimated for New York State at \$440.9 million. The return period for an ice storm with a similar magnitude is estimated to be 100 years for northern

Ice Storm 1998

Category: *Disastrous 1*

- Northern New York
- 1.4 million without power; 300,000 NYS



New York and is comparable only to a similar event in 1921; therefore, due to monetary losses and loss due to power outages, we classified the storm as Disastrous I.

The recent October storm that affected western New York would also be classified as Disastrous I, based on similar statistics; however, given

the recent nature of the storm, we do not include this storm within our report.

Winter Storm Annual Frequency and Risk Score, 1996-2006

Explanation of Estimate	Serious	Severe	Disastrous I	Disastrous II	Catastrophic	Total
Winter Storms , except Ice Storm - estimated from NCDC data	6	4	1	0	0	11
Average Frequency Per Year (11 years)	0.55	0.36	0.09	0	0	1.00
Frequency Based Risk Score	0.55	3.64	9.09	0	0	13.27
Ice Storm Only - estimated from NCDC data	1	1	2	0	0	4
Average Frequency Per Year (11 years)	0.03	0.03	0.07	0	0	0.13
Frequency Based Risk Score	0.03	0.33	6.61	0	0	6.98
Winter Storms and Ice Storm - estimated from NCDC data	7	5	3	0	0	15
Average Frequency Per Year (11 years)	0.87	0.62	0.37	0.00	0.00	1.86
Frequency Based Risk Score	0.87	6.20	37.19	0	0	44.26

This is our winter storm annual frequency and risk score table. Risk scores were calculated based on annual frequency, and as you can see the first line deals with winter storms, except ice storms. There were six Serious events from 1996 to 2006 based on National Climatic Data Center (NCDC) data, four Severe events, and one Disastrous event. Average frequency for

Severe events would be multiplied by 10 for a risk score of 3.64. Average frequency for Disastrous I would then be multiplied by 100, which is based on our magnitude table, for a risk score of 9.09. The total risk score is 13.27 for winter storms, excluding ice storms. The overall average score for winter storms and ice storms combined is 44.26.

I'm now going to talk about "Other Severe Storm Events." There are many types of severe storms that affect the state. A severe storm is defined as hail with at least three-fourths of an inch in diameter, wind of at least 57.5 mph (50 knots), or that produces a tornado. A tornado start as a Severe storm.

Other Severe Storms

- Severe Local Storm
- Thunderstorm
- Severe Thunderstorm
- Tornadoes begin as severe thunderstorms



The NCDC data do not list storm data in this way, based on severe storm definition. Therefore, we used a high wind events and thunderstorm wind to classify severe storms. However, tornadoes are listed separately and they have their own category.

Example of Tornado Destruction in New York State May 31, 1998

Category: Severe

- F3 Struck Saratoga & Northern Rensselaer
- State of Emergency
- The National Guard
- Power-lines & trees down
- Approximately 70 people were injured
- No fatalities



This is an example of a severe tornado that affected New York State. A category F3 tornado struck Saratoga and northern Rensselaer counties on May 31, 1998. A state of emergency was declared by Governor George Pataki and the National Guard was called in to assist with cleanup. About 70 people were injured and there were no fatalities. Almost 345 homes and businesses were damaged or destroyed.


Wind Events & Tornado Annual Frequency and Risk Score

Tornadoes	11	2	0	0	0	88
Average Frequency Per Year (55 years)	0.2	0.04	0	0	0	1.63
Frequency Based Risk Score	0.2	0.4	0	0	0	0.6
High Wind Only	3	6	1	0	0	10
Average Frequency Per Year (11 years)	0.25	0.50	0.08	0	0	0.83
Frequency Based Risk Score	0.25	4.96	8.26	0	0	13.47
Thunderstorm Wind Only	3	1	0	0	0	4
Average Frequency Per Year (11 years)	0.1	0.03	0	0	0	0.13
Frequency Based Risk Score	0.1	0.33	0	0	0	0.43
All High Wind Events- excluding Tornadoes	6	7	1	0	0	14
Average Frequency Per Year (11 years)	0.69	0.81	0.12	0	0	1.62
Frequency Based Risk Score	0.69	8.1	11.57	0	0	20.36

This is our frequency and risk score table for wind and tornado events in New York State. Tornadoes are listed first with a total risk score of 0.6. High wind events are listed next with one disastrous event for a total risk score of 13.47. Thunderstorms are next, with three being Serious and one

Severe for a total risk score of 0.43. All of the events, excluding the tornados, have a total magnitude score of 20.36.

Flood



“the accumulation of water within a water body and the overflow of excess water onto adjacent floodplain lands”

Types:


- Flash
- River
- Dam Breach
- Local Drainage
- Coastal – *excluded* – *under storm surge*

I am now going to talk about floods. Here’s the definition of floods and the various types, flash floods being the most dominant type. According to NCDC data, there were 2,101 flood events from 1993 to mid-2006, resulting in 43 deaths, 33 injuries, \$1.8 billion in property damage, and \$3.2 million in crop damage.

Delaware Basin Flood June 27-28, 2006

Classification: Disaster 1

- 18 inches rain
- Record high levels
- 4 fatalities
- 885 million damage
- Over 9000 evacuated
- Major highways closed



This is an example of a disastrous I flood based on our magnitude table. The Delaware Basin flood was classified as a Disastrous I. There were record high levels of water observed in the rivers, as 18 inches of rain fell. Four people died, there were close to \$1 billion in damages, over 9,000 persons had to be evacuated, and major highways had to be closed.

This is a flood frequency and risk score table (see next page). We used two different sets of data from 1954 to 2006, which are FEMA data, and we also used NCDC, which is from 1993 to 2006. We classified 20 total flood events from this data based on our magnitude table out of the 2,101. Only two floods are considered as Disastrous I, for a total magnitude score of 10.65.

Coastal storms are derived from hurricanes, nor’easters, and tropical storms. These do not include storms that cause storm surge, which will be talked about later. We used histori-

Flood: Annual Frequency and Risk Score (1954-2006 and 1993-2006)

Explanation of Estimate	Serious	Severe	Disastrous I	Disastrous II	Catastrophic	Total
Working Estimate (Based on 2 databases)	13.5	4.5	2	0	0	20
Annual Frequency Per Year (Derived from 2 databases)	0.56	0.185	0.0824	0.00	0.00	0.827
Magnitude	1	10	100	1000	10000	-
Risk Score	0.56	1.85	8.24	0	0	10.65

Coastal Storms

Explanation of Estimate	Source	Serious	Severe	Disastrous I	Disastrous II	Catastrophic	Any
Total frequency 1900-2004	FEMA; NOAA	3	1	16	1	1	20
Average annual frequency		0.03	0.01	0.15	1	1	
Risk Scores		0.03	0.10	15.24			15.36

Heat Wave: Annual Frequency and Risk Score

Explanation of Estimate	Source	Serious	Severe	Disastrous I	Disastrous II	Catastrophic	Any
Heat events 1993-2001	NCDC/NOAA	2					2
Heat events 2000-2006	NYCDOMH		1	1			2
Average annual frequency		0.22	0.14	0.14			0.51
Risk Scores		0.22	1.43	14.29			15.94

cal frequency data from the National Oceanic Administration and FEMA. For over a 105 year period, there were 20 coastal storms that impacted New York City and Long Island. Again, a regional analysis would be useful in this case. Categorizing these storms based on our magnitude table, there were three Serious storms, one Severe, and 16 Disastrous I storms, for a total risk score of 15.0.

As you can see, the annual frequency risk score table for heat wave shows 20,000 deaths attributed from heat waves in the U.S. over a 40-year period, from 1936 to 1975. In 1980, 1,250 deaths were claimed, which the National oceanic & Atmospheric Administration (NOAA) considers to be a Disastrous heat wave. Since 1880, temperatures in New York have already risen an average of four degrees. The total combined heat wave risk score is 15.94. Thank you, and now Carol will talk to you about storm surge and earthquakes.

Carol Yamarino:

Storm Surge



As a result of.....

- Hurricane
- Nor'easter
- Earthquake or sea shelf movement

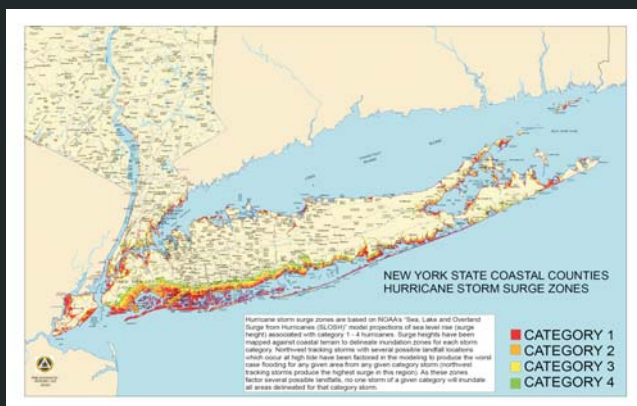
Storm surge occurs mostly from hurricanes, possibly nor'easters and, most infrequently, earthquakes. And of course that's something we don't typically worry about along the coastline of New York City, but we know it can happen.

Hurricanes that Affected NYC/LI Coastlines

Month/Year	Category by STATE	NAME
September 1858	Category 1	"New England"
September 1869	Category 1	"Eastern New England"
August 1893	Category 1	"Midnight Storm"
October 1894	Category 1	(no name)
September 1938	Category 3	"New England"
September 1944	Category 3	(no name)
September 1960	Category 3	"Donna"
June 1972	Category 1	"Agnes"
August 1976	Category 1	"Belle"
September 1985	Category 3	"Gloria"

What you see here is a list of some hurricanes that have occurred over the last 150-odd years, mostly Category 1, some Category 3 from the Saffir-Simpson scale. For purposes of storm surge, it correlates almost directly; Category 1 would be a low storm surge. But we were concerned mostly about Categories 3, 4, and 5, and that correlated with the map the New York State Emergency Management Office (NYSEMO) put together.

NYS Coastal Surge Zones Reference: NYSEMO



This is a map that shows the areas of inundation water levels that could impact Long Island and New York City. This is a map prepared by NYSEMO. As you can see, most of Long Island would be impacted by a simple Category 1 and 2 hurricane. Then you can see a little bit higher developments, but further up along the Hudson, Category 2 and 3 ar-

Risk Score

Explanation of Estimate	Source	Serious	Severe	Disastrous I	Disastrous II	Catastrophic	Any
Occurrence of Hurricanes Along NYS Coast 1851-2005	NOAA	6	1	5	0	0	12
Individual risk scores by magnitude		0.04	0.06	3.23	0	0	3.33

areas along the Hudson River would also be affected by a storm surge. The reason for that is the northwest tracking of the storm as it would come up off the Atlantic coast, as it hits the 90-degree angle that is produced by Long Island and Manhattan, gives the water nowhere to go and it inundates the low continental shelf of Long Island and surges

forward up through the Hudson River.

High risk scores are based on past historical occurrences of hurricanes. We took into account for purposes of this risk score, approximately 155 years of data of historical hurricanes.

Limitations

- Variables in climate
- North American oscillation
- Global warming
- Unstable Mother Earth
- Changes in continental shelf of NYC/LI

There were 12 occurrences that correlated with our magnitude scale, which translates to the average annual frequency of six for Serious, one for Severe, and five for Disastrous I. Individual risk score is 3.33. There are, of course, limitations. There are variations in our climate occurring as we speak. We have global warming raising the sea level. There

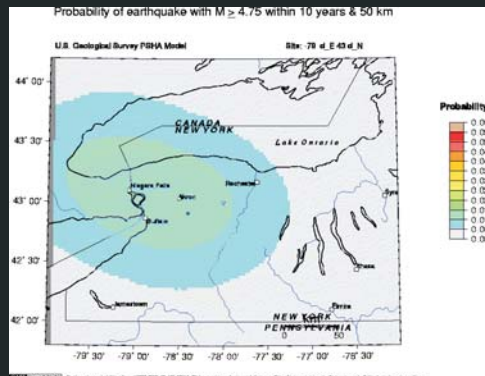
is concern for the North American oscillation of the El Niña and El Niño effect, which affects the frequency and intensity of the storms.

And there's the instability of an earthquake. Between 1730 and 1986, New York State was the third most seismically active state east of the Mississippi. These patterns are yet to be fully understood by experts given that according to tectonic theory, earthquakes are be-

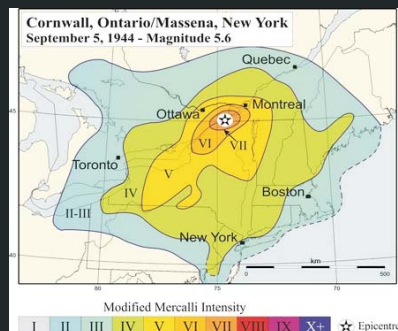
Earthquake Events, 1877-2002

Date	Location	Richter Magnitude	Mercalli Intensity	Our Magnitude
11/4/1877	Upstate NY	4.9	VII	Serious
8/10/1884	NYC	5.5	VII	Serious
2/10/1914	Ontario, CA	5.2	VII	Severe
4/20/1931	Lake George	4.7	VII	Serious
11/1/1935	Ontario, CA	5.9	VII	Serious
9/4/1944	Massena	5.8	VIII	Disastrous I
4/20/2002	Plattsburgh	5.1	VIII	Severe

Probability With Geographical Distribution



Massena-Cornwall, 1944



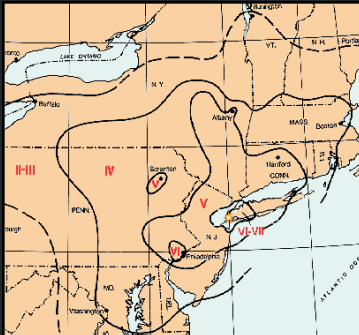
lieved to occur along three different types of plate margins that do not exist in New York State.

We have a map showing probability with geographic distribution. This is upstate New York. What we're showing here are areas that could be affected by an earthquake. Northern New York would be affected by an earthquake more than the Great Lakes area, Buffalo, where we're located. The next map shows New York City.

This is an earthquake that occurred in Massena and Cornwall that caused the most destruction from any recorded earthquake in New York State, and it was approximately a VI on the Richter scale. Those categories are showing the Mercalli intensity, which is different from the Richter scale. This earthquake was felt from Canada to Maine to Indiana.

For an earthquake in New York City, we don't have the damages estimate, but it was a 5.5 in 1884. The earthquake

New York City, 1884



shook foundations, damaged chimneys, and violently agitated the water in the Hoosatonic River. And again it shows you the Mercalli intensities.

Frequency-Based Risk Score

Earthquake: Risk Score Based on Average Annual Frequency						
	Serious	Severe	Disastrous I	Disastrous II	Catastrophic	Total
Total Events, 1877-2005 (USGS Records)	4	3	1	0	0	8
Risk Score	0.03	0.23	0.78	0	0	1.04

Our frequency and risk-based scores: There have been seven destructive earthquakes in New York State based on available data, and our total annual frequency of a serious or greater earthquake at 0.625 for a final risk score of 1.047. This risk score may not fully explain potential threats caused by destructive earthquakes and further research is needed to better determine an accurate risk score.

Expert Estimate Risk Score

Earthquake: Risk Score Based On Expert Estimates of Future Probability						
	Serious	Severe	Disastrous I	Disastrous II	Catastrophic	Total
Probability Estimates (Source, USGS Seismic Hazard Maps)	0.005	0.002	0.0022	0.0009	-	-
Risk Score	0.005	0.02	0.22	0.9	-	1.145

When we factored in expert estimates, we came up with a slightly higher risk score of 1.145. These estimates are based on the potential exposure of urban populations to an earthquake for the V, VI, and VII Richter scale.

We are concerned for this very low risk score, knowing full well that the potential for an earthquake to cause a disastrous or even catastrophic

event in New York State, primarily New York City, does exist; thus, we are very interested in your advice regarding the measurement of this hazard.

We're now going to move on to technological hazards by my colleague, Pavan.

Pavan Yadav:

Thank you, Carol. My name is Pavan Yadav and I'm going to talk about technological hazards such as airplane crashes, structural failures, fires, and hazardous materials (hazmat).

Airplane Crashes

Reasons: weather conditions, mechanical failure, human error

Casualties may occur on board or on ground

Terrorism not counted

Airplane crashes occur due to bad weather conditions, mechanical failures, human errors, or terrorist attack; however, we will discuss elsewhere the airplane crashes due to terrorism.

Three major airplane crashes occurred in 2001, including 9/11. Belle Harbor caused 422 casualties plus many more on the ground. In 1996, a plane crashed into the Atlantic Ocean and caused 230 casualties. These serious airplane crashes caused us to consider the airplane crashes as a major hazard.

Disastrous Air Crashes in NYS

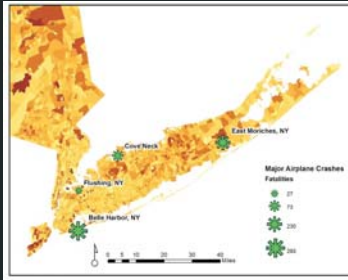
- In 2001:
 - 3 Disastrous Air Crashes, Including 9/11
- Belle Harbor (Nov., 2001)
 - crashed into a residential area,
 - 265 fatalities
- East Moriches (July, 1996)
 - crashed into the Atlantic Ocean
 - 230 fatalities



Of airplane crashes, 60 percent were on the ground and around 80 percent were within a two-to-three mile ra-

Geographic Distribution

- Research reveals that
 - Only 5% of crashes occur en route.
 - Around 80% are high impact crashes occurs within two miles of the airport
- Areas near airports are most vulnerable to air crashes.
- Of NY's 143 public airports, the highest traffic at NYC airports.
- All disastrous crashes were in NYC



Geographic Location of Major Airplane Crashes, 1986-2005
(Source: NHTSA's Aviation Accident Database, US Census)

dus of the airport. On the map, you can see all major airplane crashes that occurred in or around New York City.

Also, of the 143 airports in New York State, the highest air traffic is in New York City airports, the most vulnerable area. According to the National Transportation Safety Board data, in the last 25 years, 188 fatal crash events have occurred in New York State. Of all of them, two were serious and two were disasters, per our definition. Based on these data the total risk score for airplane crashes is 20.2.

Fatal Air Crashes in NYS: Annual Frequency and Risk Score, 1986-2005

	Serious	Severe	Disastrous I	Disastrous II	Catastrophic	Total
Events	184	2	2	0	0	188
Annual Frequency	9.2	0.1	0.1	0	0	9.4
Risk Score	9.2	1	10	0	0	20.2

Structural failures are the full or partial collapse of buildings, dams, or bridges that may cause casualties, injuries, or property loss and destruction.

Structural Failures



Structural, partial, full collapse of the dam, building or bridge that results fatalities, injuries, property damage, economic loss and disruption

The causes of dam failure might be heavy rainfall or flooding, structural inefficiency, poor maintenance, or failure of upstream dams of that waterway.

In 1972, the Buffalo Creek Dam failure in West Virginia caused 125 fatalities, more

Dam Failures

- Causes
 - heavy rainfall and flooding
 - structural inefficiency
 - poor maintenance
 - failure of upstream dams
- In 1972, Buffalo Creek, West Virginia - 125 fatalities, 1,100 injuries and 3,000 homeless
- In last 25 years
 - no fatal dam failure
 - produced relatively little damage
 - Reason: low in height and not in downstream settlements.
- Of 1971 dams, 19% are high hazard classified
- 378 dams labeled "high risk," - NYS must continue to pay attention to this hazard

than 1,100 injuries, and left more than 3,000 people homeless. This incident shows the severity of that type of event. Fortunately, in the last 25 years in New York State, 15 dam failures were recorded, but there were no fatalities and very little property damage. The reason might be that dams were low in height and not upstream of settlements.

Building Failures

- July 1981, Kansas City, Hyatt Regency Hotel, 114 death and 200 injuries
- June 2006, NYC, 1 death, 9 rescued
- 225 recorded failures, 57 in NY – Ranks First(1989-2000)
- Reason: comparatively older building stock

Of the 1,971 dams in the state, 19 percent are classified as high hazard dams by the National Inventory of Dams. Considering this large number, New York State must continue to pay attention to this hazard.

Bridge Failure

- April, 1987, Schoharie Creek Bridge NY-Thruway - 5 vehicles plunged, 10 death
- 503 recorded failures, 64 in NY – Ranks Second (1989-2000)
- Data does not allow us to classify by magnitude.

Building failures: In 1981, the Hyatt Regency Hotel disaster in Kansas City caused 140 fatalities and more than 200 injuries. Between 1989 and 2000, a total of 225 building failures were recorded 57 of which were in New York State.

There has only been one "serious" bridge failure in New York State. In 1987, the Schoharie Creek Bridge par-

tially failed and five vehicles plunged into the river, causing 10 deaths. From 1989 to 2000, 503 bridge failures were recorded in the U.S., 64 of which were in New York State, which ranked second on the U.S.

Now I will pass on to Melissa Fratello, who will cover fire and hazmat events.

Melissa Fratello:

Thank you, Pavan. Within the scope of this study, a disastrous fire can be defined as those structural, urban, or wildfires that are the cause of multiple deaths, and/or are significantly costly in damage, and where they fall outside of the scope of local protection personnel capabilities, as is often the case in the event of wildfire.

Perhaps the most notable fire event in New York State was the Triangle Shirtwaist Company fire on March 25, 1911. It gained national attention as nearly 145 individuals, all female laborers, perished due to inadequate access to fire exits. The tragedy of this event resulted in the first step in a long progression of fire legislation providing that all high rises have adequate fire exits.

Major Fires, 1990-2005

	<i>Serious</i>	<i>Severe</i>	<i>Disastrous I</i>	<i>Disastrous II</i>	<i>Catastrophic</i>	<i>Total</i>
<i>Residential Fires</i>	18	0	0	0	0	18
<i>Non-Residential Fires</i>	17	3	0	0	0	20
<i>Wildfire</i>	2	0	1	0	0	3

This table presents data collected from the National Fire Protection Association documents, which revealed that since 1990, there have been a total of 38 structural fires that have resulted in damage in four magnitude categories of serious to Disastrous I. Three major wildfires have been recorded in New York State, the most destructive being the Adirondack wildfire of 1903 and the remaining two, although less destructive, were declared state emergencies.

ing the Adirondack wildfire of 1903 and the remaining two, although less destructive, were declared state emergencies.

The average annual frequency for structural fires, serious or greater, is 2.375. These data result in a final risk score of 5.05 for all fires total.

Risk Score

Fire Events: Events; Average Annual Frequency; Risk Score By Magnitude

	<i>Serious</i>	<i>Severe</i>	<i>Disastrous I</i>	<i>Disastrous II</i>	<i>Catastrophic</i>	<i>Total</i>
<i>Risk Score, ANY Structural Fire Event</i>	2.19	1.86	0	0	0	4.06
<i>Risk Score, Wildfire</i>	0.02	0	0.97	0	0	0.99
<i>Risk Score, ANY FIRE</i>	2.21	1.86	0.97	0	0	5.05

Hazardous Materials (Hazmat)



- Sudden release of hazardous materials
- Numerous substances: medical waste, radioactive materials, chlorine, ammonia, mercury, lead and others
- Fixed-site: a chemical plant
- Mobile: roads, air, water or pipes
- Excluding terrorism here

Hazmat Event Examples



Texas City, Texas 1947:

- An explosion of a fertilizer tanker
- Killed 600, injured 3,500

Mississauga, Canada 1979

- A major railroad derailment
- Evacuated 218,000 people

No Large Hazmat Event in New York

Now on to hazmat events. This research discusses hazmat events caused by sudden release of hazardous material, not due to long-term exposure happening at a fixed site, such as a chemical plant or other form of industry. We also explore mobile hazmat events that happened during the transport of hazardous materials by roads, air, water, or pipes. This research excludes terrorism.

Hazmat involves numerous substances that range from medical waste to radioactive materials, chlorine, ammonia, mercury, lead, and many other chemicals. Events are generally most dangerous when they involve the moving of more than one chemical.

The two most destructive and deadly hazmat events took place in Texas City, Texas, in 1947, and Mississauga, Canada, in 1979. In Texas City, Texas, an explosion occurred on a fertilizer tanker, docked by a cluster of industries that worked with hazardous substances. The explosions spread flames across the

docks, sinking boats and spreading to other buildings. The explosion could be felt in Houston and most of the site was completely destroyed. It ultimately killed 600 people and injured 3,500 more.

In Mississauga, Canada, a major railroad derailment occurred in the city that is outside Toronto and a few hours north of New York State. Railroad equipment failed and a train car collided with others and caused an explosion. Most of Mississauga had to be evacuated, which included 218,000 people and entire hospitals and nursing homes.

No large hazmat event of this level of destruction and impact has occurred in New York State, although New York State currently has the second highest frequency of hazmat events in the nation, second to Texas when combining fixed-site and mobile events.

**Hazmat: Annual Frequency & Risk Score,
1993-2005
(Fixed-Site & Mobile)**

	Serious	Severe	Disastrous I	Disastrous II	Catastrophic	Total
Events	46	--	--	--	--	46
Annual Frequency	3.83	--	--	--	--	3.83
Risk Score	3.83	--	--	--	--	3.83

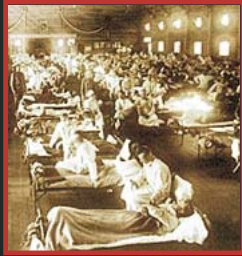
Out of the thousands of reported hazmat events that occur annually, few have had disastrous impact. According to data from the New York State Department of Health Office of Hazardous Substance Surveillance, there have been 46 hazmat events from 1993 to 2005 that can be categorized as serious. Forty-three of those events resulted in deaths and the

other three had evacuations of 100 or more people. This gives hazmat a final risk score of 3.83, based on data recorded from 1993 to 2005. Recording for hazmat events varies, and is spread across numerous agencies. This task frequency was calculated using data from the Hazardous Substances Surveillance, which does not include petroleum incidents. And now I will pass the presentation on to Lindsay Allen, who will discuss pandemic flu.

Lindsay Allen:

Thank you, Melissa. In researching epidemiological disasters, we chose to focus on pandemic flu. Although H5N1 influenza has a low human transmission where it is found, it

Epidemiological Disaster: Pandemic Influenza



- Cannot be detected until first human transmitted infections
- Potential to infect and kill millions
- Wide global spread
- Drastic disruption of critical services
- Great economic loss
- Slow recovery

The Spanish Flu of 1918



- Within the span of 8 months in the United States, 0.67% of the US population died
- Post World War I military camps are believed to have been the hub of origination of the virus in the United States
- Overall, more than 500,000 New Yorkers were infected with the Spanish flu and 33,000 of them died

has an extremely high mortality rate when transmission does occur. So, if an outbreak were to occur in the United States, New York State would be under a major threat.

We also considered the West Nile Virus, a possible outbreak and a possible severe acute respiratory syndrome (SARS) outbreak, but those simply do not pose a threat of such enormous magnitude as pandemic flu does.

This slide lists a few of the characterizing details of pandemic flu.

Our model of a terrible pandemic affecting New York is the Spanish flu of 1918. If

this type of event were to come to New York City, it would be in the “catastrophic level” in our terms.

We chose to look at the numbers of pandemic deaths that would be above and beyond those caused by seasonal flu. In the United States, roughly 36,000 people die every year from seasonal influenza.

The numbers we’re looking at are above and beyond those deaths. For a Disastrous II level, it would be thousands of deaths above seasonal flu level, and for Catastrophic it would be 10,000s of deaths above the average annual flu rate.

Pandemic Flu Outbreaks, 1700-2006

Serious	Severe	Disastrous I	Disastrous II	Catastrophic	Total
--	--	--	12	1	13

Pandemic Influenza: Frequency-Based Risk Score

Category	Serious	Severe	Disaster I	Disaster II	Catastrophic	Total
# of events over 306 years	0	0	0	12	1	13
Frequency Based Risk Score	0	0	0	39	33	72

Pandemic Influenza: Expert Estimate Risk Score

Category	Serious	Severe	Disaster I	Disaster II	Catastrophic	Total
Frequency Based Risk Score	0	0	0	62	560	622

Approximately 13 flu events have taken place or have affected the United States over the past 306 years (since 1700). The 1918 flu was the only catastrophic pandemic event recorded. The other 12 had single thousands of deaths and were categorized (in our method) as Disastrous II. It is estimated that the flu of 1918 killed roughly 33,000

people in New York State. Again, just to reiterate, these numbers are above and beyond the annual seasonal flu number of deaths.

When we look at these 13 flu events that have taken place that are all pandemic flu events and the expert estimates that we looked at to determine risk score, we find that frequency-based risk score takes the past into consideration, but not the future. It does not take into account the fact that the H5N1 virus is circulating globally. It also doesn't take into effect many other qualitative factors, such as the increased mobility that humans have today, despite the fact that our medical capabilities are a lot greater.

Expert Estimate of Future Probabilities

Annual Probability of "At Least One" Pandemic Influenza in the United States (Expert Estimate Based)

	Explanation of Estimate	Source	Serious	Severe	Disastrous I	Disastrous II	Catastrophic	Any
A	Pandemic Flu Model for magnitude estimate; CBO data for annual probability.	RMS/CBO	--	--	--	0.0300	0.0075	0.0375
B	Expert Estimate.	J. Michael Steele	--	--	--	0.1000	0.1000	0.2000
C	Expert Estimate from a panel of communications and finance experts when asked what they thought the likelihood of human-to-human transmission of avian flu would be in the next three years. (adjusted per year)	Baruch Fishoff	--	--	--	0.1000	0.1000	0.2000
D	Expert Estimate from a panel of medical experts when asked what they thought the likelihood of human-to-human transmission of avian flu would be in the next three years. (adjusted per year)	Baruch Fishoff	--	--	--	0.0165	0.0165	0.0330
1	Expert Estimate Probability					0.0616	0.0560	0.1176

The expert estimate, however, is a probability and that takes past, present, and future possibilities into consideration.

If a pandemic flu event were to break out in the U.S., it won't have geographical boundaries. So, because there is no boundary put on the pandemic flu, we have applied national figures to our data for the state.

Basically, these expert estimates that we present here are based on future probabilities. The first that we have is a probability from Risk Management Solutions, based on the CBO frequency data. They believe that if a pandemic were to occur, there would be one-in-five chance of that the outbreak impact would be greater than that of the 1918 flu event, which is beyond catastrophic for our purposes.

The second estimate that we have is from Dr. J. Michael Steele of the University of Pennsylvania. He believes that in the next year there could be a 20 percent possibility of a pandemic flu event occurring in the United States. Also Dr. Baruch Fischhoff from Carnegie Mellon University cited two panels of experts who he questioned on the probability of a pandemic flu event occurring in the next three years. Medical experts on his panel estimated a 10 percent chance over the next three years.

From composite sources, the final expert estimate probability was 0.1176, which is about 12 percent chance per year that this pandemic flu could break out in the United States.

Limitations

- Probability of an outbreak next year depends on the development of the pathogen this year.
- For practical purposes, probability of occurrence and risk scores should be evaluated frequently.
- More reliable estimates would require consultation with a committee of public health and epidemiological health specialists.

The probability of an outbreak next year depends on the development of the pathogen this year. Therefore, if H5N1 or a mutation of that virus were to occur this year, we could see more of a development in the next year or in the coming years.

For practical purposes, the probability of occurrence and risk score should be re-evaluated frequently.

More reliable estimates would require consultation with a committee of public health and medical experts.

I'm going to turn this over now to my colleague, Julie Gotham, who is going to talk about terrorism.

Terrorism



conventional and suicide bombings, CBRN WMD, airline attacks, infrastructure attacks, and arson

“premeditated; perpetrated by a sub-national or clandestine agent; politically motivated, potentially including religious, philosophical, or culturally symbolic motivations; violent; and perpetrated against a noncombatant target”

Julie Gotham:

Thank you, Lindsay. Listed here, you see the definition of terrorism from the National Counterterrorism Center. We discovered that there is no universal definition of terrorism. There are actually over 100 definitions, so this proved to be a limitation in our data collection.

Also listed here are potential terrorist tactics. Traditionally, conventional bombings have been the weapons of choice for terrorists, yet suicide bombings and weapons of mass destruction are becoming more of a threat.

Recent Terrorism in NYS

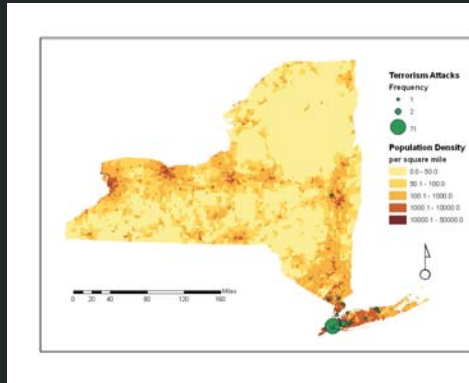
Year	Perpetrators	Incident
1993	"Blind Sheik"; radical Islamists	NYC World Trade Center vehicle bombing*; convictions
1993	"Blind Sheik"; radical Islamists	NYC landmark bomb plot foiled; convictions
1997	al-Qaeda	NYC subway bomb plot foiled; convictions
2001	al-Qaeda	NYC World Trade Center airline attacks**; convictions
2001	Unknown	NYC <i>Anthrax</i> mailings; unsolved
2002	"Lackawanna Six"; Yemeni-Americans	Buffalo material support to al-Qaeda foiled; convictions
2003	al-Qaeda	NYC weapons smuggling foiled; convictions
2003	al-Qaeda	NYC bridge surveillance operations foiled; convicted
2004	Pakistani Immigrant	NYC subway bomb plot foiled; conviction
2004	Muslim Immigrants	Albany material support to Ansar al-Islam; convictions
2006	al-Qaeda	Transatlantic aircraft plot foiled; arrests
2006	al-Qaeda	NYC Holland Tunnel bomb plot foiled; arrests

Here is a table of recent terrorist events in New York State. As you can see, the majority have involved Islamic fundamentalists and Al Qaeda. Also the majority have occurred in New York City. More than half of these events were foiled, leading to arrests and convictions.

Over the past 45 years, 74 terrorism incidents occurred in New York State. This is approximately 18 percent of the total number of U.S. incidents. The majority were minor, caused by special interest groups such as environmental and animal rights extremists. There are fewer incidents now than in the 1980s, yet it is important to note that they are becoming more lethal. For example, 9/11 was the most deadly attack in United States history. It claimed more lives than all previous terrorist acts combined. Also, the Anthrax mailings during the fall of 2001 were the first fatal terrorist attacks using a biological agent in the U.S.

25 Year Record in NYS

- 74 recorded terrorist incidents
- Vast majority minor
- Majority occurring during the 1980s
- 80.7% in NYC
- Another 18.2% in surrounding areas of NYC
- Only 1.1% in Upstate



As you can see on the map, 81 percent of New York State events over the past 25 years occurred in New York City, 18 percent occurred around New York City, and only 1 percent occurred in upstate New York.

We retrieved data from the Memorial Institute for the Prevention of Terrorism

(MIPT) for the years 1980 through 2005; however, we chose to use the data from 1990 through 2005, because we feel it is the best representation of current trends in terrorism.

Annual Frequency of Terrorism and Terrorism Risk Score, 1990-2005

	Serious (x1)	Severe (x10)	Disastrous I (x100)	Disastrous II (x1000)	Catastrophic (x10000)	Total
Terrorist Events	21	1	1	1	0	24
Average Frequency per Year	1.31	0.0625	0.0625	0.0625	0.00	1.5
Magnitude Score	1	10	100	1,000	10,000	----
Frequency-Based Risk Score	1.31	0.625	6.25	62.5	0.00	70.69

Based on this 16 year time span, we categorized 21 Serious incidents, one Severe, one Disastrous, and one Disastrous II, for a total of 24 events. The average frequency of any terrorist event for a year, based on historical frequency is 1.5 times per year. Also, you can see that the frequency-based risk score is 70.69.

Terrorism cannot be predicted based on historic frequency alone because it's a threat driven by human intent and intelligence. For example, terrorist groups and strategies often react to current political climates. As for estimates of future probabilities for terrorism, these were difficult to locate, in part because of security issues.

Here is an example (see next page) of future probability-based estimated provided by Risk Management Solutions (a terrorism model provided by RSM); we assigned a risk score to it for comparative purposes. Note that the future-based risk score is 189.81 and is

Expert Estimate of Future Probabilities

Explanation of Estimate	Source	Serious	Severe	Disastrous I	Disastrous II	Catastrophic	Any
US Est. Prob. Attack, 2004 (NYS Location Factor of .16)	RMS	—	—	.0171	.0171	.0171	.0512
Magnitude Score		1	10	100	1,000	10,000	—
Probability-Based Risk Score		0	0	1.71	17.1	171	189.81

more than double the historic-based risk score shown on the previous slide. We feel the expert estimates for future probabilities in combination with historic data are important considerations, especially for hazards with rapidly changing conditions, such as terrorism.

This concludes our overview of the hazards we studied this semester. I will continue with a brief discussion of our risk scores and relation to policymaking.

Keep in mind the purpose of our model is not to drive policy, but to inform it. It's a low-cost, one step improvement beyond currently recommended risk protocols.

Comparative risk scores can be used on a state or local level to allocate budgets to government agencies, such as NYSEMO and the Department of Public Health. They can also be used to direct agency funding for personnel and equipment, training, and public education. For example, should NYSEMO spend millions of dollars on a two-year counterterrorism training activity culminating in a full-scale simulation of a terrorist attack? Or, should money be spent on a large scale joint hospital pandemic flu exercise that monitors and responds to hospital systems?

These are the types of issues that multihazard risk scores can inform.

Some challenges of applying risk score to policy include budgeting as a political process. There is no single budget allocation for the state. Decisions need to be made in terms of incremental versus total allocations, and multiyear versus single year expenditures. Levels of higher investment should also be tracked before budgeting.

Finally, this is only one piece of a much larger puzzle. We only looked at threats here, not vulnerabilities. So we feel the vulnerability on a regional level needs to be addressed,

along with Homeland Security capabilities, population densities, critical infrastructure, and transportation assets.

Recommendations

1. *Creation of State Office of Hazard Assessment or 5-year State Risk Project*

- Provides data, evaluates methodologies, approves reports, and educates state, counties, municipalities

2. *Expert Panel*

- Uses data to assess hazards with rapidly-altering conditions

3. *State Risk Board*

- Honorary board of leaders to issue formal risk findings

Here are our recommendations based on our findings. We are recommending the creation of a State Office of Hazard Assessment or a five-year State risk project. Also, a panel of hazard experts and the State Risk Board. We imagine a State Office of Hazard Assessment would collect data, organize it, and interpret it. It would provide the data to develop these and other ap-

proved methods to evaluate methodologies, draw up reports and guidelines, as well as help local jurisdictions to develop their own hazard analyses. The office would refine our methodology and reflect the best, most up-to-date data sources with constant revisions.

We envision a professional staff of three-to-five members located in NYSEMO or the Office of Homeland Security, or a similar location.

For data that are unavailable or doubtful, the State Office of Hazard Assessment would turn to our panel of experts to further assess those hazards of rapidly altering conditions, such as bioterrorism, radiological terrorism, pandemic flu, and storm surge. These types of panels are necessary because past frequencies are not adequate enough to assess multihazards. We feel that the expert estimates of future events are equally valuable.

Lastly, we imagine a State Risk Board would be an honorary group of respected leaders from different disciplines who would take a draft report from the State Office of Hazard Assessment and based on their wisdom would approve or adjust it so that it could be released to the public.

And now, Elea will come back up and present our risk score model with comparative risk scores.

Elea Mihou:



This is an example of our findings. These are all based on historic frequency. Historic frequency, again, is multiplied by the assessed magnitude, meaning numbers of deaths, injuries, and economic loss. I want to note here that we were probably overly conservative about economic losses, and might have underestimated some of the loss, something

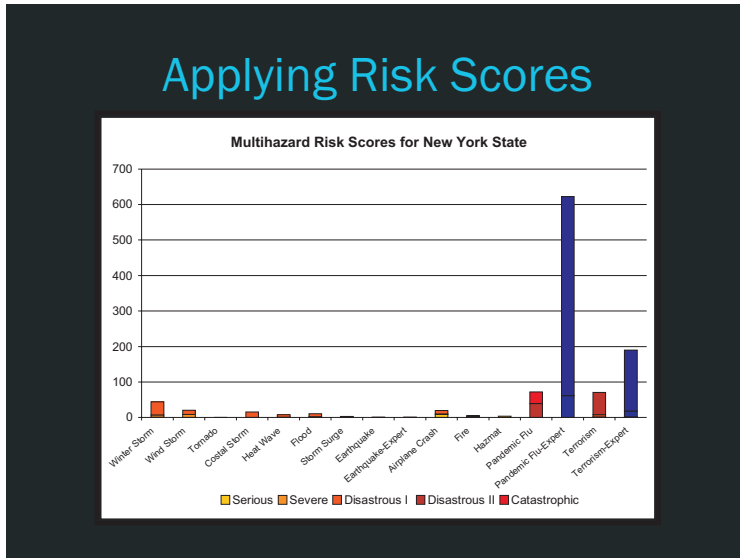
that could be improved in the future. And also we feel that hazmat events and earthquakes are being underestimated in the sense that a significant event from earthquakes or hazmat could cause mass destruction that we weren't sure how to account for in this. But here you are seeing a sort of breakout on what we think the risks are and the hazards are in terms of one another.



We did all of this using modeling within Excel. We wanted to create a program that is dynamic, so as risks change, as events change, one could easily update and account for this. Here we see pandemic flu and terrorism with other things like earthquake damages (that are possibly too low), to winter storms and others. We have here on

color scale ranging from serious to catastrophic. We wanted to be able to assess in terms of events that happen regularly and are deadly, but also might have some level of preparedness versus extreme events that happen rarely and because of that are catastrophic in their results.

Applying Risk Scores



This is an example of our model that also equates the expert estimates in it. Again, in terms of our limitations, pandemic flu incorporates four extra expert estimates that then were averaged and totaled. As for terrorism and earthquakes, it only involved one expert estimate. We wanted to give you an example of what this modeling could

do, and also how historic frequency could be compared to expert estimates side-by-side.

I want to thank everyone. At this time, I'm open to taking questions and facilitating a conversation here. And so, the floor is open if anyone has any questions or comments?

Eliot Rich:

I'm from SUNY Albany. Thinking about 9/11 classified as a terrorism incident, there are some health officials would say that the after-effects of it may look more like a hazmat situation when we've got hundreds of fire fighters with chronic illness, potentially disastrous effects on the ability of City to continue to fight fires as more and more of their trained personnel are ill. How does that kind of classification fit into your model, and what might be the effects of your analysis if you shifted it in Category?

Elea Mihou:

That's an excellent question. It's something that we've really debated because so many of these hazard types spill over into one another. September 11th could be classified under a plane crash, under a hazmat event, under health risks, under a building collapse, under a large-scale fire; I mean, it was so many things simultaneously. But ultimately we felt that terrorism was unique in that it was premeditated and intentional, where with hazmat we were looking at accidental releases, equipment failures, human error, and fires. Also we incorporated arson in some cases. The difference with terrorism is that a large-scale, potentially catastrophic or disastrous event with political, religious, or cultural intents are

meditated and coordinated. And we thought that this was an important distinction, because in some of our work, we realize that there's a lot that spillover and that preparing for these events, one part is preparing for another.

But in terms of mitigation, they can be very different, and so a flood would require different land use, an earthquake would require a different building code, and terrorism would require an increase in intelligence. So, just in terms of the mitigating needs, before we move on to vulnerability and preparedness that goes across hazard types, we wanted to have a different category for terrorism just in that the mitigation would involve an increase in intelligence and coordination that was very different from all our hazard types because of its political intent.

We realized that in action, it's a plane crash, it's a building fire, it's a hazmat event, it's a health risk, it's so many things at once, as many things are. But thank you for your question. I'm going to turn this over to Julie, as well, who was the specialist in terrorism.

Julie Gotham:

I'm just going to add that I think, if given more time, we would have liked to look at cascading effects surrounding all of these hazards more. So terrorism is definitely one where the cascading effects are multiple. Hopefully, we can consider this next semester.

Elea Mihou:

It's one of the difficult areas, even with an extreme weather event, like the snow storm we just had in Buffalo. We asked ourselves, "So, people don't have electricity, maybe they are starting fires in bathtubs." And now you have an increase in house fires at the same time that you have poor road conditions. And one event of wet and cold becomes something completely different, and some of these things are cascading, they spill over, and we recognize that in preparedness, that means we need to be prepared across the board.

George Nealon:

I'm with the Division of the Budget. In the pandemic flu data, it was on the table of the panel of experts where the panel of commercial and finance experts were predicting three year Avian flu, and the medical experts were predicting it. The commercial and finance people

were given the same amount of credibility as the medical people, with the commercial and finance people predicting it as six times more likely. But that was just thrown in there. That skewed that data up on the pandemic flu. I think you need to look at whether communication and finance people can predict medical things as well as medical people can.

Elea Mihou:

You bring up an excellent point in terms of a major limitation I'm going to hand over to Lindsay. But this is, again, something we were sort of struggling with and we felt that, to some extent, insurance companies had modeling systems that we might want to tap into in the future, and we can't necessarily speak for the credibility of anyone else's study. Look at how much conditions are changing, even just the fact that we can catch a flight in New York City to Tokyo today, and that people are so mobile. But Lindsay can speak better to that question.

Lindsay Allen:

These communications and finance experts took into account what the economic impact of a pandemic flu event would be. By kind of averaging that in with the rest, it does shoot it up quite a bit, yet at the same point in time, we think it's valid to cover many different expert opinions.

Elea Mihou:

And we recognize that we didn't have the same level of expert estimates in all of our categories to even it out. And again, we don't suggest that you apply these findings as they are, but that this is a system of modeling that can be adjusted through a state risk board.

Victor Asal:

I'm from SUNY Albany. This is very interesting given that there's currently a backlash going on against the overestimation of both terrorism and pandemics, and you seem to be indicating that for state officials and local officials, those are the two things that they should be paying attention to in terms of risk factors. The other is that even if you go with the 10 percent a year risk that the medical panel of experts are suggesting, that's still enormously

high. You're still going to call the figure that's higher will then be lower than terrorism, but still be higher than any of your other hazards.

Also, one technical point, which I don't think is going to change your risk factors tremendously, but when you are using the MIPT database, you want to use the 1998 to 2005. Use of the data from 1990 to 1997 is only for international attacks, so it's simply not comparable to the data from 1998 to 2005. So you just want to chop off those first six years and use that in your risk factor analysis.

Tom Gais:

I'm with the Rockefeller Institute. A couple of questions, more about how this differs from the assumptions or activities going on now in the status quo. First, you had a series of recommendations about what ought to be done in New York State, and I was wondering if you could tell us how that differs from the planning occurring now in New York State or New York City, or for New York State by federal authorities? I mean, why is this necessary compared to what's being done now?

Secondly, it was already said that this is interesting about the flu and terrorism as sort reinforcing certain, or at least actually contradicting, concerns now that we're putting too much emphasis on that. Are there any of these risk assessments that suggest that there are areas where we're overinvesting in protection or underinvesting, putting aside the flu or terrorism issues?

Elea Mihou:

Well, I'm going to turn those over to my colleagues, but just briefly. In terms of under- and overinvestment, we're not prepared to answer that question. We haven't had an opportunity yet to look at what the existing funding is already and what areas of vulnerability are. We are envisioning that being a second step that will take place in this research and something that we could answer better in the future.

As to your first question, I think that's an excellent question. One of the biggest problems we've had in doing this research and being able to present it with credibility and assurance is that the limitations of data were so great. There are so many different agencies doing

so many different things, and we felt that there was really a need for more overhead coordination to help do this. But, Professor Sternberg, would you like to speak to that?

Ernest Sternberg:

I just want to say there are many members of this audience who are better qualified to answer this question about what's presently being done in hazard assessment in New York.

Julie Gotham:

I'm just going to make a brief comment. I think ours is a modest approach. We're just looking to maybe create a small little office that can help streamline a lot of these data. We were involved in this for almost three solid months of just trying to collect data and try to streamline in it some way. So, we are hoping just to make a small improvement in what is being done right now.

Jack Brennan:

I'm with the Town of Bethlehem. Your recommendations were to continue the study. Was that recommendation to continue to study the raw data to find out the frequencies or to study the comparative aspects or response aspects to planning and mitigation?

Elea Mihou:

Both. We think that in terms of our data on frequency and probability and ultimate risk score, that there are improvements that need to be made before it should be applied, so that needs to take place. But, also, we recognize that in terms of vulnerability and existing preparedness, pandemic flu might be something that is potentially catastrophic but some municipalities currently have plans in place to deal with that, while for something that may be less visible like a heat wave, there might not be preparedness in place. And we aren't in a position where we can assess that. And so, we were envisioning a step to continuing this and really be able to do a full, encompassing report.

Jack Brennan:

You don't feel that in the bureaucracy of the state that's already being done?

Elea Mihou:

We couldn't answer that; I'm not sure.

Richard Minoque:

In your presentation earlier you suggested that with the Hazards New York (HAZNY)

that there was some inherent weaknesses maybe. Just to review, what would those weaknesses be if you were to try to articulate them?

Elea Mihou:

Well, I'll turn this over to Melissa but briefly — in terms of terminology and definitions the problems with HAZNY was the hierarchy of hazard types. Hazards weren't necessarily comparable in historic frequencies. Tornados were rated very high, even though they have a low fatality rates in the state, and things that might incur a higher fatality were rated lower, and so we wanted to have something that was more data based. But, Melissa, do you have anything you'd like to speak to in terms of HAZNY?

Melissa Fratello:

Basically, from going through an overview of the software, it seemed that there would have been a lot of freedom in the data collection process before you actually go into the software and answer the questions that we were prompted with, such as, "How often does this event occur?" The answers are, "Very frequently," "Infrequently," "Sometimes." So they're really loosely defined categories. I think in that case, we felt that could have attached a more substantial meaning to those risk categories.

Elea Mihou:

We wanted to be able to qualify what "high" was, how many deaths that implied, how much loss that implied, and have some sort of scale that could range these. We realize it's an imperfect scale that we're still figuring out.

John Gibb:

I'm from the State Emergency Management Office. First of all, I congratulate all of you on your good work. We do not do enough quantitative assessment of hazards and risk in the state. Now, for HAZNY, I'd like to put in context what is partly developed by your predecessors from the University at Albany. We use it as a starting point for discussions in developing local emergency plans and so there are many decisions that are made in a HAZNY assessment that are just based on the anecdotal information available between the users. It's kind of snapshot on the data brought together at that time. You couldn't put together all 57 HAZNYs for the State of New York and come up with a state risk assessment. It's a good starting point for quantitative assessment.

Elea Mihou:

Thank you for that, and again, to sort of defend HAZNY, we realize that many of our limitations are the same as HAZNY's. It's a complicated and interconnected endeavor.

Bill Shea:

I'm also from the State Emergency Management Office. Just furthering on HAZNY, two points I'd like to make. One of them is in terms of the frequency of events, there are ground rules based on probabilities. A frequent event that occurs more than once a year, so it's a very high probability of occurrence versus a rare event, once every 50 to 100 years, which has a much lower probability. One of the things that HAZNY will consider from a response planning perspective, which basing something solely on frequencies doesn't necessarily gather, is that sometimes a hazard may appear to be approaching a community. For instance, meteorologists in the weather service told us in a personal communication that a tropical system will approach the coast of Long Island, within 150 miles, let's say an average of once every eight years. But if you only look at land form storms and then base your assessment on what has actually occurred versus what you had to actually stand up for and prepare for, then you start to weigh something a little bit different in terms of where the preparedness things are. Looking solely at what is hit versus what could be hit is a little bit different.

Elea Mihou

You raise an excellent point and we're trying to account for that in expert estimates, and the future probabilities you might factor into the things that could not only be intensified and worsen, but that might even be close to happening and are significant unto themselves. Like I said, ultimately we're really trying to advance more of a databased model for doing risk assessment, and we realize that these findings need more work before they should be applied.

John Gibb:

One of the big issues that I seem to face is this perception that these systems assess these risks and are not necessarily interested in historical perspective or quantitative assessment. As part of the research or your discussions, can you talk about public perception and how that has to be added in?

Elea Mihou:

Yes, it was something that we started to have a brief discussion on toward the end of the study. There's a recent report that Professor Sternberg is more familiar with about New Orleans and Katrina, and some of the reasons why there weren't greater methods for preparedness taken locally sooner. Some of the things kind of came down to an overload of information that some people felt, or a "boy who cried wolf" scenario, that they kept hearing things for so long that it just became background noise. And this was something we thought should be considered and used in the future. We are also concerned about giving policymakers so much information that it became useless — basically handing out a bookshelf of things that would take them weeks to get through and would be information overload. We wanted something user-friendly, policy-friendly, and also public-friendly, so we weren't just more of "the boy crying wolf."

But this was something that we were looking for in discussions for future research, and not that we really had anything sort of conclusive, but just was in the back of our minds to be wary of.

Thank you for joining us today.