September 2014

Regional Disaster Response Strategy

A plan for disaster preparedness, response, and recovery in Central Connecticut

EDA Award number 01-69-14226

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A plan for disaster preparedness, response, and recovery in Central Connecticut

& Final report on EDA Award number 01-69-14226

Prepared by the Central Connecticut Regional Planning Agency for the municipalities of Berlin, Bristol, Burlington, New Britain, Plainville, Plymouth, and Southington

Completed September 2014

About CCRPA

The Central Connecticut Regional Planning Agency (CCRPA) is the regional and metropolitan planning organization for the cities of Bristol and New Britain and the towns of Berlin, Burlington, Plainville, Plymouth, and Southington. For over 45 years, CCRPA has worked with government, business, and the public to develop a vision for the region and resolve its challenges. The Agency's mission is to plan and promote regional policies and programs to enhance the vitality, accessibility, and quality of life in our communities.

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Finally, the substance and findings of the work are dedicated to the public. The author and publisher are solely responsible for the accuracy of the statements and interpretations contained in this publication.

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Introduction

Natural and man-made disasters can have crippling effects throughout a regional economy. These effects, as varied as property loss, destruction of critical infrastructure, and loss of confidence, have long-lasting impacts. In an effort to reduce the severity and duration of these impacts the Central Connecticut Regional Planning Agency (CCRPA) was awarded grant funding from the Economic Development Administration (EDA) to complete a disaster resiliency plan for the Central Connecticut Region. The Central Connecticut Region comprises the cities of Bristol and New Britain and the towns of Berlin, Burlington, Plainville, Plymouth, and Southington. The purpose of the plan is to assess the risk various types of disaster pose to Central Connecticut, identify the impacts that are likely to be felt, assess the effectiveness of current disaster response protocols, and outline goals and recommendations to increase the resilience of the region's economy.

Resilience, the overarching goal of this plan, is the capacity of the region and its economy to recover from a disaster. To evaluate how communities deal with disaster, it helps to think in terms of a framework. The disaster resiliency framework takes an integrative approach to managing disasters and their impacts and includes four components or phases:

Anticipation and Reflection: A necessary first step is gathering information about what could happen. This includes an analysis of which disasters have occurred and are possible as well as the risks they pose. Risk is not just

the likelihood of an event occurring but also the impact of said event.

Preparedness: Once a region has information about its risks, it can take action to reduce those risks and better prepare for future emergency events. This may include actions such as flood control projects, infrastructure hardening, or diversifying the economy (not being dependent on a single company or industry).

Response: Despite the best efforts of planners, engineers, and policy makers, disasters will occur. When a hurricane hits or a major employer fails, community leaders must take action to respond to the event. These are the actions that occur during and immediately after the event and include evacuations, cleanup, and sheltering.

Recovery: After the emergency responders have gone home and immediate threat has passed, the region and its economy enter the recovery phase. In many ways, the success of this phase is the true test of a region's resiliency. It is also dependent on the successful implementation of the previous phases. For example, the ability of a company to recover from a flood will depend on how well they anticipated that flood, reduced their risk by elevating critical machinery and creating off-site backups of documentation, and responded to the immediate aftermath by contacting customers, cleaning up any damage, and getting their business going again. If a business has taken the first three steps, it is more likely to enjoy long-term recovery and bounce back. The same is true of a regional economy. As the region and community recovers, the process will start afresh with a reassessment of how to better anticipate and prepare for the next disaster.

The resiliency framework is designed to speed up recovery, but it can still be a long process. Long after the flood waters have receded, roads have been cleared, and people have returned to their homes, the effects of lost productivity, destroyed products, and damaged reputations, can reverberate for years or decades.

In order to better understand the vulnerabilities of our communities and the dangers they face, CCRPA staff applied this disaster resiliency framework to Central Connecticut. Staff looked to the history of the region and

similar communities, and the effects past events have had and the probability that they will happen in the future. When possible, staff conducted simulations and analyses, which detailed how past events could impact present conditions. Staff then examined the current preparedness, response, and recovery measures in place. From the historical data and the current activities in the region, CCRPA developed a list of goals for the region with the aim of better anticipating the effects of disasters to improve future economic resiliency.

This document also serves as a final report for the Economic Development Administration grant that made this process possible. The next section details the planning process followed by CCRPA. It also lists the activities taken by staff and their accomplishments.

Planning Process & Report

CCRPA began work on this disaster resiliency project in December 2012. The process has involved: town, state, and public meetings; intensive data analysis; disaster simulation; business outreach; grant writing; and a workshop for small- and medium-sized businesses. The following is an accounting of the process and the activities and accomplishments that CCRPA undertook for this project.

The Planning Process

Any plan that truly addresses resiliency must incorporate a broad spectrum of issues. The planning process that CCRPA followed included an analysis of land-use, demographics, economic conditions, and previous experiences with natural and man-made hazards. In order to avoid reinventing the wheel, staff thoroughly reviewed existing and in-process plans for the region, its municipalities, and the state. Below is an accounting of the steps taken in the planning process:

- Reviewed the Natural Hazard Mitigation Plan for the Central Connecticut Region, as well as plans of neighboring regions and the state.
- Reviewed relevant plans regarding land-use, economic development, transportation infrastructure, housing policy, and the environment.
- Reviewed records of historical natural disasters to better understand the history of the region.
- Reviewed weather data for the region. Specifically, staff reviewed snow fall, precipitation, wind speed, and temperature data.

- Reviewed expert analyses of weather and storm data. Special attention was paid to analyses that take climate change into account.
- Reviewed reports of man-made disasters, such as industrial spills, industrial sabotage, large-scale arson, and large-scale traffic accidents.
- Reviewed Scholarly literature on economic resiliency to natural disasters.
- Analyzed employment data.
- Compiled data on local businesses, including, location, number of employees, industry sector, and annual revenue.
- Surveyed municipal officials and businesses about disaster impacts experienced in the past.
- Interviewed municipal public works, emergency management, and planning staff regarding mitigation activities and plans.

CCRPA staff took the data from the above activities and conducted a risk analysis of the region. To do so, they performed the following activities:

- Ran the HAZ-US suite of tools to determine potential damages from natural disasters, including flooding, earthquakes, and wildfire.
- Performed an analysis with ArcGIS to determine which businesses, and how many employees, were in the highest risk locations.
- Analyzed employment data to determine which sectors were most important to the regional economy.
- Analyzed transportation routes to determine where "bottlenecks" and "choke points" exist.
- Analyzed development patterns to determine land change over the years.
- Analyzed demographic data to determine where vulnerable populations live and what changes in the demographic make-up of the region are likely to occur.
- Analyzed what impact demographic changes will have on the region's vulnerability to natural and man-made disasters.
- Prepared this plan and assessment of the region's experience with disasters.

Public participation

To facilitate public participation, CCRPA turned to its economic development committee, with representation from both the public and private sectors. This board, the

Central Connecticut Economic Development Alliance, meets quarterly; this planning process was included on the agenda for each of the meetings that took place during the project period. CCRPA staff solicited input from the members of the committee, as well as any members of the general public who attended the meetings. Attendance ranged from business owners to members of the Connecticut General Assembly. Many interesting ideas were generated at these meetings and have been incorporated into this plan.

The public was also given the opportunity to participate through a web-based survey, which was distributed by the region's chambers of commerce. A final method of outreach was a workshop that was held for small- and medium-sized businesses. At that meeting, attendees were surveyed about their experience with disasters, their level of preparedness, and their concerns. People who attended this workshop were also asked to fill out a short survey when they registered for the event. The results of that survey are discussed later in this document.

Figure 1: *Panelists at the Disaster Resiliency Workshop*

Figure 2: *CCRPA presented at a webinar sponsored by the National Association of Development Organizations.*

Accomplishments & Activities

The Central Connecticut Disaster Resiliency Project is more than just a planning exercise; it was designed from day-one to provide assistance to businesses and municipalities. That assistance was provided through the following activities:

- CCRPA staff organized a day-long workshop for small- and medium-sized businesses. The workshop introduced participants to business continuity planning, emergency preparedness, disaster response, and disaster recovery. Panelists and presenters included the Travelers Institute (of Traveler's Insurance, Northeast Utilities, the Small Business Administration, Governor Malloy, the Connecticut Division of Emergency Management and Homeland Security, the City of New Britain, and many others. The event was well-attended and garnered significant coverage in the press, which contributed to overall awareness of the need for disaster preparedness.
- CCRPA staff applied for and obtained funding from FEMA for all seven municipalities to update their Natural Hazard Mitigation Plans. These plans will be updated by 2016 to maintain eligibility for future FEMA grant funding. The plans will also include a discussion of economic resiliency which will be drawn from this report.
- Staff prepared grant applications for the purchase of a sandbag filling machine, a new generator for an emergency shelter, removal of an obsolete dam, and a flood control project.
- Staff coordinated with Bristol, Plainville, and Plymouth on a project to analyze flooding problems on the Pequabuck River.

Figure 3: Participants at the Disaster Resiliency Workshop engaged in a spirited discussion of disaster preparedness.

- CCRPA staff applied for and obtained funding from the EPA for a non-point urban stormwater runoff mitigation project for the Pequabuck watershed.
- Staff participated in a webinar organized by the National Association of Development Organizations (NADO) in June 2014. The webinar was on the topic of promoting business continuity planning to businesses.
- Staff assisted NADO with their ongoing disaster resiliency work by discussing insights that CCRPA gained through this planning process.
- Staff provided information to municipal officials regarding economic vulnerability to natural and man-made disasters.

Profile of the Region

The Central Connecticut Region is small, but richly varied. The region comprises seven municipalities that span two counties (Hartford and Litchfield): the cities of New Britain and Bristol, and the towns of Berlin, Burlington, Plainville, Plymouth, and Southington. These seven municipalities are diverse in many ways: urban, suburban, and rural; hilly and flat; young and old; dense and sparsely populated. They have differing levels of wealth, educational attainment, and ethnic diversity. They enjoy varying levels of accessibility via highways, rail lines, and bus routes. However they share many common goals, including a strong commitment to protecting their economic interests and businesses from the ravages of natural hazards.

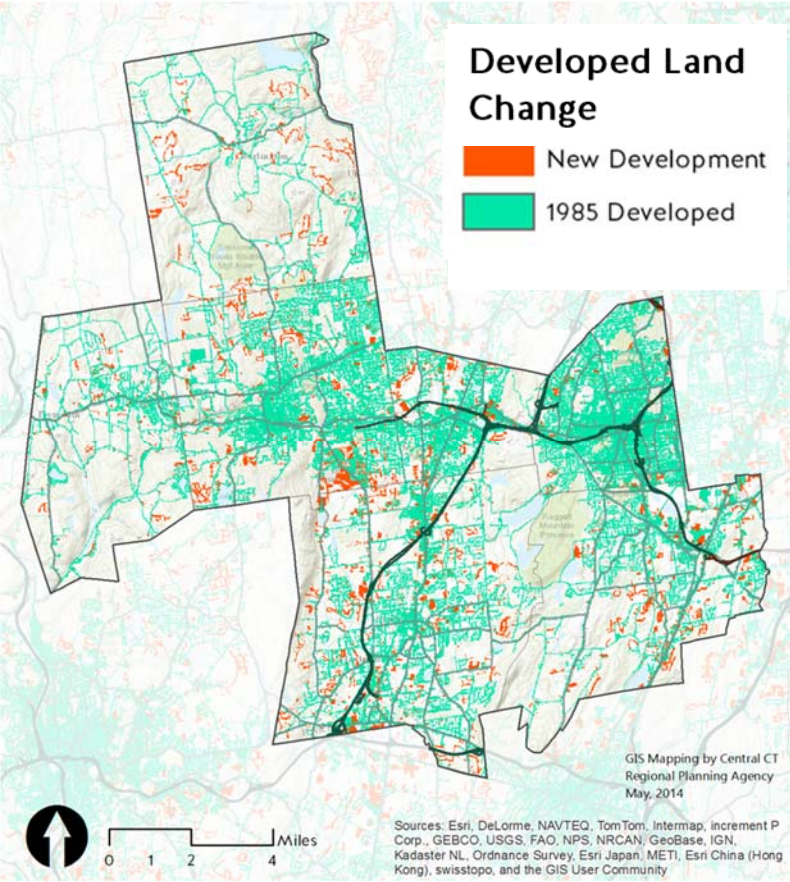


Figure 4: *New development between 1985 and 2010.*

Land Cover

Towns in the region exhibit a typical development pattern for New England: dense population centers (often more than one per town) clustered around rivers, where mills and other businesses were once located. These population centers may have a rich mix of uses, with additional residential development spiraling outward, creating relatively compact villages. Development in recent years has largely abandoned the traditional centralized pattern, and followed a more sprawling pattern, with new development radiating out ever further from traditional population centers, and filling in the open space and former agricultural fields that once separated village centers.

Much of the development the region has seen since 1985 has come at the cost (mainly) of its agricultural land and deciduous and coniferous forests. The maps on the following page, derived from the UConn Center for Land -Use Education and Research (CLEAR), show a snapshot of current land cover as well as where land cover has changed since 1985. The rate of land cover change can be seen in figure 1. The diagram does not include land cover classes which did not change between 1985 and 2010 (known as land cover persistence). As the land cover change map shows, the most endangered land, by far, is agricultural land, 30% of which has been lost to development.

As development in the region increases, the magnitude of the damage caused by the disasters also increases. Total

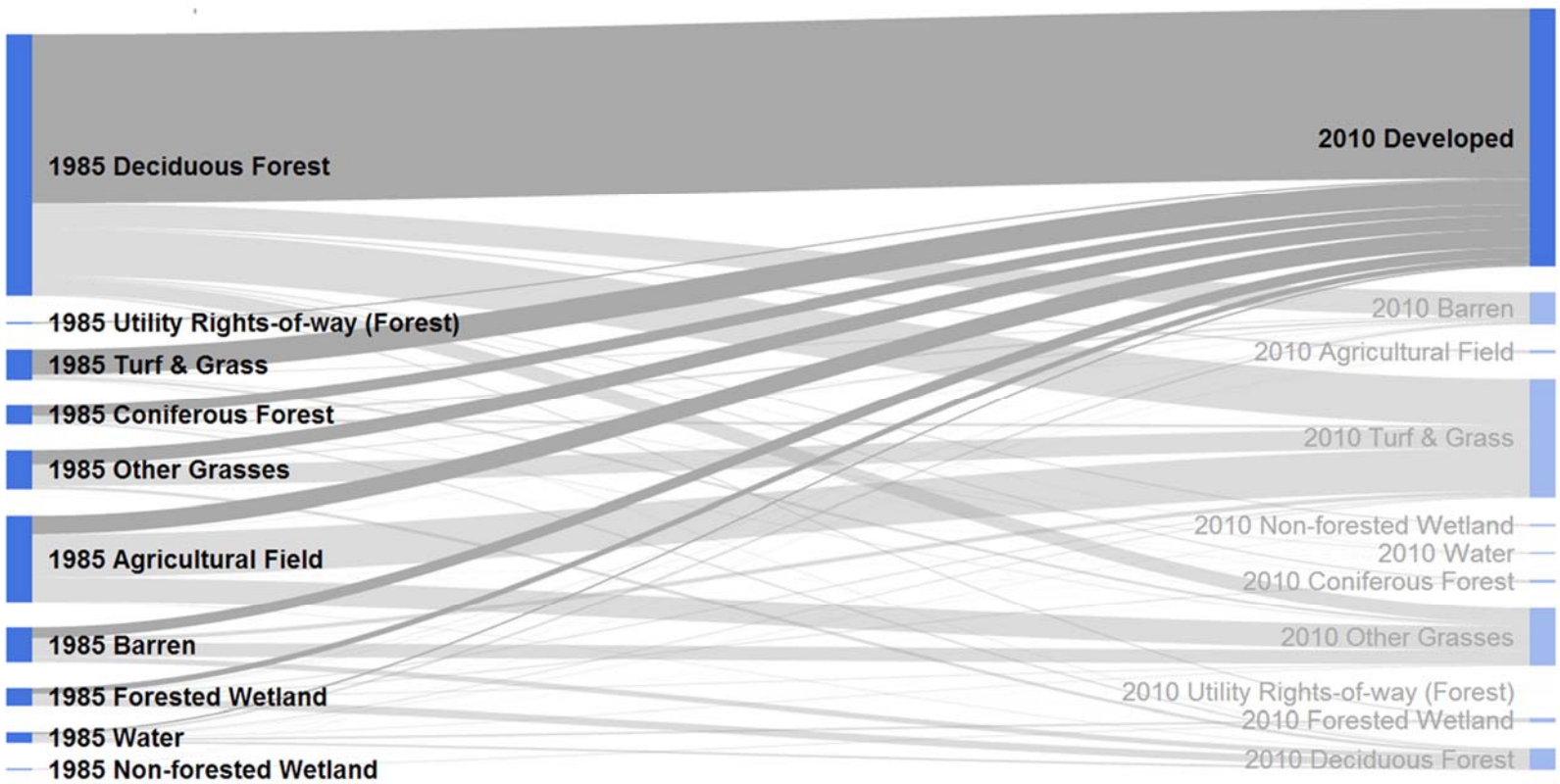


Figure 5: *Changes in land cover between 1985 and 2010.*

damages increase for two reasons. First, because there are more homes, businesses, and other assets in a given area, more homes, businesses and assets are affected by the disaster. Second, impermeable surface is linked to more severe and rapid flooding events. Continued development has caused the percentage of impermeable surface area within the region to increase. Therefore when heavy rain events hit the region the resulting storm water quickly flows through storm drains and across parking lots and lawns, into brooks and rivers leading to a higher peak elevation flood surge. This phenomenon, created by development, has increased the damages associated with severe weather conditions.

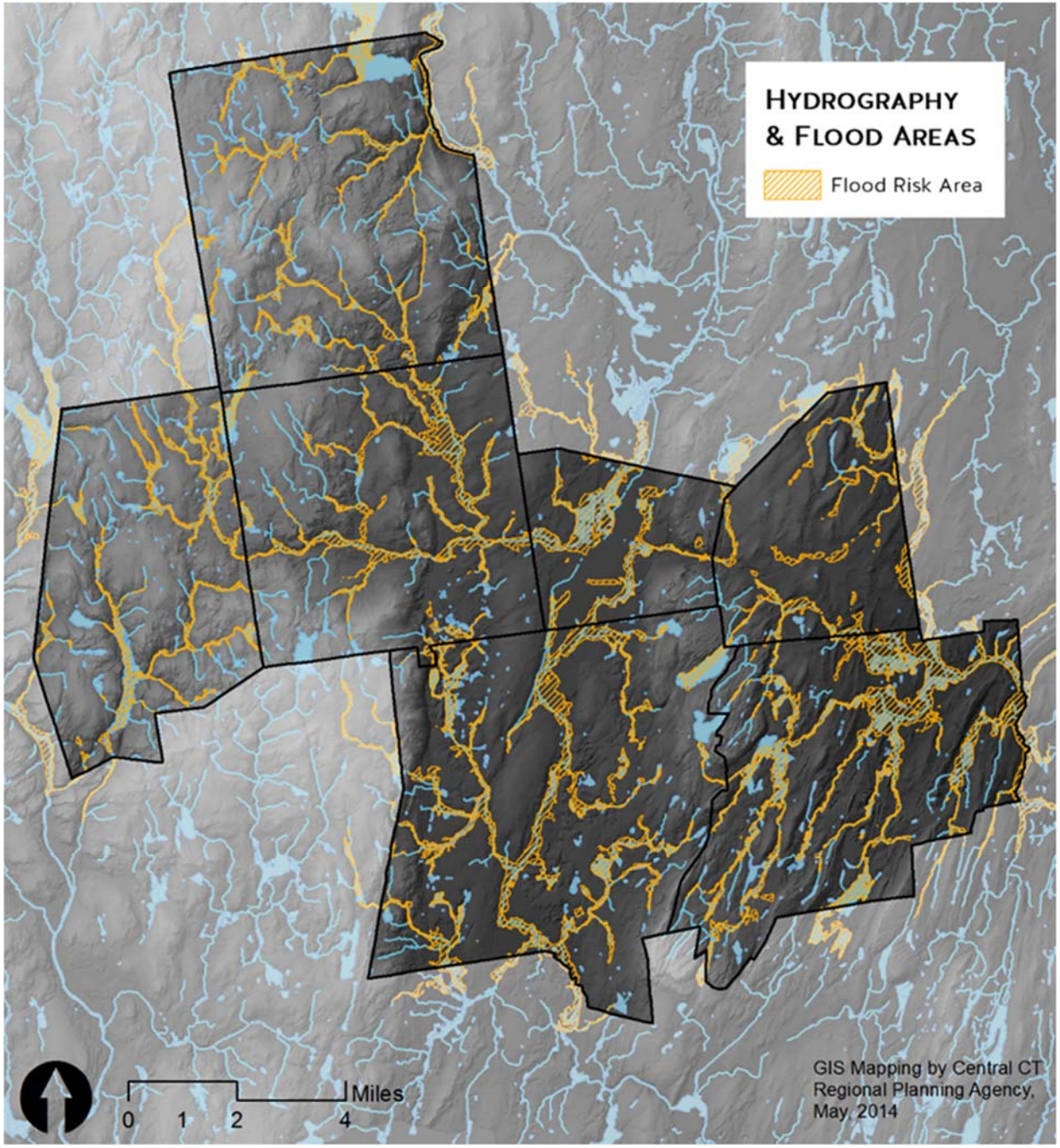


Figure 6: *The regions his home to many streams, brooks and rivers and as a result much of the area is at some risk of flooding*

Hydrology

Several rivers run through the region, including the Quinnipiac, Mattabessett, and the Pequabuck. These rivers along with myriad streams and brooks feed into and flow from several lakes, ponds, and reservoirs.

Historic development patterns in the region's municipalities favored sites near bodies of waters. Rivers provided power for mills and factories, transportation of people and goods, and water for irrigation of agricultural fields. While development along these rivers provided economic and aesthetic benefits, many have been polluted and their uses are restricted by the Connecticut Department of Energy and Environmental Protection (DEEP). Within the region the Pequabuck is rated as impaired for habitat for fish, other aquatic life and

Table 1: *Population projections 2010 through 2025*

Community	2010	2015	2020	2025	% Change
Berlin	19,866	20,531	21,017	21,390	7.67%
Bristol	60,477	60,807	60,956	60,704	0.38%
Burlington	9,301	9,618	9,858	10,071	8.28%
New Britain	73,206	74,554	76,017	77,358	5.67%
Plainville	17,716	18,145	18,498	18,760	5.89%
Plymouth	12,243	12,550	12,790	12,968	5.92%
Southington	43,069	44,295	45,141	45,806	6.35%
Region	235,878	240,500	244,277	247,057	4.74%
CT	3,574,097	3,644,546	3,702,472	3,746,184	4.81%

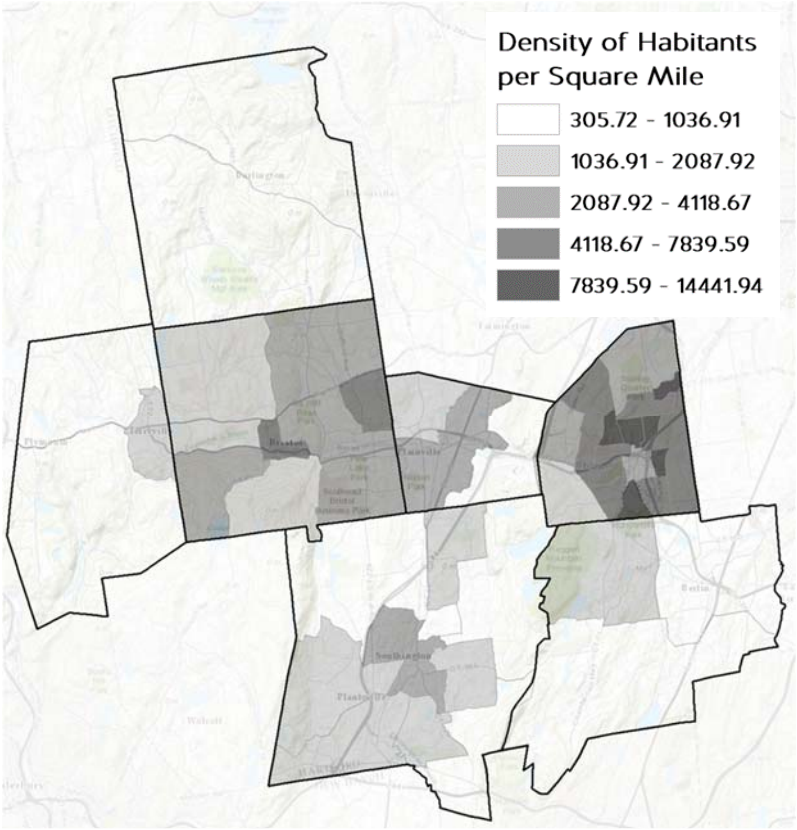
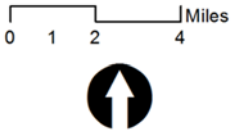


Figure 7: *Residential density by Census tract for the region*



GIS Mapping by Central CT Regional Planning Agency, May, 2014.

Sources: Esri, DeLome, NAVTEQ, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), Swisstopo, and the GIS User Community

Table 2: *Population over 60*

Community	2010	2015	2020	2025	% Change
Berlin	4,836	5,891	6,962	7,927	63.92%
Bristol	12,440	13,878	15,902	17,435	40.15%
Burlington	1,550	1,992	2,498	3,099	99.94%
New Britain	11,992	12,732	13,940	14,967	24.81%
Plainville	3,860	4,423	5,050	5,459	41.42%
Plymouth	2,305	2,853	3,530	4,125	78.96%
Southington	10,362	11,905	13,539	15,013	44.89%
Region	47,345	53,674	61,421	68,025	43.68%
Connecticut	709,854	811,655	937,745	1,054,031	48.49%

wildlife, and recreation from headwaters to its confluence with the Farmington River. The Quinnipiac is also rated as impaired for habitat for fish, other aquatic life and wildlife, and recreation from headwaters to Hamilton Pond where it remains impaired for the above listed uses and also becomes impaired for fish consumption.

The concentration of development next to bodies of water, rivers in particular, also introduced increased risk of flooding and erosion. Flooding from these rivers already has dramatic impacts on the region's towns. Catastrophic flood events punctuate the region's historical record and have left indelible marks on the natural and built environment. Even with modern engineering and flood control measures, the region's waterways periodically overrun their banks, rendering roads impassable and flooding homes and businesses.

Population & Demographics

The Central Connecticut Region covers 166.3 square miles and is home to 235,878 residents. At roughly 1,418 people per square mile, the region is nearly twice as densely populated as Connecticut, which has 701 people per square mile. However, the density varies greatly across the seven municipalities. New Britain has 73,206 people living in only 13.4 square miles for a density of 5,463 people per square mile. This density is over twice that of Bristol, the second densest municipality in the region. In contrast, the least dense municipality, Burlington, has 305 people per square mile.

According to the Connecticut State Data Center, the Central Connecticut Region is expected to grow at a moderate pace over the next fifteen years. Population projections show the region is expected to grow by 4.7% by 2025. While the region overall is expected to grow, projections for individual towns vary. The populations of Burlington and Berlin are projected to grow 8.28% and 7.67% respectively while Bristol is projected to increase 0.38%, the lowest increase of the seven municipalities.

As the entire state of Connecticut is aging, so too is the population in the Central Connecticut region. According to the 2010 Census, 20% of the region's total population is 60 years old or older. In every town the percent of the population aged 60 years and older will increase by 2025. In Burlington, the population aged 60 and older will increase 99%, from 1,550 people in 2010 to 3,099 by 2025. The total population of the Central

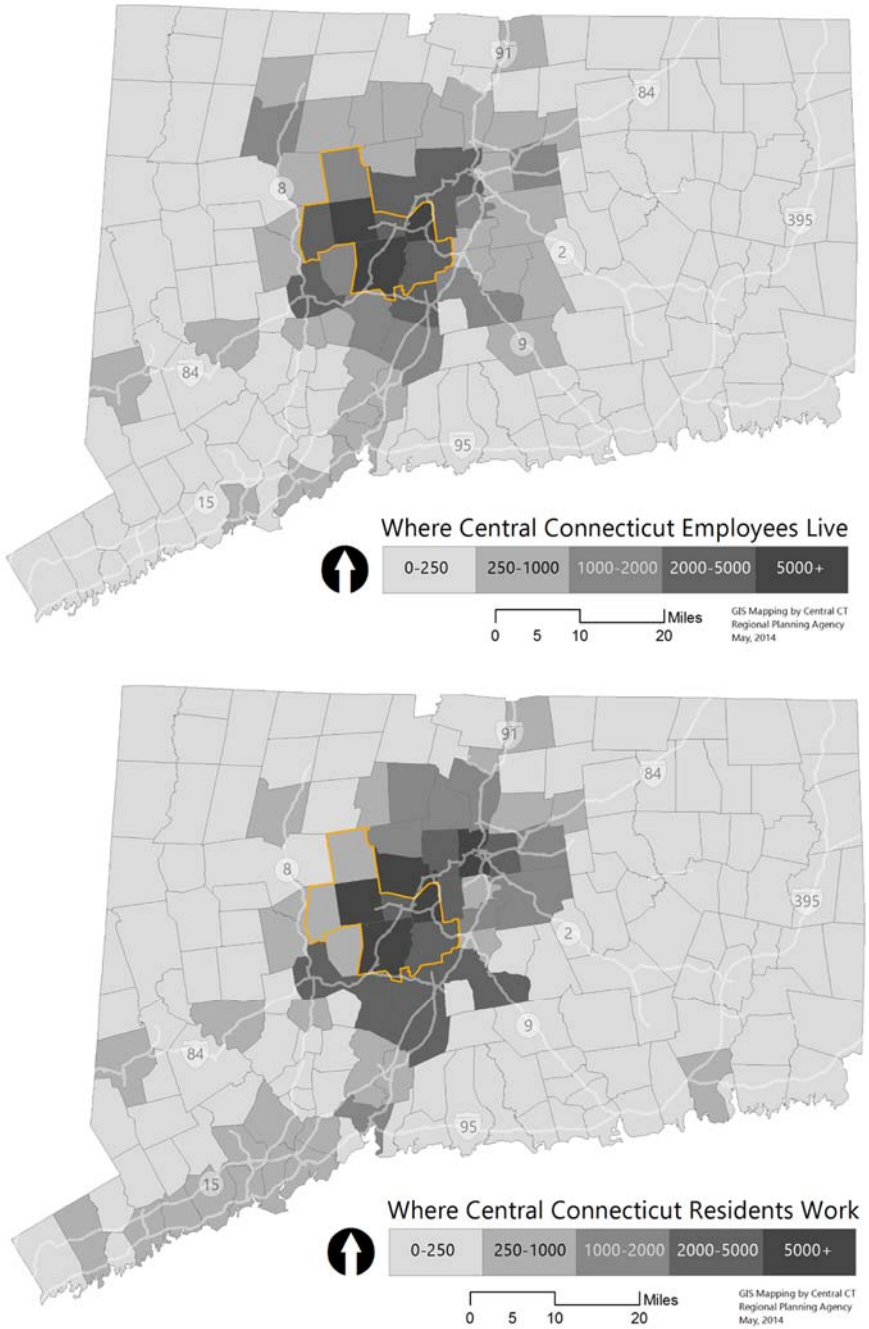


Figure 8: *Daily, commuters both enter and leave the region for work*

Table 3: *Central Connecticut Industries & Wages 2012*

Industry	Units		Annual Average Employment		Total Annual Wages ($Millions)		
Total - All Industries	5,250		84,852		4,411.1		
Agriculture, Forestry, Fishing and Hunting*	-	-%	-	-%	$	-	-%
Mining*	-	-%	-	-%	$	-	-%
Utilities*	5	0.10%	87	0.10%	$	11	0.24%
Construction	593	11.30%	4,220	4.97%	$	253	5.74%
Manufacturing	545	10.38%	12,529	14.77%	$	857	19.43%
Wholesale Trade	337	6.42%	2,631	3.10%	$	152	3.45%
Retail Trade	640	12.19%	9,734	11.47%	$	275	6.22%
Transportation and Warehousing*	69	1.31%	1,224	1.44%	$	42	0.94%
Information*	34	0.65%	4,253	5.01%	$	499	11.32%
Finance and Insurance*	165	3.14%	2,116	2.49%	$	156	3.54%
Real Estate and Rental and Leasing*	140	2.67%	554	0.65%	$	22	0.50%
Professional, Scientific, and Technical Services*	378	7.20%	1,883	2.22%	$	139	3.15%
Management of Companies and Enterprises*	12	0.23%	297	0.35%	$	51	1.15%
Administrative and Support and Waste Management and Remediation Services	276	5.26%	3,341	3.94%	$	117	2.65%
Educational Services*	26	0.50%	221	0.26%	$	7	0.16%
Health Care and Social Assistance	519	9.89%	15,055	17.74%	$	704	15.97%
Arts, Entertainment, and Recreation*	54	1.03%	944	1.11%	$	15	0.34%
Accommodation and Food Services	421	8.02%	5,707	6.73%	$	91	2.06%
Other Services (except Public Administration)	682	12.99%	2,923	3.45%	$	75	1.70%
Unclassifiable/unknown industry*	6	0.11%	2	0.00%	$	0	0.00%
Total Government	159	3.03%	11,614	13.69%	$	611	13.86%
Federal Government	15	0.29%	365	0.43%	$	23	0.52%
State Government	27	0.51%	3,458	4.08%	$	161	3.65%
Local/Municipal Government	117	2.23%	7,791	9.18%	$	428	9.70%

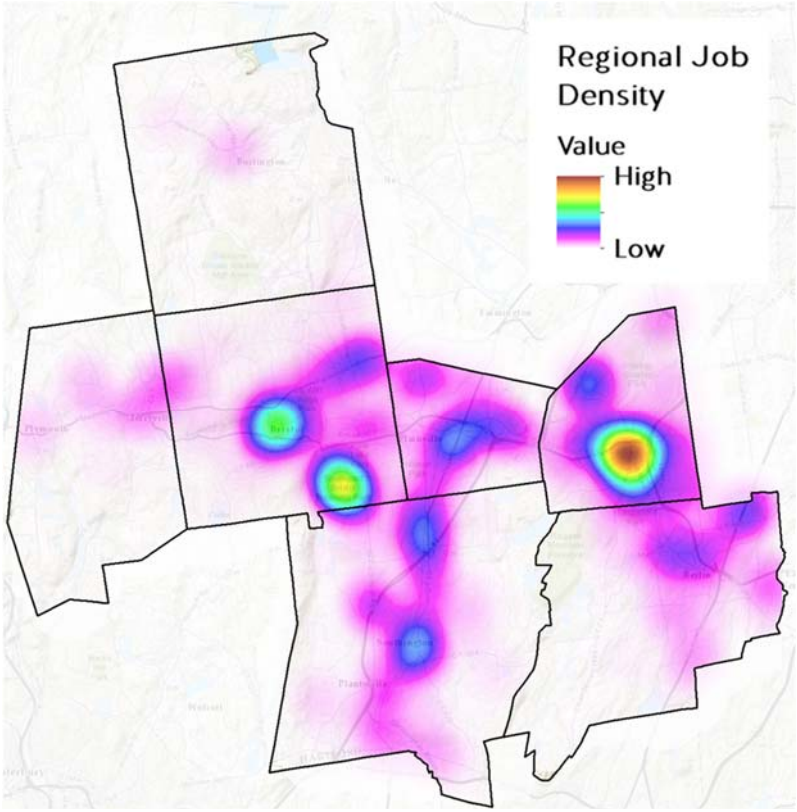
**Data is not available for these fields in all towns. Actual numbers may be the same or higher*

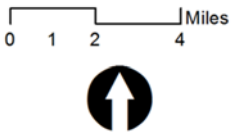
Connecticut Region in 2025 is projected to be 247,057, of which 68,025 or 27.5% will be 60 or older.

This demographic shift presents potential difficulties in hazardous conditions. An older population may be less mobile, more dependent on neighbors and family, and less able to evacuate or survive in isolation. They may also be unable to endure extended periods without heat or electricity. Facilities caring for the older population need to be equipped with supplies that can allow residents to shelter in place. Municipalities must also consider added need for medical sheltering. Therefore resilience plans for an aging population must address protection of critical facilities and vulnerable populations to ensure that all residents are able to weather the storms.

Geography & Transportation

The region acts as something of a crossroads between three of the state's three urban centers: Hartford, to the northeast, bordered by the city of New Britain; Waterbury, to the southwest, bordered by Plymouth; and New Haven, far to the south but accessible via Routes 5 and 15, a major road in Berlin. Interstate 84, which serves ¾ of the state and connects Interstate 90 (the Massachusetts Turnpike) and northern New England with major highways in New York, New Jersey, and Pennsylvania, passes through New Britain, Plainville, and Southington. In Hartford, I-84 connects to the state's





GIS Mapping by Central CT Regional Planning Agency, May, 2014.

Sources: Esri, DeLome, NAVTEQ, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), Swisstopo, and the GIS User Community

Figure 9: *'Hot Spots' indicate highest density of jobs within the region.*

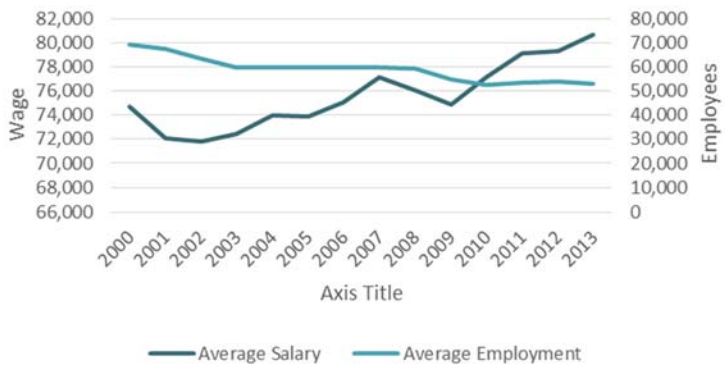
Table 4: *Labor Force July 1st 2012*

	Population	Labor Force	Employed	Unemployed	Rate
Berlin	20,463	11,225	10,340	885	7.88%
Bristol	60,603	34,037	30,892	3,145	9.24%
Burlington	9,434	5,439	5,067	372	6.84%
New Britain	73,153	36,626	31,927	4,699	12.83%
Plainville	17,819	10,366	9,460	906	8.74%
Plymouth	12,089	6,979	6,252	727	10.42%
Southington	43,434	24,606	22,815	1,791	7.28%
Total	236,995	129,278	116,753	12,525	9.69%

north-south interstate, I-91, which provides a connection to New Haven and I-95. Route 9 is another major freeway which passes through Berlin and New Britain and provides a connection to I-91 that bypasses Hartford. Burlington, Bristol, and Plainville access these freeways via Route 72, a small freeway connecter that joins I-84 in Plainville and terminates in Bristol. To the west of the region, Route 8 provides a north-south connection to Waterbury.

Residents of the region spend, on average, 47 minutes per day commuting to and from work on these freeways, as the majority of the region is not well served by public transit. According to the 2010 Census, of the 115,380 residents of the region who work outside their homes, 85% drive to work alone, 8% carpool, and 1% (1,476 people) take public transit. Some residents also walk (2%) and bike (.1%) and use other modes (2%). The Longitudinal Employer-Household Dynamics data identify roughly 113,000 workers/employees living within the region and only 88,500 jobs within the region. Of these regional workers, only 39,000 work within the region. The other 73,900 employees commute beyond the boundaries of the region. Nearly 50,000 workers commute into the region every day for their jobs. The high number of residents commuting by car is due in part to limited bus service in the region. Busses do not serve all the towns in the region, transfers between routes are notoriously difficult, and service hours are limited, making the bus an often inconvenient and difficult option even for those without cars.

Total number of manufacturing jobs and average salary



The figures to the left show both where Central Connecticut resident work and where workers live. While many residents of the region also work within the region many commute to Hartford, New Haven, and Waterbury. Likewise many of the Region's workers commute in from other regions. The flow of employees to and from the region implies that further resiliency initiatives can be considered at the inter-regional or state level.

Despite limited bus service, some residents in the region have no choice but to rely on public transportation. Across the region, 2% of owner-occupied households and 6% of renter-occupied households did not have access to a vehicle in 2010. The carless are largely concentrated in New Britain (16% of the city) and Bristol (5% of the city). While these residents have some access to public transportation, .5% (486 people) of owner-occupied units without access to cars and .4% (390 people) of carless renter-occupied units are located in the three towns without any transit service whatsoever. These individuals may find it difficult to evacuate or access designated shelters and other resources in the event of a disaster.

While the region is well connected with a variety of transportation routes traversing its seven municipalities, it is essential that these routes remain passable during and following a disaster to allow residents to access

U.S. manufacturing productivity (base year 2009 = 100)

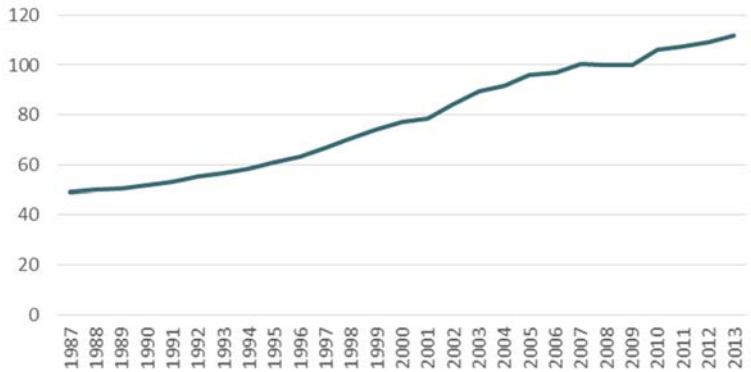


Figure 10 & 11: *Manufacturing is trending towards fewer, more productive and better paid jobs*

shelters and also provide efficient and timely recovery of the region's businesses.

Economic Profile & Labor Force

Central Connecticut is endowed with many economic assets and competitive advantages and is home to the headquarters and branches of many large national enterprises that bring stability and recognition to the region. The Region is known for its strong manufacturing sector, an industry that remains an important cornerstone in the local economy. The 2012 Quarterly Census of Employment and Wages shows that, although manufacturing only accounts for 10% of local enterprises, it accounts for 15% of local jobs and over 19% of aggregated local wages. Other important industries to the region include health care and social services and retail trade. The information industry continues to play a growing role in the economy of Bristol where ESPN is headquartered. For more details on wages within the region see *page 26*.

The region also faces a number of economic challenges. In 2012, the regional labor force numbered 129,278. Of these workers over 12,500 are unable to find employment. The rate of unemployment for 2012 was 9.69% which is above the state rate, 8.50%, and the national rate, 8.20%, for the same period. In New Britain the unemployment rate was 12.83% signaling even greater localized economic difficulty. (*Table 4*)

Economic Base

Based on 2009 data, in Central Connecticut, the economic base is made up of the following industries: *Construction, Manufacturing, Retail Trade, Information, Health Care and Social Assistance,* and *Other Services*. (*Central Connecticut Comprehensive Economic Development Strategy, 2011*) As these sectors represent the exporting industries for the Region it is important to identify those enterprises that are located in areas of high risk.

CCRPA has identified six target economic clusters within the Region. Among these, the Bioscience/Biotechnology, Health Services; and Printing & Publishing

(Broadcasting) clusters are considered to have the best potential for growth in Central Connecticut. In attempting to anticipate future economic resiliency for the region, these industries should be studied further for vulnerability from exogenous risk. For this report they are treated no differently than any other industry.

A second set of three clusters was also identified in the 2011 CEDS as already having a significant presence (Metal Manufacturing), as being linked to important statewide clusters (Aerospace & Defense) or as providing essential regional benefits (Agriculture). To reinforce economic resiliency and encourage future growth, regulatory support and public projects can prioritize businesses that fall in the target clusters and that are also at greater risk.

For employment, Central Connecticut's population has historically been and is currently highly dependent on manufacturing. More than 15% of jobs in the region are currently in manufacturing. Manufacturing has always been a welcome part of the local economy for several reasons. First, salaries for workers in this industry are among the highest for the region. Second, across the US, manufacturing is responsible for the majority of all R&D spending, which makes it an important cornerstone to maintaining local technological advantages. Third, manufacturing disproportionally rewards higher education relative to other industries.

However the industry's physical and human capital is in the midst of a transition. As the baby boomer generation approaches retirement there is great demand for new employees in the industry. For this new generation to benefit fully from the compensation premiums associated with the industry they will have to be highly trained with some post-secondary education or a bachelor's degree.

Many of the reductions in employment within the industry in recent years have occurred as a result of automation and the integration of computer aided technologies into the manufacturing process. A continued reduction of the industry's dependence on labor, especially cheap labor, has several implications for the region. The first and most encouraging is that companies will find a smaller benefit to relocating to cheaper labor markets. However, if new companies do not locate to the region or if existing companies do not

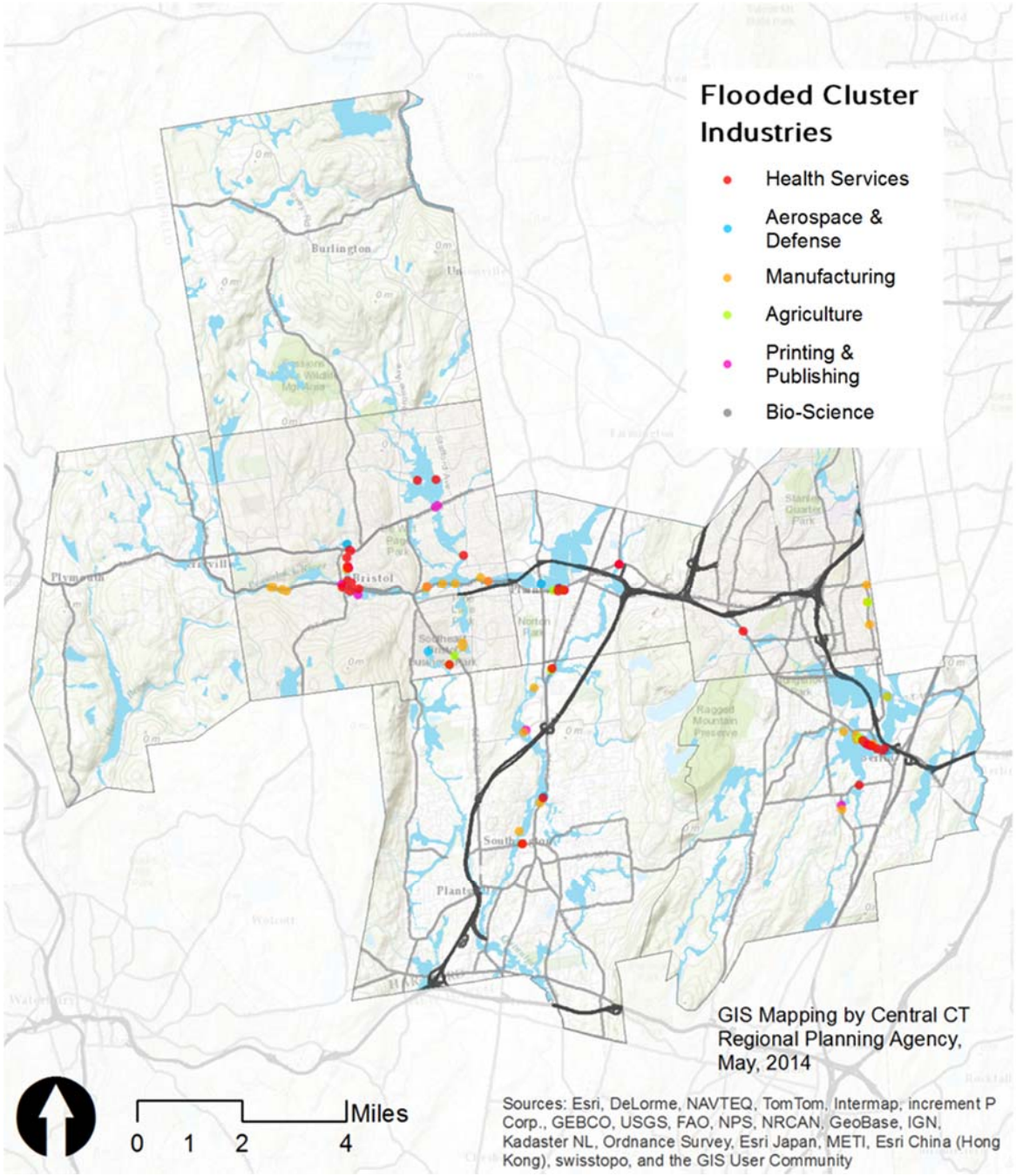


Figure 12: *Many of Central CT's 'Cluster Industries' are also at risk.*

Wages & Multipliers

High multipliers in the manufacturing industry are attributed to the high wages associated with these jobs. Generally, the higher an employee's wage, the greater the percentage of their salary they spend on discretionary items and services. These items and services may include, restaurants, real estate, cleaning services, legal services, construction, medical services, retail, personal services and so forth. By extension other industries in the region that have high monetary levels of compensation should also be recognized for the role they play in creating jobs in supporting industries. These industries include the utilities, information, finance and insurance, professional and technical services, and management companies and enterprises. Losses in these "high multiplier" industries may have economic impacts that ripple through the economy.

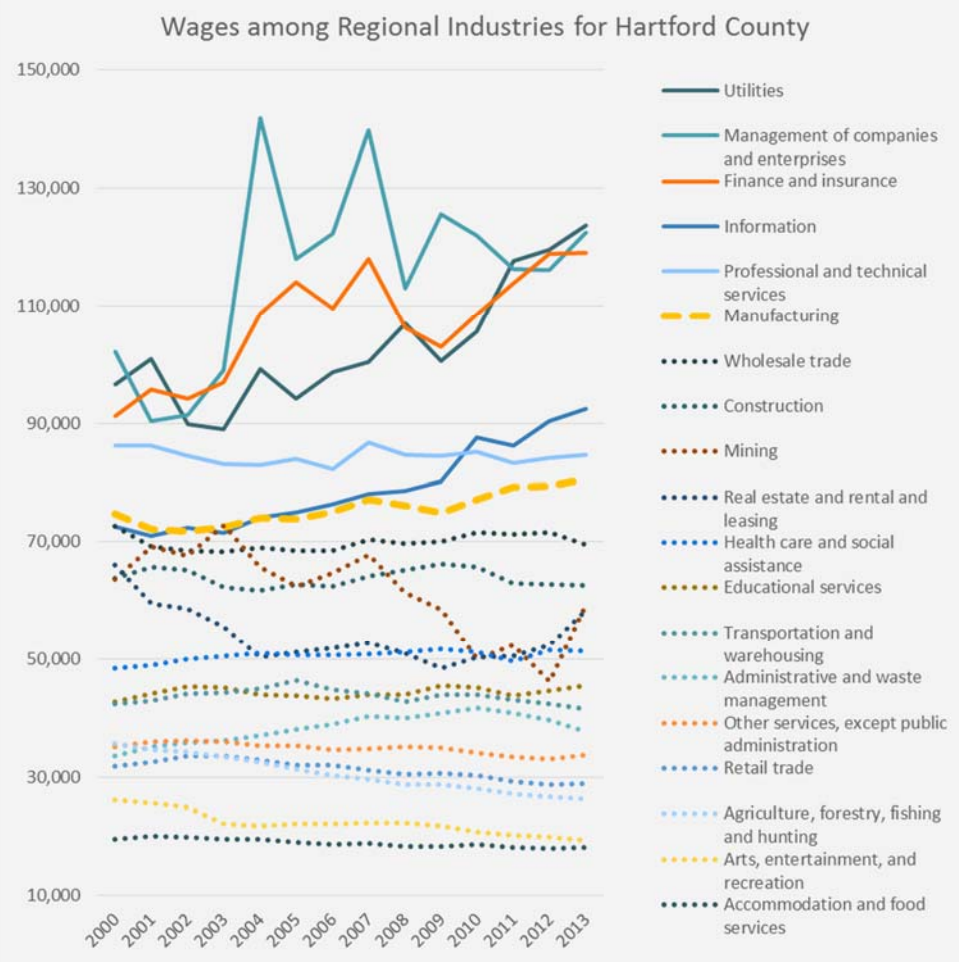


Figure 13 *Higher wage occupations tend to support more jobs in support sectors.*

expand, the manufacturing industry will continue to shed jobs.

Beyond manufacturing, the industry also contributes to job creation in other fields. The National Association of Manufactures estimates that for every one job created in manufacturing 0.58 jobs are created in other fields. This complimentary effect is known as a multiplier. To take the above example, we would say that manufacturing has a multiplier of 1.58. For the Central Connecticut region this implies that 19,800 jobs are held directly in manufacturing or indirectly supported by the industry. This amounts to 23.3% of employment within the region.

As productivity has increased within the industry, so has specialization. One positive outcome of this trend is that the employment multiplier for manufacturing has been on the rise and is expected to continue to rise from 1.58 to 2, or optimistically 3. The net effect on the local economy is that while the number of manufacturing jobs falls, the number of manufacturing-related jobs will rise. Therefore when a new manufacturer locates to the region the positive effect on related labor markets will be greater than ever before.

In this regard the region has the advantage of a strong existing manufacturing sector. The expertise of this sector can be used to spawn new companies. The region can work to help employees spin off their own enterprises while simultaneously ensuring that the labor market is trained not only for the higher demands of the newest technologies but also for the complimentary industries. In terms of policy, regional leaders can encourage economic development by continuing to support industries that rely on computer numerical control (CNC) machines while also exploring opportunities to develop additive manufacturing (3D printing). Furthermore the region can court a younger, well educated workforce by promoting the financial compensation advantages associated with the manufacturing industry, particularly the advantages associated with additional education.

Economic Risk

Central Connecticut owes much of its early economic development to the region's rivers and streams. The energy these waterways provided and the cargo they carried facilitated the region's transition from an

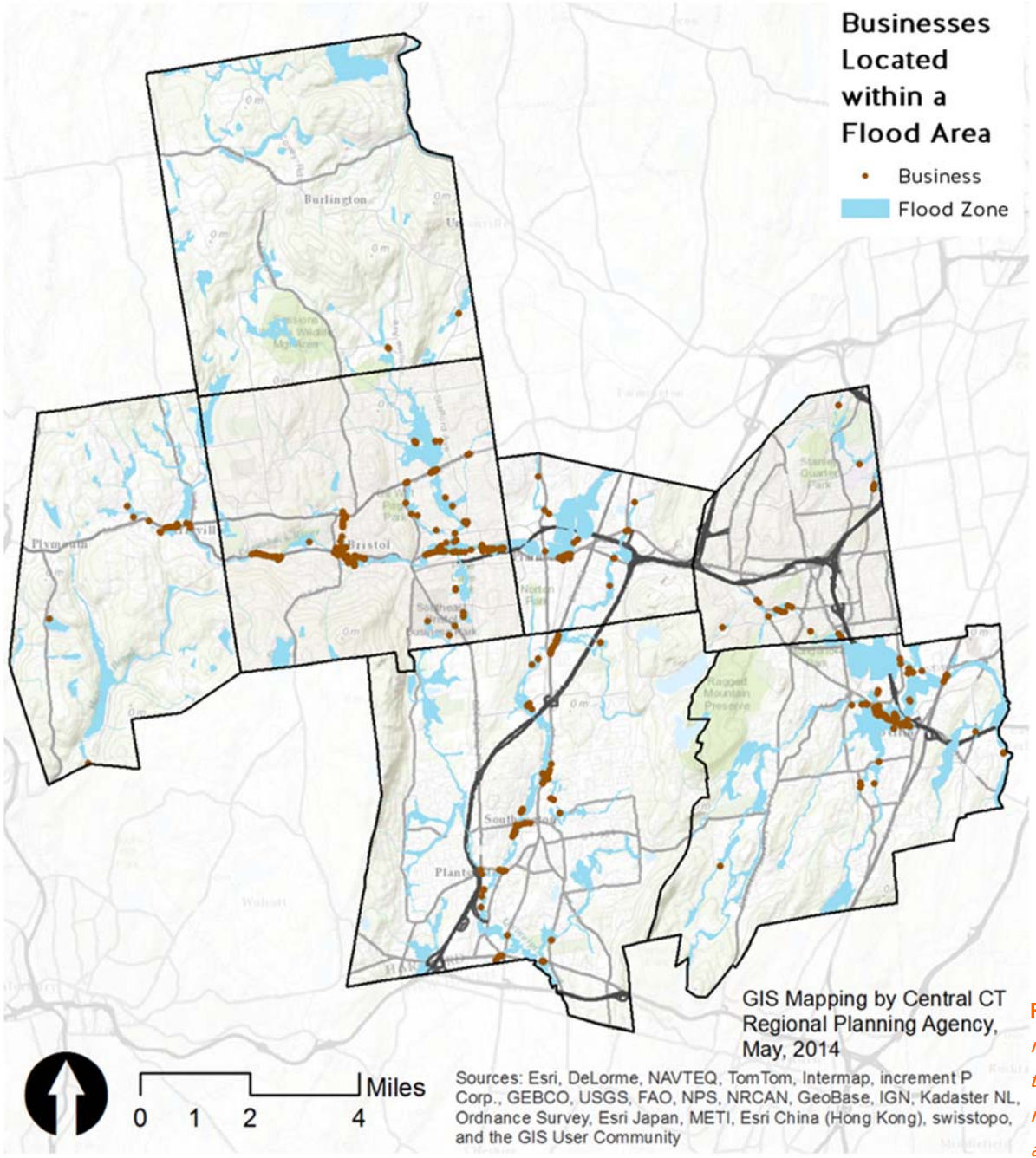


Figure 14: *At risk firms seem to cluster in identifiable areas*

Table 5: *Jobs and businesses in Flood Zone*

	Businesses within Floodway	% of Businesses within Floodway	Employees within Floodway	% of Employees within Floodway
Berlin	231	17.55%	2350	16.99%
Bristol	353	14.11%	3485	12.06%
Burlington	3	1.04%	25	1.52%
New Britain	26	0.94%	489	1.65%
Plainville	104	9.19%	1214	25.27%
Plymouth	29	7.30%	189	4.59%
Southington	200	8.75%	2121	9.82%
Region	946	8.85%	9873	9.44%

agricultural economy to an industrial economy. While the remnants of canals, mills and factories, many of which are still active, tell the story of this industrial past, the potential for a flood surge to breach their banks is emblematic of the risk weather presents local economic activity. The same structures that were designed to make the economy productive can threaten the very forces that keep it functioning. Just as highways and electric power, the life blood of modern production, can be shut down from an extreme weather event, halting economic activity.

If a business is forced to close because of weather, physical damages or any other emergency event the forfeited production and forgone wages often represent a permanent economic loss. Anecdotal evidence from local chambers of commerce and business leaders indicates that for a small or medium sized business even a couple days of lost production can be enough to lead to closure. The proportion of local enterprises and jobs that are located in flood zones represent an easily identifiable economic risk. Table 5 above catalogues these at-risk companies and at-risk jobs.

In most of the Central Connecticut towns, only a small proportion of businesses are at risk. The obvious exceptions being Berlin and Bristol which both have more than 1 in 10 Businesses exposed to some level of flood risk. Not surprisingly a large proportion of jobs in Berlin and Bristol are also exposed to flood risk. With regard to employment risk, Plainville stands out as being at particular risk with over 1 in 4 employees working within the 1% flood zone. Continued support for moving

high risk or repeat loss facilities to safer grounds would reduce economic vulnerability.

Disaster Risks to the Region

The Federal Emergency Management Agency defines disasters in their State and Local Mitigation Planning Guide (2003) as "events that can cause loss of life and property, environmental damage, and disruption of governmental, social, and economic activities. They occur when hazards impact human settlements and the built environment." Disasters are commonly categorized as being natural or man-made. The Central Connecticut Region has experienced a range of disasters in recent years. The following provides an examination of these disasters. The section is divided into two parts, natural disasters and man-made disasters.

Natural Disasters

Natural disasters affect thousands of people every year. It is important that communities and businesses understand the risks posed by natural disasters and ensure that adequate preparedness and recovery procedures are in place before disaster strikes. The following provides an overview of natural disasters that are likely to impact the Central Connecticut Region. The section includes a description of the disaster, provides an historic look at recent disasters in the region, analyzes the probability the disaster will strike again, and assesses the impact of each. Particular emphasis is given to floods, severe winter storms, and tropical cyclones (hurricanes and tropical storms), which are most common in the region. Other natural disasters examined, which can impact the region but are less likely to occur, include tornadoes, wildfires, drought, earthquakes, and dam failure.

Throughout the following section all estimates of costs and damages given in dollars are not inflation adjusted.

Floods

Flooding is the most common natural disaster encountered in the Central Connecticut Region. Triggered by a variety of events, floods can occur at any time in the region. Heavy precipitation is common throughout the year, and each season brings its own source of floods: from mid-summer through fall, hurricanes bring wind and torrential rain; winter Nor'Easters pound the region with snow and rain; in spring snowmelt inundates local hydrologic systems; and summer thunderstorms can bring flash floods in minutes. Historical development patterns encouraged dense construction of town centers near water bodies; consequently many areas with chronic flooding problems are in population centers.

Historic Flood Events

Historically, the region has seen a great deal of flooding. The National Climatic Data Center's (NCDC) Storm Events Database lists many flood events for Hartford and Litchfield Counties, 208 events between 1996-2011 and 9 flood events for the Central Connecticut region since 2006(beginning of NOAA's NWS records). The storms listed in NCDC's database only present notable storm events tied to flooding but unlisted storms also have a significant impact on the region. In 1992, for example, New Britain experienced extensive flooding from a rainstorm that, according to a report by Maguire Group, exceeded a 100-year storm. The flooding that resulted from this unlisted storm inundated local playing fields and caused $654,000 worth of damage to bridges, culverts, and roads.

The following details recent floods in the region:

April 16-18, 1996: Two to three inches of rain fell on April 16th in northern Connecticut, with totals of 3 to 5 inches in the south portion of Hartford and Tolland Counties. All of the rain fell in about a 12 hour period. The ground had remained saturated from heavy snowmelt during the previous week and this combined with the heavy rain to produce urban flooding, flooding of small streams, and minor to moderate flooding of the major rivers. A flash

flood occurred in Berlin, where boats were needed to rescue people stuck in two cars on Route 71.

September 16, 1999: Tropical Storm Floyd brought torrential rainfall and strong winds to northern Connecticut, as it tracked up the Connecticut River valley into central Massachusetts. Although many areas received torrential rainfall, with totals between 4 and 8 inches, the heaviest rain fell in western Hartford County where as much as 10.80 inches was reported in Bristol. Smaller rivers such as the Quinnipiac, North Branch Park, and Burlington Brook rose rapidly out of their banks. Crests of 2 to 3 feet above flood stage occurred by daybreak on the 17th.

June 30-July 1, 1998**:** An area of heavy showers and thunderstorms associated with a slow moving warm front brought 2 to 4 inches of rainfall, resulting in street, basement, small stream, and river flooding in Hartford County. The Quinnipiac River in Southington reached flood stage at 6:10 PM on June 30th, crested at 4.24 feet at 8:39 PM and continued flooding through midnight before falling below flood stage on July 1st.

September 28, 2003: Significant urban flooding affected central Hartford County, after nearly 4 inches of rain fell in a few hours. Several cars were stranded in Berlin and West Hartford, and Willow Brook rose out of its banks in New Britain, flooding a nearby park. This event included flash flooding in Berlin that caused $25,000 worth of property damage.

December 12, 2008: While a major ice storm affected Massachusetts and Southern New Hampshire, three to four inches of rain fell in Connecticut resulting in small stream and some street flooding. Roack Road in Burlington was closed due to flooding.

August 28, 2011: Hurricane Irene made landfall in Connecticut as a tropical storm, producing significant amounts of rain, storm surge, inland and coastal flooding, and wind damage across southern New England and much of the east coast of the United States. Four to ten inches of heavy rain from the storm caused the Pequabuck River to overflow its banks, flooding homes and businesses throughout Bristol. At least 50 people were evacuated from areas around the river and took shelter at Chippens Hill Middle School. Roads were

also flooded, becoming impassable with water approximately three and a half feet deep. Flood waters also washed out a portion of Route 72. Forty high water rescues took place in Bristol. A 46 year old man drowned while canoeing in floodwaters when his canoe capsized. Tropical Storm Irene also flooded parts of Burlington, with Bunnell Brook having its third worst flood on record. Inland flooding resulted in 1 fatality and $8 million in property damages.

September 8, 2011: A slow moving cold front moved across Southern New England and stalled just south of the area. This front was instrumental in bringing tropical moisture from the remnants of Tropical Storm Lee into New England. Rainfall totals throughout the region over the four days totaled anywhere from two to eight inches. The majority of flooding in urban areas occurred on September 8 as a band of very heavy rain dumped up to two inches of rain in an hour in some locations. Scoville Street, West Chippens Hill Road, and the George Washington Turnpike in Burlington were flooded with one foot of water. In addition, Bunnell Brook at Burlington experienced minor flooding.

Probability

The floods are often described in terms of the annual percentage chance of occurrence. Flood plains have been delineated by FEMA to reflect 1% and 0.2% annual flood events previously known as 100-year and 500-year floods respectively. However, because an n% flood plain reflects the percentage chance that area will be inundated in any given year, it is possible to observe a 1% flood more than once every 100 years. Furthermore, an n% flood plain is based on empirical evidence. If more or less floods of a certain magnitude are observed, FEMA redesignates the flood plains and corresponding insurance maps. This means that there can be a lag between the official risk and the empirical risk. A table of the two terms, n% flood and their corresponding n year floods is found in Figure 13.

The Connecticut Department of Transportation (ConnDOT) also keeps indexes linking return periods with expected precipitation. A chart including events by expected return period, the expected volume of precipitation recorded in one day for each hypothetical event, the observed number of events that have crossed

**A "Floodway" is the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than a designated height. (FEMA 2014)*

Table 6: *Both statistical and observed return periods and annual likelihood of an event*

Return Period	Expected Probability (n%)	Expected Rain Fall/Day	Observed Occurrences	Observed Probability
100	1%	7	4	8.2%
50	2%	6.35	5	10.2%
25	4%	5.75	8	16.4%
10	10%	4.95	10	20.5%
5	20%	4.2	17	34.8%
2	50%	3.25	41	84.0%

the volume threshold* and the observed probability for the return of any such event in any given year* is given in *Table 6*. This table highlights the uncertainty of the predictions. According to the official numbers, 2% annual events have occurred 5 times in the last roughly 50 years. This implies that there is actually a 10% annual observed chance of an event of this magnitude within the region; this is five times more likely than official probability. Municipalities can improve their resiliency by looking at local observed severe weather and by exceeding, where necessary, state requirements to meet local needs.

The National Climate Assessment estimates 5-20% more precipitation during winter and spring months for the northeast by the turn of the next century. The assessment also predicts an increase in severe weather events for the region which may increase the chance of experiencing floods. Intense precipitation, combined with an increase in impervious surfaces and thus increase in surface runoff, means the region has to be particularly aware of flooding risks.

Impacts

As recorded in the above descriptions of past flooding events, the impacts go beyond lost or damaged property and include reducing access to transportation and limiting the movement of economic goods and services. All seven towns in the region are impacted by floods on a regular basis. The Pequabuck, Quinnipiac, and Mattabesset Rivers flow through the region, and all have flood-prone areas. Impacts from flooding vary according to the severity of each flood event, but can range from minor damage of personal property to dam failure, septic

and sewer system failure, and even the destruction of homes and businesses and loss of lives. Flood damage is predictable in its location, however, and every town in the region has one or more specific properties that are damaged by flooding on a regular basis. These properties are defined by the National Flood Insurance Program (NFIP) as repetitive flood loss properties or severe repetitive flood loss properties (SRLP).

Property Damage

According to FEMA's Repetitive Loss Property Database, the region has 72 repetitive loss properties (RLP) with five of those properties being Severe Repetitive Loss Properties (SLRP). These properties observed 209 flood events from 2004-2010 and have incurred $3.08 million in repairs to buildings and replacement of building contents over the last 30 years.

The majority of the repetitive loss properties in the region are privately owned and have not been mitigated. Towns in the region differ in their ability to acquire and remediate these properties; while some structures have been demolished, others still stand. Some properties have not flooded for over a decade, and are low on municipalities' priority lists; others lie in areas known for frequent flooding, but are privately owned and beyond municipal reach.

Economic Impacts

Estimations for the economic impacts of a 1% and 0.2% year flood scenario were generated using FEMA's hazard simulation software, HAZUS-MH. The results of the HAZUS flood analysis for the region highlight just how expensive these disasters can be. A summary of the building inventory data stored in HAZUS revealed that a 1% flood that floods all reaches simultaneously could cause building damage (including contents and other variables) ranging from $9.5 million in Burlington to $185.4 million in Bristol. A 0.2% flood has damage values ranging from $11.9 million in Burlington to $200.8 million in Bristol as shown in Figure 15. On average around 60% of this damage occurs to the contents within the building and another 36% is estimated to occur to the building itself. The remaining 4% of losses is made up from relocation costs, inventory loss, income loss and lost wages.

The simulations also provide a depreciated replacement value for the buildings impacted by floods and their contents. These depreciated values are reflected in Figure 14 as thin orange rectangles overlapping the full damage estimates for the region. The depreciated replacement value of the buildings and their contents for the region is about 36.8% of the full replacement cost. The amount of damage usually covered by the NFIPs insurance policies tend to occur in between the full replacement cost and the depreciated replacement cost, according to the HAZUS Flood Technical Manual.

Displaced Residents

HAZUS flood simulations also provide estimates for displaced people and public shelter requirements. In the case of the 1% yearly flood scenario, it is estimated that 16,163 people would be displaced, including households that are evacuated. Of these displaced people, an estimated 11,911 people (out of 226,695) will seek

Estimated property damage under a 100 year (1% annual) and 500 year flood (0.2% annual) scenario.

Figure 15: *The 1% and .02% flooding would cause significant damage is it is unclear just how much value can be recouped through NFIP.*

temporary shelter in public shelters. Bristol, Berlin, New Britain, and Southington all have the largest amounts of displaced people as seen in Figure 16.

Displaced residents have a widespread impact on the business community and economic resiliency of the region. If residents are displaced from their homes due to flooding, they will most likely focus on immediate survival and recovery, and will be less concerned with returning to work until they know their family is cared for and safe. Thus with a reduced workforce, it will be difficult for businesses in the region to continue normal operations and operate at full capacity.

Businesses

While HAZUS flood simulations provide an overview of damage to the region on the whole, additional analysis was conducted to assess the impacts of flooding on businesses. Using data collected from RefUSA, the

Estimated number of displaced residents under a 100 year (1% annual) and 500 year flood (0.2% annual) scenario.

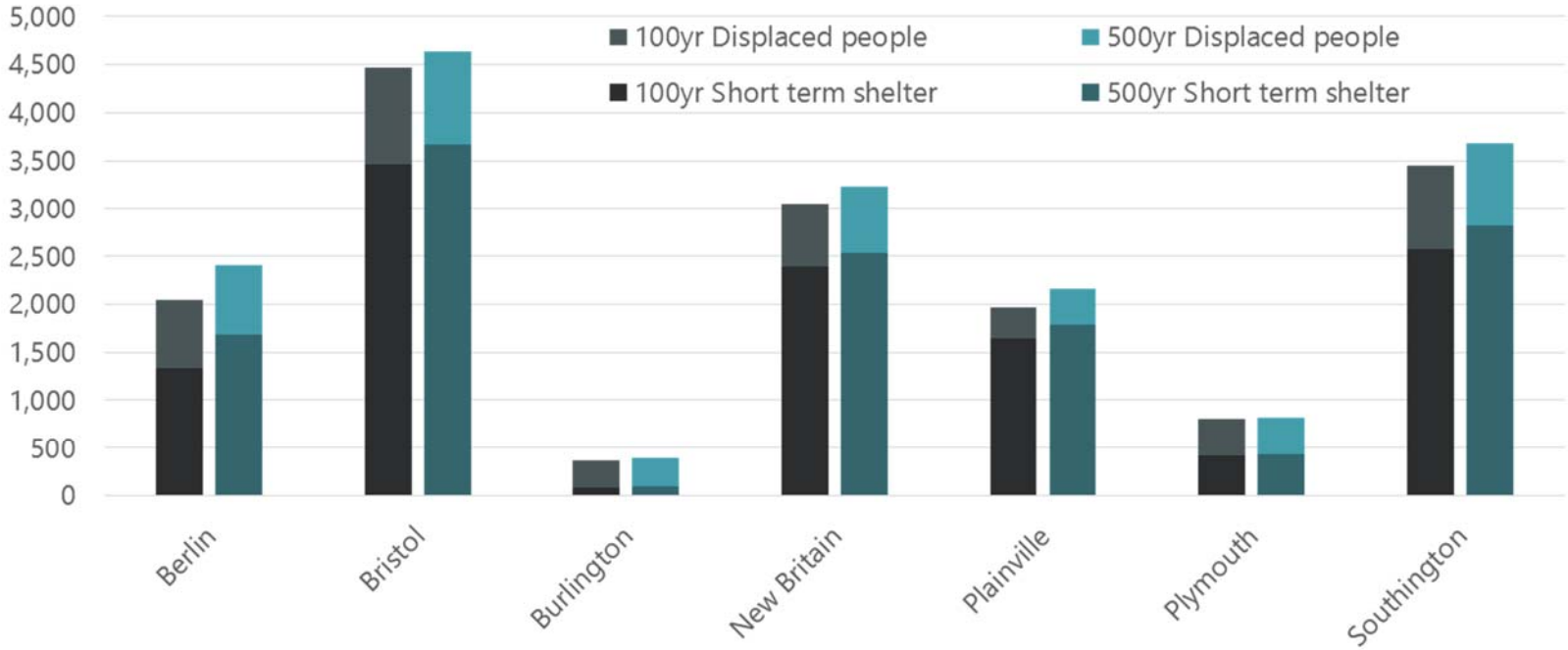


Figure 16: *High estimated numbers of displaced residents will require shelter*

analysis revealed that region wide, there are 946 businesses in a FEMA-designated flood zone (9% of all businesses in the region). According to FEMA ~40% of small businesses do not reopen after being impacted by a flood event. There are 666 businesses in the 1% annual flood zone (formerly referred to as the 100-year zone) and 280 are in the 0.2% annual flood zone (formerly referred to as the 500-year zone). While development is now discouraged (or outright banned) in floodways*, there are still 85 businesses throughout the region that are located in a floodway. Combined, the businesses in designated flood zones employ a total of 9,873 people and are responsible for $3.2 billion in sales (with 86% of firms reporting).

Flood-prone businesses are not distributed evenly throughout the region. The largest city in the region, New Britain, has only 26 flood-prone businesses (just 3% of the region's total). Bristol, the region's second largest city, represents the largest concentration of these businesses, with 351 of them located in the city. Berlin, which is the second smallest town in the region, has the second largest concentration of flood-prone businesses, with 231 of them (25% of the total). Southington and Plainville have the third and fourth largest concentrations, 200 and 104 businesses respectively.

Winter Storms

Winter storms, consisting of snow, ice, wind, and other cold weather precipitation, are a regular occurrence in Connecticut. Some winter storms are mild and of little consequence. However others, including blizzards, ice storms, and Nor'Easters cause large scale and regular disruptions by restricted transportation, lost electricity, and incurred physical damages.

Historic Winter Weather

According to FEMA's disaster history, 5 of the 19 major disaster declarations in Connecticut since 1954 have been prompted by snowfall. The following provides an overview of winter storms in recent history:

January 7, 1996: The "Blizzard of '96" was one of the most significant winter storms to hit southern New England in the past 20 years. However, by the National Weather Service definition, no actual blizzard conditions occurred in the state. Snowfall across the north and northeast

portions of the state ranged from 15 to 23 inches, with New Britain reporting 18 inches. This storm disrupted transportation systems and closed schools and businesses.

December 7, 1996: This storm brought heavy, wet snow and resulted in widespread power outages. A total of 225,000 electric customers lost power statewide, including 100,000 in central Connecticut. Power remained out for several days, despite the efforts of dozens of electric company repair crews, many from out-of-state. Many roads remained unplowed until the utility companies could repair fallen wires. Up to 22 shelters were opened across the region and many residents left their unheated and darkened homes. Many vehicles and homes were damaged by falling tree limbs and damage was estimated in the millions of dollars.

November 16, 2002: A major ice storm caused significant damage in north central Connecticut. There were numerous reports of downed trees, limbs, and power lines as a result of one-half to three quarters of an inch of ice. An estimated 100,000 customers in Hartford and Tolland Counties were left without power because of the storm. The damage from the ice storm was compounded by high winds one day later. Gusts as high as 50 mph hampered the cleanup effort, downing more trees and branches which were weighted down by ice. Total damage from the storm in Hartford County was estimated at two million dollars.

February 2, 2011: A series of significant heavy snow events occurred between December 26, 2010 and February 2, 2011. From February 1st through the 2nd, a total of 6-11 inches of snow fell across Hartford County, with upwards of a quarter inch of ice accumulation for isolated locations. Across Connecticut, numerous roof collapses due to heavy snow load occurred, including 75 structures in Hartford County. Snow for the winter season totaled 86.4 inches.

February 8, 2013: An historic blizzard deposited tremendous amounts of snow over southern New England. Most locations received 2 to 2.5 feet of snow. Isolated thunderstorms were common across the region during the height of the storm. During the night, rates of accumulation reaching 2 to 3 inch per hour were common throughout the region. The Connecticut Department of Agriculture reported that more than 140 agricultural

Table 7: *Plainville snow removal budget 2004 - 2012*

Year	Budgeted	Total Cost	Sand/Salt Cost	Snow (inches)
2004	$99,000	$150,746	$59,725	86.0
2005	$99,240	$237,011	$65,000	77.0
2006	$97,000	$192,113	$60,000	67.0
2007	$96,800	$129,594	$60,400	26.5
2008	$96,800	$241,229	$83,600	42.0
2009	$127,692	$239,317	$170,025	46.7
2010	$127,692	$189,015	$104,050	34.0
2011	$132,240	$104,478	$54,778	22.0
2012	$132,240	$241,715	$98,443	64.0

structures were damaged or destroyed throughout the state because of the weight of the snow.

Probability

Winter storms of varying levels of severity are fairly common in the region. Data from the weather station in Burlington reveals that in an average year there are 85 days when it snows .1 inches or more. Most of those days (54) are during December through February. During this same time period, there are 32 days where snow totals at least 1 inch and 3 days on average have a snowfall total of 10 inches or higher. These data demonstrate that the Central Connecticut Region should expect several heavy snows per year and therefore should be adequately prepared for these storms.

Impacts

While picturesque, snow and ice can create impassable roads, interrupt utility service, knock down trees and power lines, and isolate people in their homes or workplaces, sometimes without electricity or heat. Melting snow and ice can also cause flooding, as can winter rainstorms that hit when the ground is already

Table 8: *Snow weight*

Type	Equivalent to 1" of water	Load per Square Foot	Maximum
Fresh Snow	10-12"	5 lbs	4 ft.
Packed Snow	3-5"	5 lbs	2 ft.

frozen. The following examines the impact of snow storms on the region.

Municipal Budgets

Snow and ice removal has a tremendous impact on municipal budgets. The impact varies by town; some towns use their own staff to clear roads, which may represent savings but also be inefficient. Other towns hire contractors to remove 100% of the snow and ice. The remainder of towns use a combination of town staff and contractors. Regardless of staffing, every town is faced with spending between $100,000 and $1 million per year on snow and ice management.

In recent years, towns have budgeted and spent widely varying amounts on their snow removal budgets depending on severity. The winter of 2013-14 saw the state and many towns exceeding their budgets and running out of salt, sand, and other resources before the winter ended.

For example, Plainville regularly had to extend their snow removal budget in order to adequately clear multiple feet of snow of the past several winters. See *Table 7* on the preceding page for recent snow removal budgets in Plainville.

The size, scope, and timing of a particular storm can drastically affect towns' annual expenditures. Blizzards in 1888 and 1978 each delivered nearly a season's worth of snow in a single event. Nor'Easters in 1979, 1983, 1988, 1992, 1996, 2003, 2005, 2007, 2011, 2013, and 2014 dropped masses of snow, causing deadly car crashes and widespread blackouts. Even storms that are not unusual can cause damage and loss of life.

Roof Collapse

Heavy snow and ice accumulation brings with it the threat of roof collapse and catastrophic damage to the building's occupants. As seen in *Table 8* snow alone can put a large burden on roofs, however when coupled with rain and sleet, this load per square foot increases.

Two feet of old snow and two feet of new snow could weigh as much as 60 pounds per square foot of roof space, which is beyond the typical snow load capacity of most roofs. One inch of ice is equivalent to one foot of fresh snow. A house should be able to support 20 to 25 pounds of snow per square foot. (IIBHS, 2012)

The winter of 2011 saw many buildings condemned by snow accumulation, collapsing their roofs. In Southington several businesses experienced roof collapse including the Home Depot and Country Dog Training. Yarde Metals also had to be evacuated after the roof was damaged (Vallee, 2011). In Plainville, the roof of Classic Auto Body of Plainville collapsed. The building was condemned and the owners estimated the damages to exceed $100,000 (Sopchak, 2011).

Road Closures

Like many other types of disasters, winter weather and heavy snowfall can cause localized and widespread road closures. Closures can result from a variety of causes such as poor driving conditions, heavy snow and drifts, as well detritus like fallen trees and power lines. When a blizzard struck on February 8th, 2013, Governor Malloy called for a traffic ban on all vehicles except for those emergency response and recovery vehicles with the capacity to maneuver in heavy snow for the following day. Events with large impacts on transit also have major economic impacts, like preventing employees from reaching work and halting or delaying shipments and deliveries. Regional firm should consider how they will deal with these predictable decreases in productivity.

Burst Pipes

Cold and winter weather not only wreaks havoc outside a building, but inside as well. Frozen pipes can cause severe damage. A complete ice blockage in a pipe causes freezing and expansion which in turn causes water pressure to increase to the faucet. The increase in water pressure leads to pipe failure. In 2013, frozen and broken water pipes ranked second to hurricanes in terms of both the number of homes damaged and the total amount of damages claimed in the U.S. (IINC, 2014) While there are few records of burst pipes in the region, in nearby Farmington at the UConn Health Center, a frozen sprinkler pipe burst. This caused extensive damage, with

water leaking into the main floor, the ground floor and a storage room, some labor and delivery rooms, as well as the newborn nursery. (Lank, 2014)

Tropical Cyclones: Hurricanes and Tropical Storms

A tropical cyclone is defined by the National Weather Service as a "rotating, organized system of clouds and thunderstorms that originates over tropical or subtropical waters and has a closed low-level circulation." A tropical cyclone is further classified as a tropical depression, tropical storm, hurricane, or major hurricane, and is most likely to form from June 1 through November 30. Please refer to preceding description.

Historic Tropical Cyclones

Tropical cyclones are the most destructive natural disasters that threaten the state of Connecticut due principally to their accompanying storm surge. Of the 19 major disaster declarations in the state since 1954, 7 have been for hurricane related damage. As a land locked region, Central Connecticut is principally insulated from the most severe risks associated with these violent storms. However, despite its location, as illustrated by figure 19, many of these storms have tracked through the region in the last 100 years. The wind and rain they brought with them caused flooding, property damage, power outages, and left extensive debris and detritus in their wake.

The most destructive and powerful recorded hurricane to hit Connecticut struck on September 21, 1938. Named the Great New England Hurricane of 1938, the strongest winds ever recorded in Southern New England occurred during this storm at the Blue Hill Observatory with sustained winds of 121 mph and a peak gust of 186 mph. The worst damage was concentrated on the coast due to massive storm surges of 14 to 18 feet. However, inland communities were not spared. Rainfall of 10 to 17 inches from the hurricane resulted in severe river flooding across Connecticut, washing away road and sections of the New York, New Haven, and Hartford Railroad lines. The Connecticut River, in Hartford reached a level of 35.4 feet, which was 19.4 feet above flood stage. A total of 8,900 homes, cottages and buildings were destroyed, and over 15,000 were damaged by the hurricane. Across Southern New England 564 people died and over 1,700 were injured

(National Weather Service Forecast Office, 2005). Due to its destruction, the hurricane of 1938 is often used as a benchmark when assessing the worst case scenario for future hurricanes to strike the region.

While no other hurricane has caused the level of destruction in Connecticut as the 1938 hurricane, other storms of significance have hit the region. The following provides an overview of these recent storms:

August 19, 1991: Hurricane Bob developed in the Bahamas, strengthening as it moved up the East Coast. Coastal communities in New England sustained winds between 75 and 100 mph, with peak wind gusts of 125 mph recorded on Cape Cod and in Wethersfield, Connecticut. Hurricane Bob caused approximately $680 million dollars of damage in Southern New England and was responsible for six deaths in Connecticut.

September 16-21, 1999: Tropical Storm Floyd dropped an average of four to eight inches of rain across the State, flooding 25 to 30 homes in Southington, which received rainfall on the order of a 250-year event. Plainville and Bristol also saw many homes flood as a result of this storm. Sixteen buildings in the state were utterly destroyed by the storm. The storm caused $2.2 million in damage .

August 28, 2011: Irene first made landfall in North Carolina as a Category 1 hurricane before moving north. By the time it reached the New York area, it was downgraded to a tropical storm. Dropping torrential rain on Connecticut, the storm caused widespread flooding, knocked power out to thousands of homes and businesses, and left many roads impassable. Tropical Storm Irene washed away a portion of Route 72 in Bristol and resulted in one death in the region.

October 29, 2012: Tropical Storm Sandy formed in the Caribbean on October 22. Moving up the coast, hitting New Jersey and New York on October 29, 2012, Tropical Storm Sandy caused extensive flooding and damage on Connecticut's coast. The National Hurricane Center Tropical Cyclone Report estimated the death count from Sandy at 147 deaths, including 5 in Connecticut. Sandy was the deadliest hurricane to hit the United States since Hurricane Katrina in 2005.

Table 9 *The **Saffir-Simpson Hurricane Wind Scale** is a 1 to 5 rating based on a hurricane's sustained wind speed. This scale estimates potential property damage. Hurricanes reaching Category 3 and higher are considered major hurricanes because of their potential for significant loss of life and damage. Category 1 and 2 storms are still dangerous, however, and require preventative measures.*

Category	Sustained Winds	Types of Damage Due to Hurricane Winds
1	74-95 mph 64-82 kt 119-153 km/h	**Very dangerous winds will produce some damage:** Well-constructed frame homes could have damage to roof, shingles, vinyl siding and gutters. Large branches of trees will snap and shallowly rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days. Hurricanes Gloria of 1985 was a Category One hurricanes at landfall.
2	96-110 mph 83-95 kt 154-177 km/h	**Extremely dangerous winds will cause extensive damage:** Well-constructed frame homes could sustain major roof and siding damage. Many shallowly rooted trees will be snapped or uprooted and block numerous roads. Near-total power loss is expected with outages that could last from several days to weeks. Hurricane Bob was a category 2 hurricane when it made land fall in Rhode Island.
3 (major)	111-129 mph 96-112 kt 178-208 km/h	**Devastating damage will occur:** Well-built framed homes may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes. The New England Hurricane of 1938 was a category 3 hurricane when it made landfall.
4 (major)	130-156 mph 113-136 kt 209-251 km/h	**Catastrophic damage will occur:** Well-built framed homes can sustain severe damage with loss of most of the roof structure and/or some exterior walls. Most trees will be snapped or uprooted and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months.
5 (major)	157 mph or higher 137 kt or higher 252 km/h or higher	**Catastrophic damage will occur:** A high percentage of framed homes will be destroyed, with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months.

Table 10: Reported damage caused by hurricanes and tropical storms in Connecticut.

Year	Name	Category	Affected Area	Damage
1938	N/A	3	Central	125 dead, $53 million (1938 dollars) in damage
1944	N/A		Whole state	7 dead, $3 to 5 million dollars (1944 dollars)
1954	Carol		Southeastern CT	0 dead, $50 million (1954 dollars)
1955	Connie & Diane		Whole state	These two storms passed through the area in little over a week resulting in, 70 deaths, massive flooding, State declared disaster area, no drinking water, 14 towns classified health hazards, $300 million (1955 dollars) in damages
1960	Donna		Whole State	homes without power
1976	Belle	1	Coastal	5 dead, some minor damage
1985	Gloria	1	Southeastern CT	power outages & downed trees, little flooding
1991	Bob	2	RI, CT, MA	light
1991	Grace		Shoreline from ME to NJ	shoreline damage
1999	Floyd	Trop. Storm	Western / Central	$2 .2 million; 418 buildings affected
2008	Hanna	Trop. Storm	Southwestern CT	1 dead, $32 ,000 in damages
2011	Irene	Trop. Storm	Whole state (FEMA)	2 deaths, $235 million
2012	Sandy	Trop. Storm	Whole state (FEMA)	4 deaths, $360 Million

Source: *State of CT 2007 Natural Hazard Mitigation Plan Update, pgs. 2 -6 to 2 -9 ; National Climatic Data Center's Storm Events database, www.cdc.gov, nydailyn-ews.com, nytimes.com; National Weather Bureau (1960)*

Probability

According to NOAA, a Category 1 hurricane can be expected to make landfall in/near Connecticut once every ten to fifteen years. A Category 2 hurricane could be expected to make landfall in/near Connecticut once every twenty-three to thirty years, and a Category 3 hurricane has a calculated return period of forty-six to seventy-four years. Based on this, the occurrence of another hurricane to impact the state can be expected within the foreseeable future.

These return periods are for the state as a whole. The return period for a storm of equal or greater strength to the 1938 storm which tracked directly through the region would understandably be longer for Central Connecticut

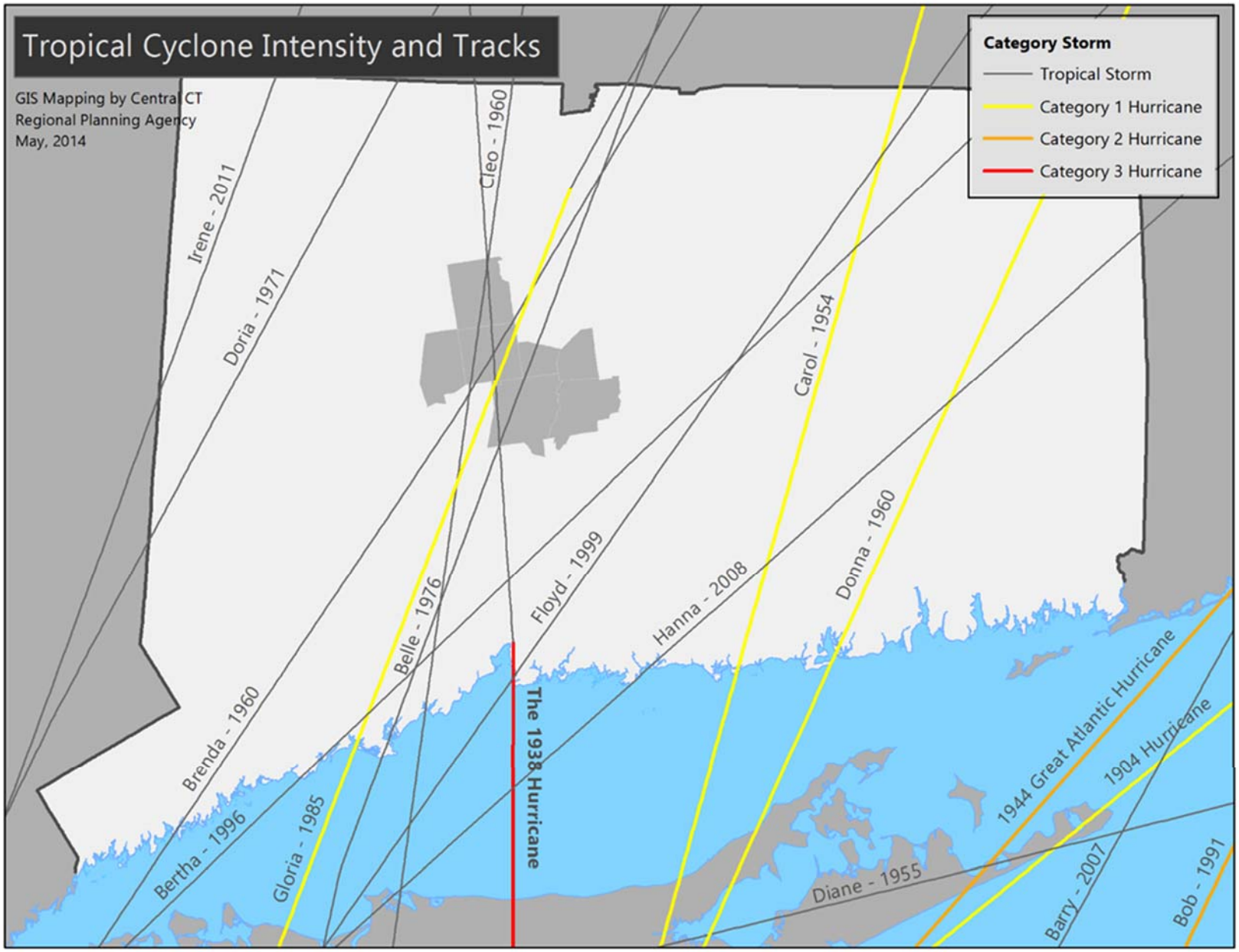


Figure 17: *Hurricanes and tropical storms regularly track through the Central Connecticut region*

Estimate of lost productivity from an event similar to the 1938 hurricane.

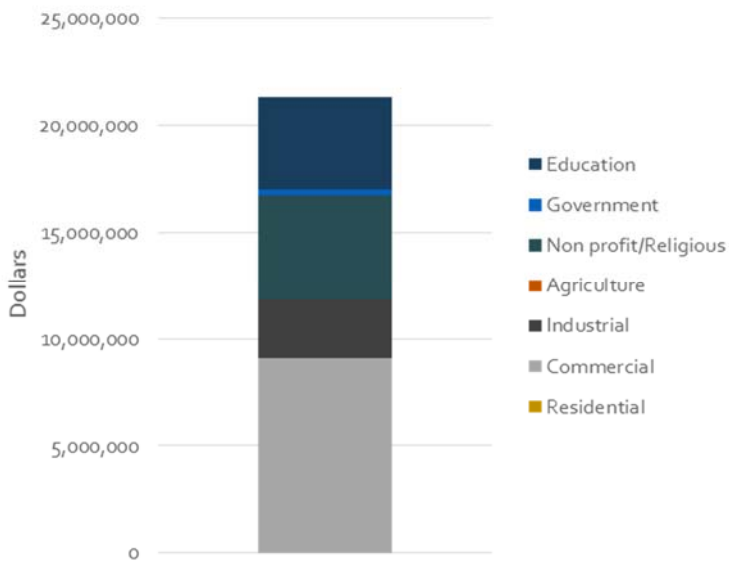


Figure 18: *Many of the most important industries of Central CT would suffer great losses if the region were hit by another storm similar to the 1938 storm*

than for the state as a whole. As discussed in the Impacts section below, a storm of this intensity would be expected to have a return period to the Region closer to 500 years. Return periods can be a helpful tool to put risk in perspective. Resident and business leaders should ask themselves, "How many times, over the course of a 30 year mortgage will a category 1 hurricane hit Connecticut?" This exercise may help frame these storms as an eventuality to be prepared for rather than a risk that can be magically avoided.

Impacts

Hurricane simulations were performed for the region for probabilistic 1% annual hurricane events as well as the historic 1938 Hurricane, the latter representing a worst case scenario storm and the impacts it would have if a similar hurricane occurred today. The 1938 hurricane has roughly a 0.2% chance to occur in any given year in this region. Historic storms provide an opportunity to compare simulated impacts to historical reports on the actual storm. In order to provide a damage comparison to the models estimates of the historic hurricane, a 2nd probabilistic scenario for a 1% hurricane scenario was ran for the region.

1938 Hurricane Simulation: Economic Impacts and Displaced Residents

The economic impacts for the hurricane simulations reflect population values for each town. The most populated and developed towns, Bristol, New Britain, and Southington, are affected the most. In the 1938 Hurricane scenario, with predicted sustained winds of approximately 85 mph and a max wind gust of 105 miles per hour, the model estimates $810 million dollars of

damage with 26,373 buildings suffering at least minor damage (*Figures 20 & 21*). Of those damaged buildings, 259 were completely destroyed. Fallen trees and damaged buildings attribute to 237,992 tons of debris, 142,474 tons of which are from trees alone. The 1938 Hurricane scenario also estimates a loss of economic output of approximately $21.3 million and a total employment loss of 85,500 days (*Figures 18 & 19*). It is also estimated that 1,657 households would be displaced with 438 people requiring short term shelter needs. Economic output is estimated to have $21 million in losses.

100-Year Hurricane Simulation: Economic Impacts and Displaced Residents

In the 1% annual hurricane simulation, the region observed around one tenth of the damage estimated in the 1938 hurricane simulation. Predicted maximum wind gusts were at 85 mph, and the model estimates $123.4 million of damage with 4,535 buildings suffering at least minor damage. Of those damaged buildings none were completely destroyed (*Figures 20 and 21*). In this simulation, fallen trees and damaged buildings attribute to 64,515 tons of debris, 46,829 tons of which from trees

Estimate of lost days of work from an event similar to the 1938 hurricane.

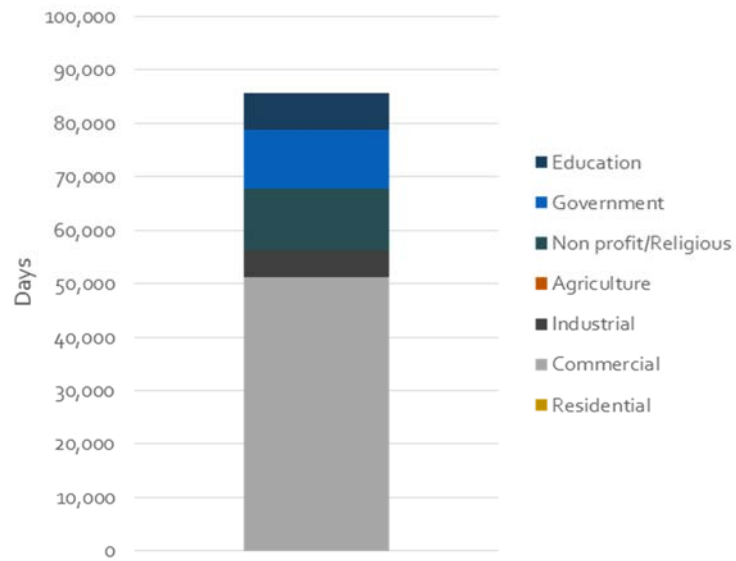


Figure 19: *workers in the commercial sector would suffer dispro-portionately if the region were hit by another storm similar to the 1938 storm*

alone. A 1% hurricane scenario also estimates a loss of economic output of approximately $2.3 million and total employment loss of 9,200 days. It is also estimated that 157 households would be displaced with 43 people requiring short term shelter needs.

Tornadoes

A tornado is a violent, destructive whirling wind storm accompanied by a funnel-shape cloud that progresses in a narrow path over the land. While tornados that strike

the region are often localized, they can have large impacts on the area affected. According to the state Hazard Mitigation Plan,

> *"The pattern of occurrence and potential locations for tornadoes to occur in Connecticut is expected to remain relatively unchanged in the 21st Century. The highest risk for tornadoes is expected in New Haven and Hartford counties. The second area of moderate to high risk is in Fairfield and New Haven Counties. The Counties of Middlesex, Tolland, and Windham have a moderate risk and the County of New London can expect a low risk."*

Tornados are measured on the Enhanced Fujita scale (EF). Wind speeds are estimated based on the damage they cause. *Table 11* links EF classifications to estimated three-second wind speed gusts

Historic Tornadoes

It is rare for Connecticut, and the region, to experience a tornado. Three tornadoes have touched down within the region in the past seventy years. A map of tornadoes in Connecticut can be found in *Figure 22*. The following details these tornadoes:

Estimated number of buildings with minor damage or worse. 1% annual storm event and 1938 hurricane.

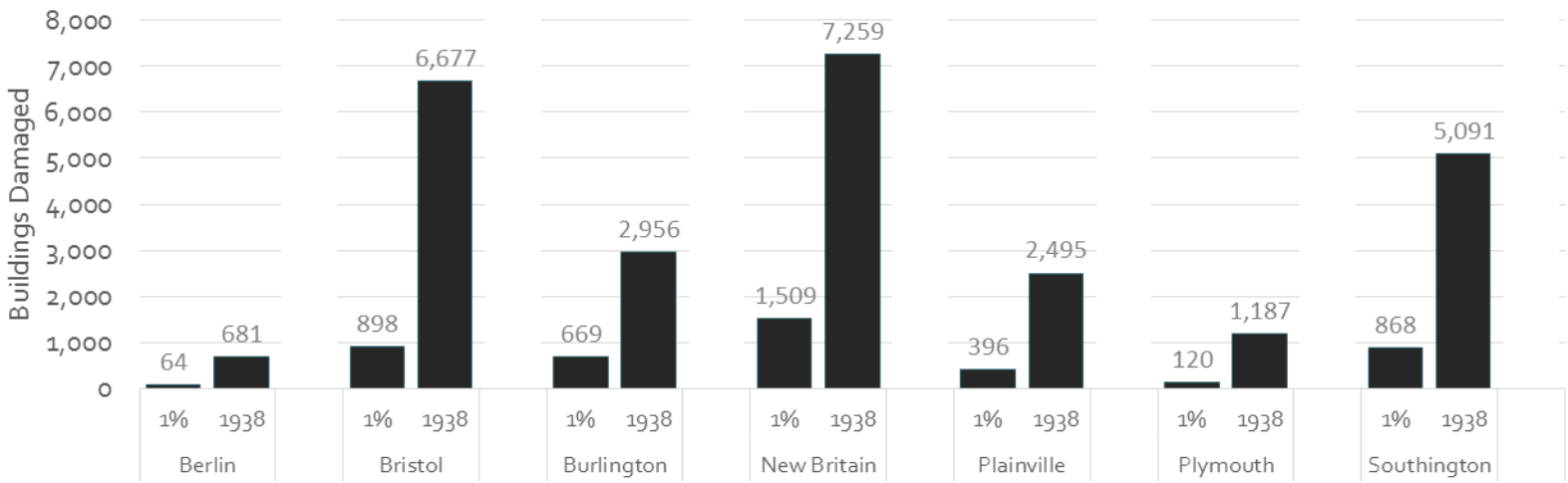


Figure 20 : *Regardless of the storm many of Central CT's buildings are vulnerable to damage of some sort*

September 24, 1942: A tornado touched down in Plainville, destroying a church.

May 21, 1962: An F3 tornado killed one person, injured 45 more, and razed or heavily damaged over 200 buildings of all types in Southington and Waterbury. (Messier, 1962; NCDC; NWS, 1962)

July 21, 2010: An EF1 tornado briefly touched down in Bristol and Plymouth. In Bristol, the Imagine Nation Museum, which was very near the damage path, recorded a wind gust of 67 mph on their anemometer. As the tornado moved through Bristol, it uprooted trees and twisted the tops off others, and left many residents without power. The tornado caused more than $550,000 in damages in Bristol alone. In Plymouth, the tornado left approximately 880 locations without power, and resulted in multiple road and business closures. Neighboring towns also experienced high winds, trees knocked down, power outages, and hail up to one inch in diameter.

Probability

Although these violent storms remain a concern for the state and region, *Table 12* shows that only a small

Estimated total economic impact under a 100 year (1% annual) and 500 year flood (0.2% annual) scenario.

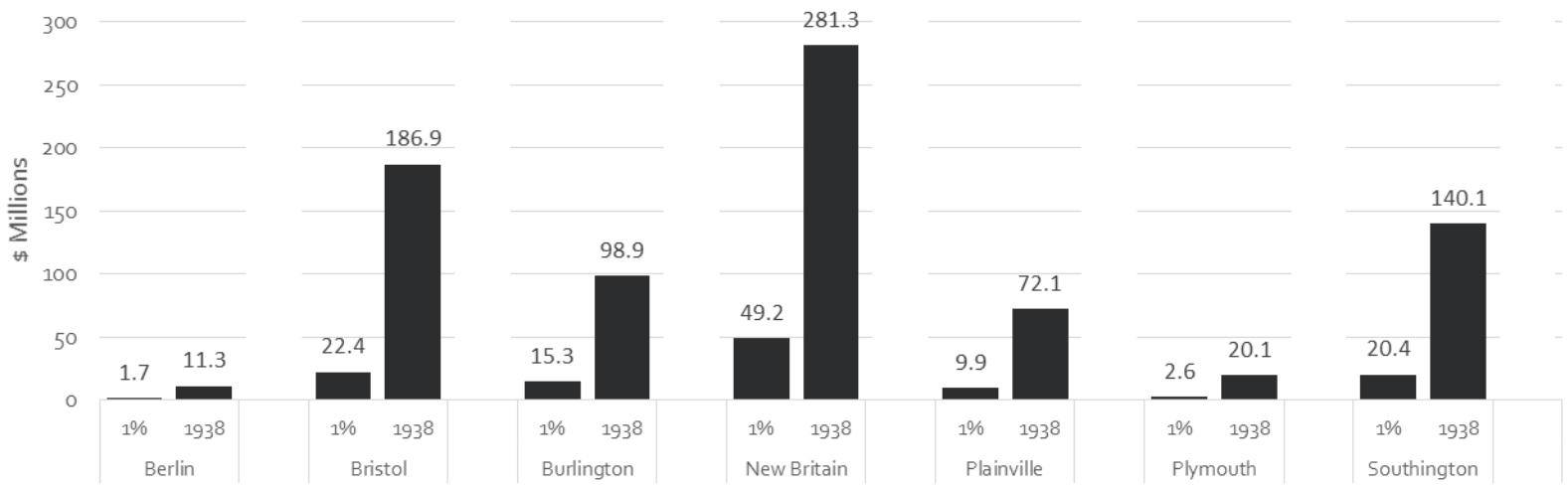


Figure 21: *Each of Central CT's town and cities would suffer economically*

percentage of the storms recorded since 1950 have been classified as F3 or higher.

While Connecticut clearly faces some risk from tornadoes, the nature of the storms makes them unpredictable. All towns in the region share equal vulnerability to these storm, and although property destruction may be unavoidable, loss of life can be minimized through efficient, coordinated response.

Impacts

Although few tornadoes have hit Connecticut and the region, those that have struck the region have had devastating impacts. According to the National Climatic Data Center Database, three people have died as a result of tornadoes since 1951 in Harford County and 541 people have been injured in both Harford and Litchfield Counties. The total property damage from the events since 1951 have cost both Counties a total of $312.83 million over the same time period.

Wildfires

NOAA defines a wildfire as any free burning uncontainable wildland fire not prescribed for the area which consumes natural fuel and spreads in response to its environment. Wildfires can burn and destroy large tracts of land, infrastructure, and personal property. Connecticut experiences three distinct fire seasons: from mid-March to mid-May, prior to leaf-out, when fuels such as grasses, dead leaves, branches and twigs on the forest floor are dried out by the sun; from mid-May to mid-September, depending in precipitation; and from October until the first snowfall, when dead leaves collect on the forest floor. Differences in available fuel and conditions lend different characteristics to fires in different seasons: spring and fall fires tend to spread quickly, burning

Table 11: *Enhanced Fujita scale*

EF Number	3 second gust (mph)
0	65-85
1	86-109
2	110-137
3	138-167
4	168-199
5	200-234

Table 12: *Observed Tornado Intensity in Connecticut*

EF Scale	Count	Percentage
0	17	17.3%
1	53	54.1%
2	22	22.4%
3	4	4.1%
4	2	2.0%

through readily-available fuels on the surface of the forest floor and causing little long-term damage; summer fires burn deeper into the ground and tend to spread less quickly and be more difficult to suppress, they are the most destructive to vegetation.

Historic Wildfires

In the last 20 years, a handful of fires have occurred in the Central Connecticut Region. Statewide droughts in 1999 and 1995 resulted in fires in the region and in other locations in the state. Several fires from the Central Connecticut region were reported on in the *Hartford Courant*:

September, 1995: During a drought, a blaze started in Southington that burned over 25 acres of land for 3 days before being contained. No homes or businesses were affected.

August, 1999: A forest fire burned over 18 acres of woodland along the Berlin/Meriden border for 7 days before being extinguished. The Berlin Fire Chief suspected that the blaze originated from a campfire. No homes or businesses were affected.

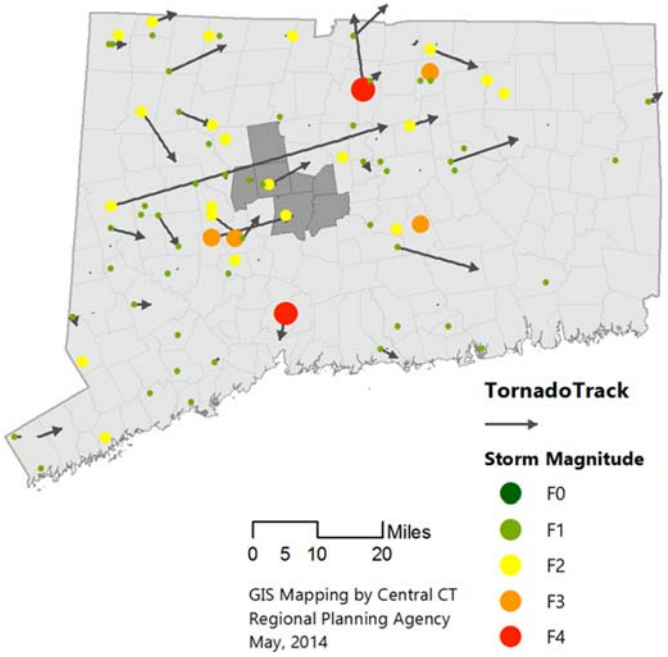


Figure 22: Recorded Tornado tracks and intensities for Connecticut

November, 1999: A blaze on water company land in Burlington and Harwinton burned for 2 days and ranged over 110 acres, 80% of which were in Burlington. The blaze did not threaten any homes or businesses.

Probability

According to the Natural Hazard Mitigation Plan for the Central Connecticut Region, fire risk in the region is roughly the same as in the rest of the state. Within the region, some towns experience a greater risk of wildfire

than others, as a result of differing amounts of forest from town to town. Many of the region's towns are home to tracts of forested land owned by water utility companies; Burlington has by far the most acreage so owned, and is also home to the Nassahegan State Forest. As a result, Burlington's fire risk is somewhat higher than the other towns'.

Impacts

The impacts from wildfires on the region have been minimal. According to statistics reported to the National Climatic Data Center, there have been no deaths or injuries, nor damage to property or crops from wildfires in the region from 1996 to 2013. However some events and statistics may not have been reported.

Drought

There is not a universal definition of a drought. What is considered a drought varies by many factors such as region and season. There are two types of droughts that are a concern in Connecticut: hydrological and agricultural droughts. Hydrological droughts are characterized by low streamflow, groundwater, and reservoir levels resulting from a lack of precipitation over the course of months. Agricultural droughts occur during the growing season due to a lack of adequate precipitation and soil moisture to sustain crops. Both types of droughts can and often do occur simultaneously.

Historic Droughts

According to the Connecticut Drought Preparedness and Response Plan, droughts have occurred periodically in the state. The most recent droughts occurred in 1964-1968, 1981, 1987, and 2002.

Probability

In the northeast, short seasonal droughts lasting one to three months usually occur every two or three years. Longer droughts, with durations exceeding three months, are less frequent and occur every twenty to thirty years. The future frequency of droughts in the region may depend upon the changes in climate and resource use.

Impacts

Drought impacts are typically felt through economic and environmental consequences rather than as a direct risk

to life and property. For example, droughts in Connecticut may destroy crops, affecting farmers and businesses that depend on farming. Droughts may also lead to losses or destruction of fish and wildlife habitat, loss of wetlands, and lower water levels in reservoirs, lakes, and ponds.

In addition, droughts can increase the severity of flooding as land that has been dry for extended periods of time does not allow water to infiltrate as quickly, which may lead to flash flooding.

Earthquakes

Earthquakes occur when two blocks of earth slip past one another; the location directly above it on the earth's surface is called the epicenter. Earthquakes felt in Connecticut and the region often originate and have their epicenter elsewhere; soft soils and filled wetlands conduct energy better than bedrock, and create instances where earthquakes with their centers in upstate New York, New Hampshire, and Massachusetts make themselves felt in Connecticut.

Historic Earthquakes

Connecticut has experienced 136 earthquakes between 1938 and 2009 (see *Figure 23*), all of which had a Richter Scale magnitude of less than 5, the most recent of which occurred in 2011. The following provides information about two notable earthquakes:

May 16, 1791: The strongest earthquake in Connecticut history occurred in East Haddam in 1791, and is recorded with intensity 7. According to USGS, the earthquake, which was felt in Boston and New York City, caused stone walls and chimney tops to fall, and latched doors to open.

October 16, 2012: A magnitude 4.6 earthquake that struck in Maine was felt in Connecticut, including the Central Connecticut Region. However no damage was reported.

Probability

According to the U.S. Geological Survey (USGS), Connecticut is in an area of moderate to low risk for earthquakes. When earthquakes are reported in Connecticut, they have most frequently occurred in the southern and eastern parts of the state (*Figure 24*) Central

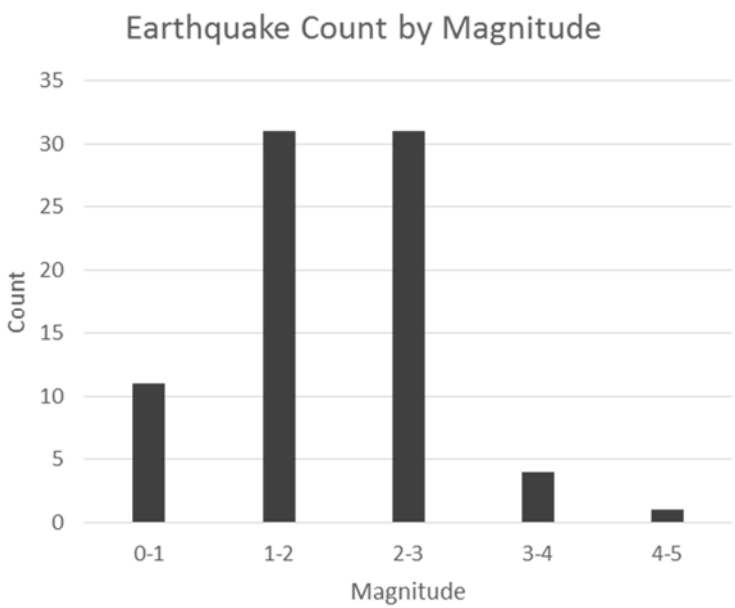


Figure 23: Of the 78 earthquakes with recorded Richter measurements experienced in CT, all had a magnitude of 5 or less , and over 94% had a magnitude of 2 or less.

Connecticut has a 2% chance of seeing an earthquake with peak ground acceleration exceeding 8-10% of gravity in 50 years (corresponding to a return period for an earthquake of this intensity of over 2,000 years). An earthquake in exceedance of 10% of gravity is generally considered one that would damage older dwellings and those not resistant to earthquakes.

Impacts

Of the towns in the region, New Britain would have the highest risk from earthquakes, simply because its buildings and infrastructure are tightly packed and many structures may have been erected before seismic impacts were incorporated into the state building code in 1992. However, due to a variety of factors including distance from fault lines, building types, and settlement patterns, risk to the region in general from earthquake damage is quite small.

A magnitude 5 Earthquake simulation was performed using HAZUS disaster simulation software for the region with East Haddam as the epicenter. Historic earthquakes have clustered around East Haddam and the area also hosts Connecticut's strongest earthquakes, a magnitude 4.4 and 7. The magnitude 5 simulation was performed because Hazus does not recognize earthquakes less than magnitude 5. Earthquakes less than magnitude 5 generally do not cause enough damage to warrant a simulation.

The simulation provide a glimpse into what damage might occur if a substantial earthquake were to occur again within the region again. The total building-related losses were estimated at $36.77 million; 19 % of the estimated losses were related to the business

interruption of the region. The magnitude 5 simulation estimates damage to 1,991 buildings out of approximately 77,000 buildings within the region; of the damaged buildings, 17.6% of them observed moderate or worse damage. In addition to buildings, an estimated 26 homes would be damaged with 19 people requiring shelter services. No power outages are expected. Total economic losses for the region are estimated at $578 million.

Dam Failure

Dam failure is generally caused by other natural hazards: floods arising from thunderstorms, spring thaw, and hurricanes; wind damage from hurricanes and tornadoes; and forces from earthquakes. Failure due to material fatigue is also possible, but regular maintenance and dam inspections can detect leaks and other signs of material fatigue before the problem escalates.

Historic Dam Failure

There has been one dam failure in Central Connecticut:

March 31, 1987: The Kenmere Reservoir Dam (Class C Dam) in Berlin collapsed on March 31, 1987, during a reconstruction effort. According to the Hartford

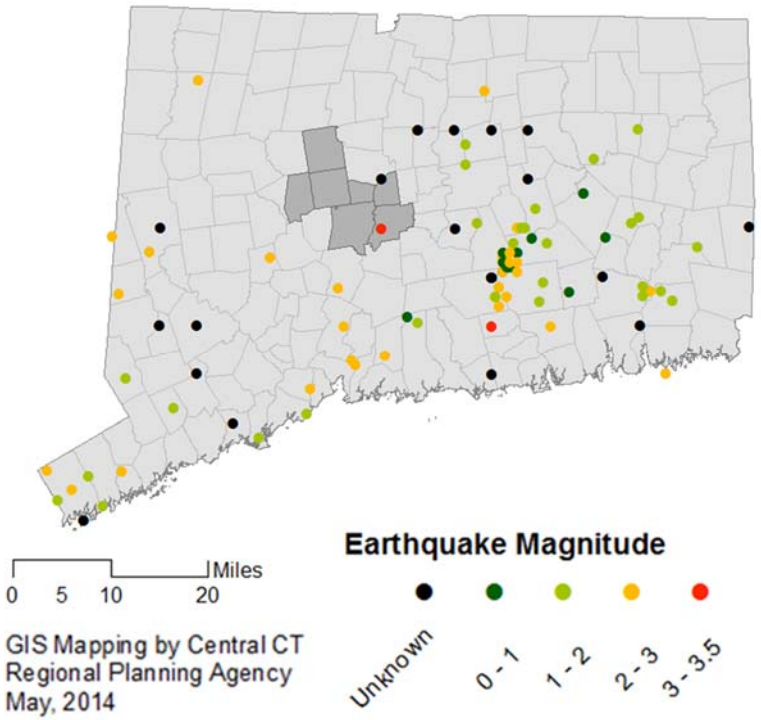


Figure 24: Recorded Connecticut earthquakes.

Courant, torrential rains overwhelmed the dam and sent roughly 80 million gallons of water into surrounding Berlin, where it destroyed a bridge, inundated homes and businesses, and did extensive damage to a municipal golf course. No serious injuries resulted from the dam failure, and the property damage incurred was estimated to be approximately $187,000 (1987 dollars).

Probability

As mentioned earlier dam failures are most likely triggered by the occurrence of another natural disaster and are not likely to occur due to regular maintenance and inspections. Dam failures are less likely to occur than the natural disasters that trigger them. For example, a 100 year flood will not always cause a dam failure.

Impacts

Not all dams pose a serious threat; the vast majority of dams in the state regulate water bodies that, either because of their size or location, would not cause major destruction in the event of a dam failure. The Connecticut Department of Energy and Environmental Protection (DEEP) has created five dam classifications based on hazard potential.

DEEP's list of dams currently has 83% of all dams in the state classified as AA, A, or BB (dam classification can change as a result of downstream development). All dams are subject to inspection by DEEP. Owners of Class B and C dams are further required to prepare Operation and Maintenance Manuals for their dams. All dam owners are obligated to periodically inspect their dams, maintain the

Dam Classification

Class AA: negligible hazard potential dam which, if it were to fail, would result in no measurable damage to roadways, land and structures, and negligible economic loss

Class A: low hazard potential dam which, if it were to fail, would result in damage to agricultural land, damage to unimproved roadways, or minimal economic loss

Class BB: moderate hazard potential dam which, if it were to fail, would result in damage to normally unoccupied storage structures, damage to low-volume roadways, or moderate economic loss

Class B: significant hazard potential dam which, if it were to fail, would result in possible loss of life; minor damage to habitable structures, residences, hospitals, convalescent homes, schools, etc; damage to or interruption of the use or service of utilities; damage to primary roadways and railroads; or significant economic loss

Class C: high hazard potential dam which, if it were to fail, would result in the probable loss of life; major damage to habitable structures, residences, hospitals, convalescent homes, schools, etc; damage to main highways; or great economic loss.

structures and their adjacent areas, keep written records of inspection and maintenance activities, and notify DEEP of major damage.

Of the 142 dams in Central Connecticut, only 19 are Class C. Another 23 are Class B, and the remaining 100 are dams with relatively little potential impact on life or property. The 19 class C dams are distributed throughout the region. Every town has at least one Class C dam, with the exception of Plainville. *Figure 25* shows the location and class of each dam in Central Connecticut

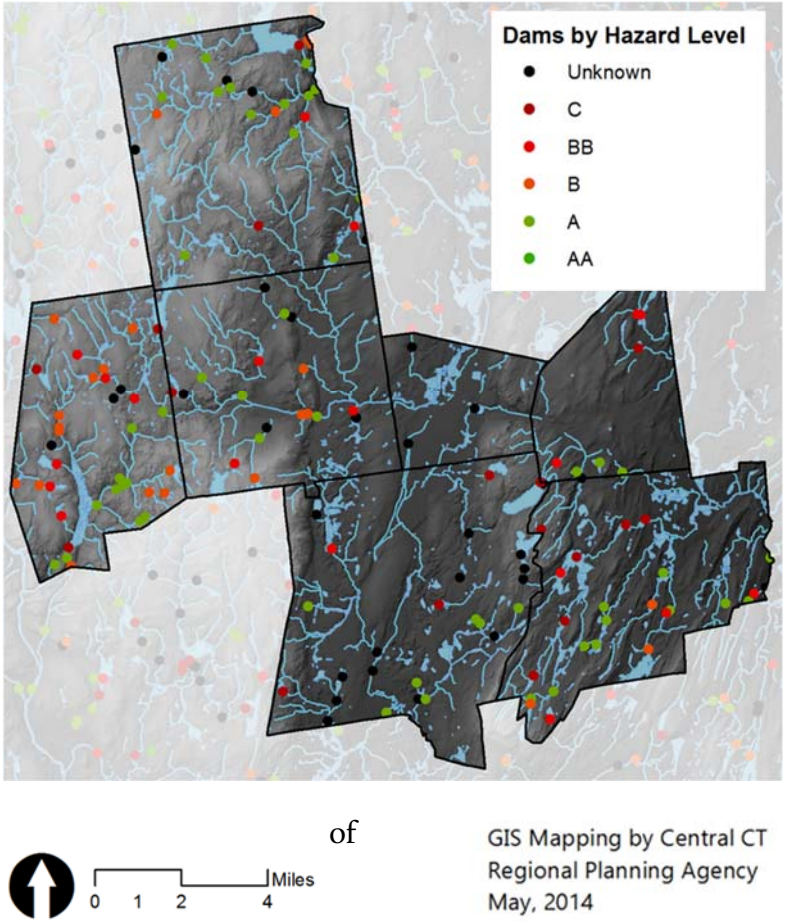


Figure 25: Central Connecticut is home to 142 dams

The three dams in the region with the largest potential for destruction are the Hancock Brook Dam in Plymouth, the Shuttle Meadow Reservoir Dam in Southington, and the Phelps Dam in Burlington. The Phelps Dam, the largest in the region, is an earth and stone structure 1,125 feet in length, which creates the Nepaug Reservoir, an 850-acre water body with a storage capacity of up to 9.8 billion gallons of water (according to the Metropolitan District Commission, which manages the reservoir). Hancock Brook Dam, the second largest dam in the region, is an earthen structure 630 feet long and 57 feet high which is maintained by the Army Corps of Engineers. It creates a 260-acre lake with a 1.3 billion gallon storage capacity. Shuttle Meadow Reservoir Dam, an earthen dam 600 feet long and 30 feet high, creates a 250-acre reservoir with storage capacity of approximately 1.5 billion gallons. The Nepaug and Shuttle Meadow Reservoirs are parts of the public water supply systems

for greater Hartford and New Britain, respectively; consequently their dams impound water on a full-time basis. The Hancock Brook Dam, by contrast, is a flood control dam built and maintained by the Army Corps of Engineers. Hancock Brook Lake, which it creates, is filled only during flood events. The lake detains flood waters and gradually releases them when floodwaters have receded.

Once a dam collapses, the damage it does is largely dependent upon the sorts of land uses surrounding it. While the Kenmere dam inflicted damage primarily upon a golf course, other dams in the region (notably the Shuttle Meadow Reservoir Dam, which overlooks densely developed New Britain) could do far more damage in a collapse. Not only can buildings downstream be inundated by resulting flooding, but they can be damaged by the violent torrent of water as well, which impacts like a battering ram. Utility connections can be severed, in turn causing fires and power outages; people can be injured or even killed by rushing waters and the debris carried therein. Refer to the severity section for Floods for more information.

Man-Made Disasters

While natural disasters have traditionally been the focus of disaster planning and mitigation efforts, recent man-made disasters including the September 11th terrorist attacks, BP oil spill in the Gulf of Mexico, and the oil train derailment in Quebec, highlight the importance of incorporating man-made disasters in disaster resiliency plans. Man-made disasters differ from natural disasters because they originate from human activity and unlike many natural disasters, may be prevented. The following examines three man-made disasters: industrial disasters, terrorism, and cyber attacks.

Industrial Accidents

For the purposes of this report, industrial accidents are defined as large scale incidents caused by a company that affects a large group of people in a given area. They may inflict great damage, injury, or loss of life to people or the environment. Examples include, hazardous material spills, fires/explosions, or building collapses.

Historic Industrial Accidents

Industrial accidents can manifest in a variety of ways ranging from onsite explosions to traffic accident spills. In recent memory there have been a few notable industrial accidents in Connecticut:

1979: The Solvents Recovery Service of New England (SRSNE) operated in Southington as an EPA-approved hazardous waste treatment and storage facility. According to the EPA, "From 1957 to 1967, stillbottom sludges were disposed of in two unlined lagoons. In 1967, sludge disposal was discontinued, and the lagoons were drained and covered with fill. After the lagoons were closed, wastes were burned in an open pit on site or disposed of off site. In the 1970s, the State ordered that the incineration practice be discontinued. Past operating practices, spills, and poor housekeeping are sources of contamination." The contamination from SRSNE affected the groundwater and soil around the site. In 1979, two town wells were closed to reduce residents' exposure to various hazardous chemicals and heavy metals. The Town of Southington Well #4 is located approximately 2,000 feet south of the site, and Well #6 is located 1,300 feet to the south of the site. The facility is also located approximately 500 feet to the west of the Quinnipiac River.

Figure 26: Workers installing a vapor recovery system at the SRSNE site in 2013.

In 1983, EPA settled a lawsuit filed against SRSNE under the authority of the Resource Conservation and Recovery Act. Under the settlement, SRSNE was required to make improvements to its solvents handling procedures; construct a groundwater pump and treatment system to prevent the migration of overburden contaminated groundwater; and install an off-site interceptor system to capture contaminated groundwater beyond the facility boundaries.

February 7, 2010: At the Kleen Energy plant in Middletown a total of 6 employees were killed and 50 were injured when, according to the Hartford Courant "[The] site erupted in fire … while workers were using pressurized natural gas to blow debris out of pipes in preparation for making the nearly completed plant operational. The highly flammable gas ignited, creating a horrific explosion that could be felt 40 miles away." Investigators issued $16.6 million in fines to the companies involved in the plant. At the time it was the third-largest work-place safety fine in US history. (Altimari and Kauffman, 2014)

March 6, 2014: On route 8 in Ansonia, two trucks crashed, including a jackknifed tractor trailer. The tractor trailer was hauling eight 55 gallon drums of spray insulation foam containing a hazardous chemical, and at least two of them began to leak onto the roadway and freeze. Unable to remove the chemical until it melted, emergency crews in hazmat gear had to physically remove the part of the road tainted by the chemical. All the while the road remained closed causing serious traffic delays from around to 2p.m. when the accident occurred to nearly 6 a.m. the next morning. (Duplantier, 2014)

April 3, 2014: In federal court, the personal care manufacturer Unilever, pleaded guilty to two felony violations of the Clean Water Act related to the December 2008 illegal discharge of industrial waste from its now-closed Clinton factory and its failure to report it in a timely manner. The company was fined $1 million and agreed to donate $3.5 million to local environmental programs and to strengthen environmental compliance programs at its U.S. plants. U.S. District Judge Robert N. Chatigny put the company on probation for three years. (Mahony, 2014)

Probability

Industrial accidents often happen at random. While many can be prevented by companies complying with safety and environmental regulations, some are unfortunately unavoidable. However, municipalities can reduce their chances of being severely affected by an industrial accident by ensuring that their zoning helps to protect their residents and natural resources, by allowing for large buffers around industrial zones for example, or

preventing industrial facilities from being built on top of or upstream from drinking water reserves. Ultimately, it is the responsibility of the company and its managers to make all employees aware of safety and environmental protocol to ensure the safety of the workers, the environment, and the members of the surrounding community.

Impacts

There is a wide range of impacts resulting from an industrial accident depending on the type, and with that comes varying levels of severity for the company and the area in which it operates. Loss of life, injury, property damage, contamination, and fines – to name a few – can forever tarnish and company's reputation and affect the community far into the future.

Terrorist Attacks

Terrorism is defined in the Code of Federal Regulations as "the unlawful use of force and violence against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political or social objectives." A report by the Federal Bureau of Investigation (Globalization of Terrorism 1993-2001) states that until the 1990s, terrorist targets were mainly selected for reasons of their vulnerability and symbolism. However during the 1990s, tactics changed; currently terrorist attacks are often aimed at inflicting massive and indiscriminate casualties upon civilian populations.

Historic Terrorist Attacks

While there have been no reported terrorist attacks in Connecticut, there have been several attacks in neighboring states:

February 26, 1993: On February 26, 1993, two men detonated a bomb in truck parked in a parking garage beneath the World Trade Center. The bomb was intended to knock down both the north and south towers, killing thousands of people. While it failed to knock down the towers, the attack killed six people and injured more than a thousand.

September 11, 2001: On September 11, 2001, terrorists simultaneously hijacked four airplanes with the intention of inflicting widespread death and destruction.

Two airplanes struck the towers of the World Trade Center, one plane hit the Pentagon, and the fourth crashed into a field in Pennsylvania. The attacks killed a total of 2,977 people.

April 15, 2013: Three people were killed and at least 264 injured when two bombs exploded near the Boston Marathon's finish line on April 15, 2013.

Probability

While it is difficult to determine the probability of a terrorist attack in Connecticut and in the region, it is important to recognize that Connecticut has several assets that could be targeted. Connecticut is considered a major transportation hub for southern New England. The state has three major highways (I-91, I-84, and I-95), the AMTRAK and Metro North train systems, Bradley International Airport, and three deepwater ports in Bridegport, New Haven, and New London. Connecticut also has a concentration of military bases, defense contractors, a nuclear power plant, and a large pharmaceutical complex. While the state has various assets that could be targeted, none of them are located in the region. Other targets within the region could include municipal offices and water reservoirs. These locations have their own security and anti-terrorism measures.

Impacts

Terrorist attacks vary greatly depending on the perpetrator and the type of target. Therefore it is nearly impossible to predict the impacts on lives and property damage. However given the changing nature of terrorist attacks as reported by the FBI, recent attacks have resulted in many civilian casualties.

In economic terms terrorist attacks and other forms of mass violence impact a region's reputation, increase uncertainty, which reduces investment and burden the local economy by with lost day of work, medical expenses and reduced productivity.

Cyber Attacks

The Department of Defense defines a cyber attack as "a hostile act using computer or related networks or systems, and intended to disrupt and/or destroy an adversary's critical cyber systems, assets, or functions." The Department of Defense goes on to state that "the intended effects of cyber attack are not necessarily

limited to the targeted computer systems or data themselves—for instance, attacks on computer systems which are intended to degrade or destroy infrastructure.....” As municipalities, businesses, and individuals come to rely more and more on computers to maintain and manage daily operations and functions, disruptions caused by cyber attacks can have devastating effects.

History

Over time cyber attacks have grown more frequent and sophisticated. From early viruses and attacks that infected computers and slowed processing speeds, to more sophisticated attacks that stole data and permitted hackers to control sensitive infrastructure, the following provides an overview of some of the significant cyber attacks in Connecticut’s recent history:

2011-2012: Central Connecticut State University experienced a security beach in which the private records, such as social security numbers, of some 18,000 students, alumni, and employees were accessed by hackers.

2013-2014: Hackers who launched a cyber attack against Target stole the personal information of at least 70 million customers, including names, mailing addresses, telephone numbers, and email addresses. It is believed attackers used memory parsing malware to capture the encrypted data as it travels through the computer. Shortly after the attack on Target, retailer Neiman Marcus was also attacked. (Finkle and Hosenball, 2014).

April 2014: In a public address on April 14, 2014, Arthur H. House, chairman of the state Public Utilities Regulatory Authority, reported that many utilities which Connecticut residents rely on for electricity, natural gas, and water have been compromised or penetrated by cyber attacks. While none of these attacks have led to blackouts or any other catastrophe the vulnerability has been identified and the state is working to strengthen it.

Probability

Over the past several years, the number of cyber attacks have been on the rise, affecting municipalities, businesses, utilities, and individuals. The US Department of Homeland Security cyber response team reported the number of attacks grew by 52% in 2012. The energy sector

was the most targeted, with 82 attacks followed by the water industry with 29 reported attacks, chemical plants with 7 attacks, and nuclear companies reported six attacks (Goldman 2013). These represent only the number of cyber attacks that were reported; companies may not report incidents and many of the cyber attacks may go undiscovered.

In April, the State of Connecticut launched a cybersecurity plan to keep utilities safe from an outside attack. Connecticut is the first state to outline a cybersecurity plan in conjunction with the utilities. Electric, natural gas, major water, municipal water, telephone and cable television companies have all cooperated in preparing the report. The utilities are working together to prevent a cyber attack that could lead to loss of water, natural gas or electric power.

Impacts

Impacts from cyber attacks vary depending on the nature of the attack. Some attacks are intended to steal the identity of individuals while others are intended to disrupt utilities. Yet other attacks are targeted at stealing information from businesses. A report from Symantec concluded that attackers may be deterred by a larger company's defenses and may target small business instead. According to the report, attackers "often choose to break the lesser defenses of a small business that has a relationship with the attacker's ultimate target, using the smaller company to leap frog into the larger one." This puts costumer information and trade secrets at risk of being stolen.

In economic terms, cyber attacks can impact a company's productivity or reputation, leading to observed drops in stock values or reduced consumer confidence. The worst case scenario would be the closure of a firm and the accompanying loss of jobs resulting from the shock.

Anticipation , Preparedness Response & Recovery

*The Central Connecticut Regional Planning Agency conducted meetings with town officials, including fire, police, public works, and emergency personnel, representatives from area chambers of commerce, and held a day long workshop for businesses. Through this outreach, CCRPA gathered information about how businesses and towns are anticipating risk and reflecting on past events, what is their current level of preparedness, how will they respond, and what plans tools they have available for recovery.**

The emergency and disaster resiliency framework, as discussed earlier, is divided into four parts: Anticipation and reflection, preparedness, response, and recovery.

A necessary first step is gathering information about what emergency events have occurred and are likely to reoccur. This is the anticipation and reflection phase of the framework. Much like the contents of this report, this includes an analysis of which disasters have occurred and are possible as well as the risks they pose. Risk is not just the likelihood of an event occurring, but also the impacts it may cause. For municipalities, this work is encompassed in by their Natural Hazard Mitigation Plan, which a town or region must have in place to be eligible for FEMA's Hazard Mitigation Grant Program. Here they

*AN ANNOTATED LIST OF RESOURCES PUBLIC AND PRIVATE SECTOR LEADERS CAN USE TO KICK START THEIR PLANNING OR RECOVER IS AVAILABLE IN APPENDIX 1 OD OF THIS DOCUMENT

catalogue all major natural hazards faced by the town. Throughout the process of researching and writing this report CCRPA staff found that municipal staff are most often the greatest source for understanding the local risks. Through their past professional experience, living and working through recent major disasters, they instinctively know where there will be problems and where extra attention will be needed. The hazard mitigation plan is an opportunity for town employees to record their knowledge and experience of past events for others to learn from. For businesses this process can be more localized and site specific. Proprietors need to know what vulnerabilities they face on site and in the surrounding neighborhood. Employees should reflect on their personal situation and anticipate transportation difficulties that might prohibit them from reporting to work.

Preparedness consists of the policy, educational and infrastructural steps taken to plan for disasters and risks identified in the previous step before an event occurs. This requires actors to synthesize the data they have collected and formalize it in actionable projects that reduce their exposure to risk and mitigate the impacts of an emergency event. Within the region municipalities are writing emergency operations plans, adopting zoning ordinances to minimize high risk uses or developments, designating emergency shelters, building new infrastructure and ensuring transportation redundancies. Businesses are creating business continuity plans, training staff, and installing emergency generators. Preparedness is of primary importance because, to a large extent, it is fixed; preparedness cannot be changed once disaster strikes and greatly affects how any organization will perform during recovery.

Response refers to the activities that occur during a disaster. At the municipal level, this includes public warning systems, activation of the emergency operations center, and rescue operations. For businesses, this would include initiating the emergency response plan that outlines actions to be taken in the initial minutes of an emergency or disaster. This also includes ensuring there are resources on site to help protect the facility and its employees from injury.

Recovery is a process; it is dynamic. During this stage business owners and community leaders are reacting and making decisions on the fly to repair their community and businesses and return to normal. The lessons learned by coping with disaster and recovery should contribute to a business or municipality's ability to anticipate risks and contribute to future preparedness through further planning and mitigation steps. (Cutter, 2008) These risk mitigating steps will help municipalities and businesses reduce the loss of life and property during future severe weather events.

This section explores what municipalities and businesses in the region are doing to anticipate, prepare for, respond to, and recover from the impacts of natural and man-made disasters.

Disaster Resiliency in Municipalities

Municipal governments are often at the forefront of disaster preparation, response, and recovery operations. The municipal role includes implementing disaster mitigation measure, developing an emergency operations plan, and educating the public about risks, preparation, response procedures, and recovery resources. While each municipality undertakes this tasks to some extent, their level of involvement, and the specific actions they take, will vary. This sections discusses a few of the activities that municipalities in Central Connecticut tend to undertake.

Anticipation and Reflection

Natural Hazard Mitigation Plan

The primary instrument for informing public leaders and local residents of the risks their towns, cities and the region face is the Natural Hazard Mitigation Plan. The Plan, which must be updated and reapproved every ten years, gives an overview of the risks faced by the region and how they relate to the geography, geology, demography and development patterns of the region to help leaders anticipate risks and review past vulnerabilities. Although the Plan is prepared at the regional level, each town must also provide mitigation goals, objectives and strategies. These strategies must be enumerated in the Plan in order for the municipality to qualify for FEMA's Hazard Mitigation Grant Program, a

major source of funding for mitigation projects and preparedness planning.

Preparedness

Local Emergency Operations Plan

All towns in Connecticut must annually prepare a Local Emergency Operations Plan and submit it to the Department of Emergency Management and Homeland Security (DEMHS) for review. These plans are meant to be applied during an emergency to maximize survival, give direction, integrate departments and expertise, define roles to departments and community leaders, and provide a basis for continued preparation. Specifically the plans identify town personnel and assign responsibilities to each department and its personnel during disasters and emergencies. As part of the plan, instructions are also outlined for activation of the emergency operations center. These plans offer communities an important opportunity to take stock of their level of preparedness and consider any additional steps they can take that may influence their ability to cope and recover.

While DEMHS provides a template for all town to use, many towns decide to use their own format. To improve the State's ability to respond with aide during an emergency event municipalities should strongly consider using the standardized template. The uniform organization allow state level responders to more easily access needed information form a plan they are familiar with.

Supplies and Resources

In recent years many municipalities in the region have acquired or upgraded their generators at key town facilities. For example, Bristol recently upgraded the generator at the senior center so that it can serve as the town's primary shelter. The generator provides enough power to support cooking functions, water, heat, and other basic necessities. In addition to ensuring adequate generator power at shelters, in the past municipalities identified a lack of supplies at shelters as being an issue. To address this, some municipalities have been increasing their on-site supplies of cots, blankets, and other necessities to ensure they can accommodate residents and reduce response time. As part of their

preparation, several municipalities have also engaged in cooperative arrangements and have established a multijurisdictional shelter. For example, Plainville has a multijurisdictional shelter that can be made available to the residents of Bristol if the need arises.

Education and Outreach

Bristol, Burlington, New Britain and Southington have Community Emergency Response Teams (CERT). CERT is composed of volunteers who received training in disaster preparedness and response. Using the training, CERT members are able to assist town personnel and support emergency response functions. For example, in Bristol CERT members are responsible for staffing the emergency shelter when it is activated. In addition, CERT members engage with the community to educate fellow residents about disaster preparedness. They also have a library of resources online that provides information about emergency situations. CERT has been an important resource to residents in the preparedness stage.

While four communities in the region have CERTs and Berlin is in the process of establishing one, those towns that have not yet decided to create one or who are not providing the team with the needed support may be putting themselves and residents at greater risk.

Building and Zoning

Municipalities in the region widely use their zoning and building codes to mitigate the effects of a disaster. To qualify for FEMA insurance, for example, towns must institute flood zones with special building codes that make buildings more resistant to historical flood elevations. Encouraging this sort of neighborhood resiliency is particularly important as studies have shown that the vulnerability of the community surrounding a business has a greater impact on the recovery of the business than internal preparedness efforts. Additionally, zoning boards and administrators can work with municipal emergency planners to better incorporate vulnerability into their zoning codes.

Open Space Acquisition and Low Impact Development

Wetland or flood plain properties have been targeted for acquisition in many of the region's municipalities. Plainville, for example, has been successful in acquiring property on Roberts Street Extension which experiences

repetitive flooding. Several municipalities also encourage low impact development in their zoning regulations. This minimizes the amount of impervious surfaces, reducing surface runoff, and thus lowering the risk of flooding.

Buried Power Lines

Many municipal regulations require utility lines in new developments be placed underground. This has been a critical component in helping to minimize power outages. In Bristol for example, nearly every new subdivision since the mid-1990s has had underground utility lines. And in Burlington, all new construction since 2005 has had underground lines.

Response

Emergency Operations Center

During the actual weather event or disaster, municipalities in the region will activate their emergency operations center (EOC) and Unified Command. The Unified Command horizontally integrates the directors of major stakeholder groups including the Mayor's Office, Connecticut Light and Power (CL&P), water and sewer, the school district, fire department and police department and manages the process of coping with the weather event or disaster. Here the relevant department heads can make decisions on the fly and with the expertise of other stakeholders. Additionally the Unified Command vertically integrates municipal governance with state governance (Department of Emergency Management and Homeland Security) and by extension federal disaster resources (Federal Emergency Management Agency). The EOC is an excellent method of expanding the community's adaptive capacity to respond to a disaster.

Figure 27: Snow was piled into vacant lots after a snow storm in 2013.

Emergency Preparedness and Disaster Recovery Workshop

On April 25, 2014, emergency responders from Connecticut's state and local agencies joined with business leaders for a full-day emergency preparedness and disaster recovery workshop aimed at preparing the state's small businesses and non-profits for the shocks associated with natural and man-made disasters. The workshop, hosted by the Central Connecticut Regional Planning Agency (CCRPA) and Central Connecticut State University's (CCSU) Institute for Technology and Business Development (ITBD), was held in partnership with more than a dozen organizations including the Travelers Institute, Connecticut Light and Power, the American Red Cross, and the City of New Britain, among many others.

More than a hundred small business owners from the region visited the downtown New Britain campus of CCSU's ITBD, where the event was held. Connecticut Governor Dannel P. Malloy and Catherine Smith, Commissioner of the Connecticut Department of Economic and Community Development, participated in the workshop, speaking to business owners about the state's response to recent weather events and the importance of planning for disaster recovery. Attendees listened to panel discussions on short- versus long-term recovery and participated in an emergency preparedness planning exercise. At all levels, experienced experts provided participants with valuable lessons on how to ensure their businesses survive and quickly recover from common weather events that disrupt economic activity.

In preparation for the workshop, special emphasis was put on outreach. Traditional methods that were used promote the event to the local business community, included press releases and email blasts. However, to better reach the targeted audience, the organizing parties relied also on more creative means of promotion. Organizers reached out to local insurance agencies, utility companies, and chambers of commerce to request their cooperation in promoting the event by including the workshop announcement in their mailings. As stakeholders in the resiliency of the community, they willingly and eagerly lent their support.

The workshop served as a first step toward developing a program to assist businesses with their continuity planning. Continuing efforts are being made for an on-going program of shorter, more topical events where business leaders can find the resources and guidance to address targeted questions or walk individually take business leaders through the process of writing a continuity plan. These smaller more frequent events are seen as the best way to maintain awareness and engagement.

Communication

During and immediately following activation of the EOC, the municipality will initiate communication with residents to inform them of the weather event or disaster and provide instructions. The majority of municipalities in the region use the Everbridge system, a reverse 911 system, for emergency notifications to residents. Municipalities will also post notifications on TV and the radio and more recently, have even been using social media such as Facebook as a means to notify residents. One municipality, Burlington, recently purchased and installed a variable message sign on Route 4 by Town Hall that can be used to communicate with residents.

Recovery

Power Restoration and Road Clearing

Immediately following a disaster, the EOC will work with the utilities and appropriate town personnel to coordinate the clearing of debris, reopening of roads, and restoration of power. In terms of power restoration, each municipality has worked with CL&P to identify priority restoration areas. These priority areas, while they differ slightly from municipality to municipality, include restoration to police, fire, and hospital facilities, followed by water, pump stations, and sewer facilities, then government installations including the town hall and government buildings used as shelters. Priority areas also include nursing homes and elderly housing; often restoration to business areas and single family homes is low on the list. Municipalities also work to clear debris and reopen roads as soon as it safe to do so. Roads are often cleared based on their classification, with minor roads having the lowest priority unless they are part of a route to a critical facility, like a hospital.

Funding Assistance

For municipalities or individuals to apply for relief from FEMA two per capita damage thresholds must be surpassed: (1) a state per capita threshold and (2) a county per capita threshold. These thresholds are updated annually and currently the state of Connecticut's per capita damage threshold is $1.39 (or roughly $4,967,994.83 aggregated damages across the state). The per capita damage threshold was $3.50 at the county level, or roughly $3,129,049.00 and $664,744.50 total for Hartford and Litchfield Counties respectively. In

addition, the governor must send a letter to the president requesting that a disaster be declared.

Once a disaster is declared municipalities can apply for public assistance from FEMA. A public assistance categorized as a small project is currently set at $68,500 but is adjusted annually. Small projects provide advantages to the subgrantees, grantees, and FEMA because the projects may be obligated based on estimated costs, which expedites processing of grant funding. Payment of the small project Federal share is made to the grantee even before the subgrantee submits documentation of costs.

If the project is estimated to exceed the maximum threshold for a small project it is considered a large project.

> *"Large project funding is based on actual documented costs. Because of the complexity and nature of most large projects, work typically is not complete at the time of FEMA approval. Therefore, most large projects initially are approved based on estimated costs. Funds are generally made available to the subgrantee on a progress payment basis as work is completed and actual costs are documented. When all work associated with the project is complete, the grantee performs a reconciliation of actual costs and transmits the information to FEMA for consideration for final funding adjustments."*

–Federal Emergency Management Agency. Determination on the Public Assistance Simplified Procedures Thresholds. Fiscal Year 2014 Report to congress Analysis Report for Sand Recovery Improvement Act of 2013. January 29, 2014.

Municipalities would pursue public assistance with the aid of their regional DEMHS representative. All Central Connecticut towns are located in region 3, excluding Plymouth which is located in region 5.

Disaster Resiliency in Businesses

Extreme weather is part of life in Central Connecticut. For this reason, many examples of best practices for disaster resiliency are found in our region. Disaster resiliency planning is a process comprising three parts: preparedness, response, and recovery.

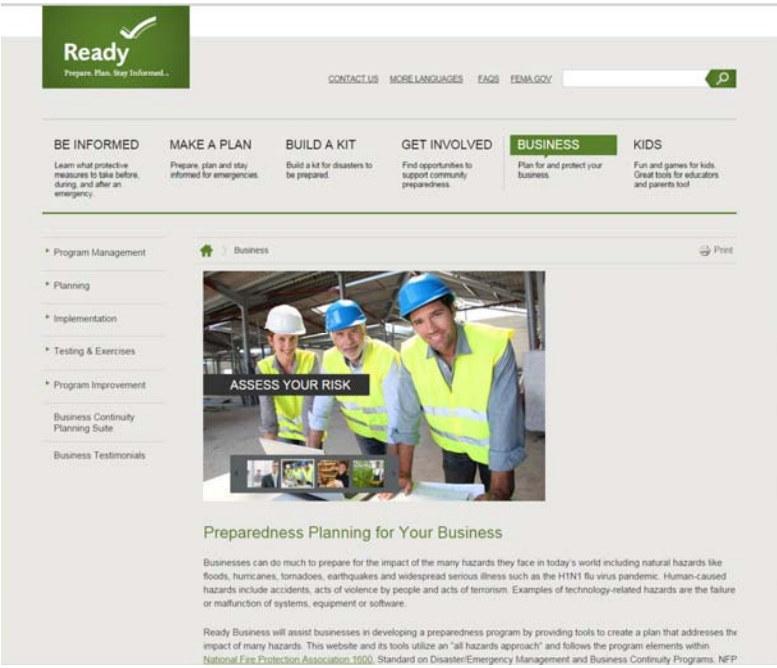


Figure 28: *Ready.gov has a comprehensive guide to emergency preparedness for businesses.*

Although the steps businesses take to improve their resiliency to emergency events will differ from a municipality, the process can be examined using the same framework. Just as for municipalities, preparedness is a fixed state reached by careful anticipation future risk and cannot be adjusted once an emergency arises, response and recovery, however, make up a process that hinges largely on the guile and acumen of local business leaders. This process is therefore subject to change as a situation develops. Ultimately the experience and lessons learned during response and recovery manifest themselves as new mitigation strategies, which are fed back through the planning process to improve anticipation and preparedness for the next event. This section illustrates what local business leaders are doing well, what they can do to improve their preparedness, and where they are still at risk.

Anticipation and Reflection

Just as with municipalities and realistic appraisal of a business's risk is a fundamental first step. All business owners should know if their property is in a floodway or flood hazard zone. They should be asking if have past storms hampered access to major roads through flooding or snow fall? How long have they lost power in the past and has anything been done that would influence the future loss of power. This site specific knowledge will help them prepare.

Preparedness

A disaster can disrupt a business' operations, leading to lost revenue and, in some cases, declining customer confidence. Both have a lasting impact on a firm. A

business continuity plan helps firms prepare for disasters and enables them to recover quickly in order to return to normal operations.

While development of a business continuity plan is important, at a disaster preparedness workshop held by the Central Connecticut Regional Planning Agency in April 2014, only 55% of businesses in attendance had such a plan in place. The workshop also revealed that generally larger businesses were more likely to have a continuity plan in place than smaller businesses, in all likelihood because they have more resources and can assign the task to a staff member. Of the larger businesses represented, those in the field of healthcare were more likely to have a business continuity plan in place.

Among those businesses in the region that are planning for disaster, several reported that they examined their IT infrastructure and decided to move to cloud based services. This protects their digital resources in the event of a disaster and allows them to set up operations in a new location while maintaining access to their data. Other businesses have worked on strengthening their

Figure 29: This tornado touched down in nearby Springfield, Massachusetts, causing severe disruptions to businesses throughout the city's down-town.

buildings, installing backup generators and purchasing their own plows to clear their facilities.

In preparing for an emergency event, exogenous factors are often those with the greatest effect on a business' survival. Businesses that lose water or electricity for an extended period of time, that are unable to ship or receive products because of a hindered transportation network, or that are located in a neighborhood that is severely affected by a disaster - even if their facilities remain operational - have the highest mortality rates. Because these factors are all beyond the scope of a

business' day-to-day operations, they often go unaddressed. Additionally, past studies have shown that preparedness, when limited to endogenous factors, has had little to no effect on resiliency (Webb, 2000).

To improve resiliency, businesses must think beyond their walls and consider what they would do if the roads close, or if power goes out for a week because of network damage across town. Additionally business leaders need to consider working with the business community at large to address these problems. Where economic clusters are concerned there are complementary interests at stake that may incentivize collective action. In addition, the ability of a business to cope with disaster is often interconnected with steps municipalities can take. Therefore the business community and municipalities should work together to strengthen the local economy's resiliency to disaster.

Response

Due to a series of severe storms in the region in recent years, many businesses are taking steps to better respond to risk. This includes planning for emergencies, and ensuring adequate supplies are on hand in the event of a storm. However, it is important that employees be made aware of severe weather or emergency protocols. At CCRPA's disaster workshop, only 37% of business owners were "very confident" that their employees knew what to do in the event of an emergency. Implementing response and emergency plans and training employees will improve businesses' response to disaster.

Recovery

Many factors contribute to a business recovering from a major disaster, many of which are outside of their control. Observed trends from across the nation clearly show that the preexisting condition of firms is usually the most important recovery factor. Larger businesses have better success rates following a disaster. Businesses that were in a weak financial position going into a disaster are less likely to survive. Construction companies generally thrive in the years directly following an event; tourism does poorly. While the services sector suffers, restaurants seem unaffected by disasters - most likely because residents are unable to cook at home and must eat out (Guimaraes, 1993; Burrus, 2002).

It is clear that a business cannot change its size, financial standing or industry once a disaster hits. The recovery process will come down to the wherewithal of the proprietor and a bit of luck. The Small Business Administration makes many financial resources available in the form of low interest loans, as opposed to disaster grants like those given to households by FEMA. However businesses that receive these loans have the same survival rate as those that do not (Webb, 2000). That is, even when a firm has access to outside capital, it is not enough to change their fate. The starkness of this observation further emphasizes the importance of a firm's antecedent condition and the need to develop a business continuity plan.

While businesses in the region seem to be aware of their risk, important yet inexpensive steps can be taken to improve the most crucial part of resiliency: preparedness. This includes completing a disaster continuity plan, informing employees of these plans, and discussing with their local chambers of commerce, trade groups, and municipalities what additional resources may be available for collective use in the event of a disaster.

Looking to the Future: Goals & Indicators

Introduction

Preparing for the next disaster will take a concerted effort by stakeholders throughout the region. That effort will require an action plan that is guided by a set of broad goals and designed to achieve specific outcomes.

This section presents the goals, actions, and indicators that are the heart of this plan. These are not actions that are to be taken solely by CCRPA; they will require a broad coalition of stakeholders to implement. It will take the combined efforts of municipalities, regional organizations, chambers of commerce, state agencies, and individual businesses and people.

Goals & Actions

The region's resiliency goals were developed through interviews with municipal officials, business owners, and a review of previously completed plans and studies. They are broad in nature and represent components of an ideal end-state for the region. Each goals is then used to guide the formation of specific actions that can be taken by the region's stakeholders.

Goal 1: Regional leaders and stakeholders will have a comprehensive collection of data about potential disasters, potential impacts, and specific areas of impact.

Action 1: Create and maintain a statistical profile of the region.

A statistical profile of the region will highlight weakness and mark progress toward resiliency. Since some businesses are affected more severely by interruptions than others and because the recovery of a business is often highly dependent on the recovery of local infrastructure and the surrounding community, a holistic and robust statistical profile of the region is important to understanding economic vulnerability and resiliency. Therefore this profile should include employment characteristics, emergency infrastructure installed, and funding to support the development of new infrastructure, all of which will shed light on municipal economic risk and progress to mitigate the risk.

The statistical profile should include:

- Days of interruption for various events;
- Proprietorship of facilities or site by business owners;
- Average number of employees or business size;
- Businesses by Industry;
- New transportation infrastructure redundancies;
- Job growth;
- New or reinforced infrastructure;
- Recovery dollars received by local businesses;
- Dollars invested by private businesses;
- Grants received by the regional businesses or municipalities;
- Demographic changes
- Shelter capacity by town

Indicators of success

- Frequency of updates
- Percent of indicators updated

Action2: Make the statistical profile available to regional stakeholders in an easy to use format.

Once created, the statistical profile should be made available to a wide range of stakeholders. An initial version of this profile is being included with this

document and will be sent to relevant stakeholders throughout the region, and made available on CCRPA's website. A more robust and easily updated system should be investigated by CCRPA that would allow for web-based presentation and easier updates.

Indicators of success

- Number of "hits" to the website
- Frequency of updates

Goal 2: The region will have a strong network of leaders in the public and private sector who work together to disseminate information and mitigate risk.

Action 1: Develop a regional forum for public and private sector leaders to discuss disaster resiliency and recovery.

Across the region towns will need leadership to ensure goals and policies pass between towns and municipal departments and on to business leaders. At a regional level this may include amending the economic development alliance bylaws to include disaster resiliency.

Indicators of Success

- Increased number of regular meetings of a regional forum for resiliency and hazard mitigation;
- Increased performance in annual EPPI simulation;
- Increased number of economic development boards that also discuss disaster resiliency;
- Increased number of representatives from the private sector that are involved.

Action 2: Support the efforts of local and regional chambers of commerce in becoming resiliency resources for their members.

Many businesses already have established relationships with their Chambers of Commerce, which opens up a potentially opportunity for a Chamber to become a resource for disaster resiliency. Not only could Chambers take the lead in distributing information about disaster, but they can also host services to aid recovery, such as mobile banking and insurance claim centers. By providing these services and letting their members know about them, Chambers can ease the recovery for their members.

Indicators of Success

- Chambers becoming leaders in preparation and recovery;
- Post-disaster events planned and organized before an event is predicted to strike

Action 3: Develop procedures for disseminating information to individuals and businesses in emergency situations.

Communication is an essential component of disaster response and recovery activities. It is important municipalities communicate with residents and business owners both during and after disasters. Some municipalities in the region use reverse calling systems to notify residents of shelter openings. However only residents with registered land lines receive the calls. Other municipalities use social media to update residents, but if the power goes out residents and businesses will have no way of staying in touch. With different communication options available, municipalities should examine ways to best maintain communication with as many residents as possible during disasters. Business owners must also stay informed of changes in the community and be able to effectively communicate with their employees during disasters. They should have a contact list of employees and discuss with employees how they will stay informed.

In addition to communication with residents and businesses, municipalities must also be able to ensure interdepartmental communication. For example the police department in Plainville currently has difficulties communicating with some of the force when they are dispatched to different areas of town due to limitations in radio capacity. In the event of an emergency this could prove very dangerous. Plainville should therefore pursue grants that will help the police department upgrade its system and improve public safety.

Indicators of Success

» Percent of residents signed up for municipal alerts

Goal 3: The region's businesses will be prepared for natural and man-made disasters and recover quickly from them.

Action 1: Create a series of outreach and education events to inform businesses of available resources and assist them with disaster preparations.

Many business owners are unaware of the myriad guides and programs available that may help them better prepare for and recover from disasters. To combat this lack of knowledge, individual towns and the region as a whole could host outreach days and conferences which would introduce business owners to these programs, not unlike the Emergency Preparedness and Disaster

Recovery Workshop that the CCRPA helped to organize in April of 2014. By providing owners with this information, they gain a more comprehensive view of their options and make a plan that best suits their needs.

In addition to resiliency education, hands on workshops to guide business owners through the steps of developing and implementing a business continuity plan might yield positive results. Some business owners may not understand the importance of business continuity planning or they may lack the manpower to prepare and update such plans. CCRPA, in partnership with local chambers of commerce, could host a business continuity workshop which would provide assistance to businesses in preparing a plan. Attendees would learn the components of a business continuity plan and would be provided assistance in preparing a plan. Participants would leave the workshop with completed plans in hand.

Indicators of Success

- Number of events held
- Attendance at events
- Attendees adopting business continuity plans or other preparedness measures.

Action 2: Create an online resource for businesses with information on business continuity planning, emergency preparedness, and disaster recovery.

An online library of resources for various disaster preparation and mitigation measures should be created to allow business owners and other members of the public easy access to information for protecting themselves and their property from disasters. An excellent example of a website providing similar information to its region is GetReadyCapitolRegion.org created by the Capitol Region Council of Governments.

Indicators of Success

- Creation of the website within six months of passage of plan
- Number of resources available
- Number hits to the web site annually

Action 3: Work with local, regional, and state partners to create a grant program to assist small and medium sized businesses prepare business continuity plans.

While many businesses know having a continuity plan is necessary, many simply do not have the resources to devote to creating one. By providing accessible grants for vulnerable businesses to prepare for disasters with, the

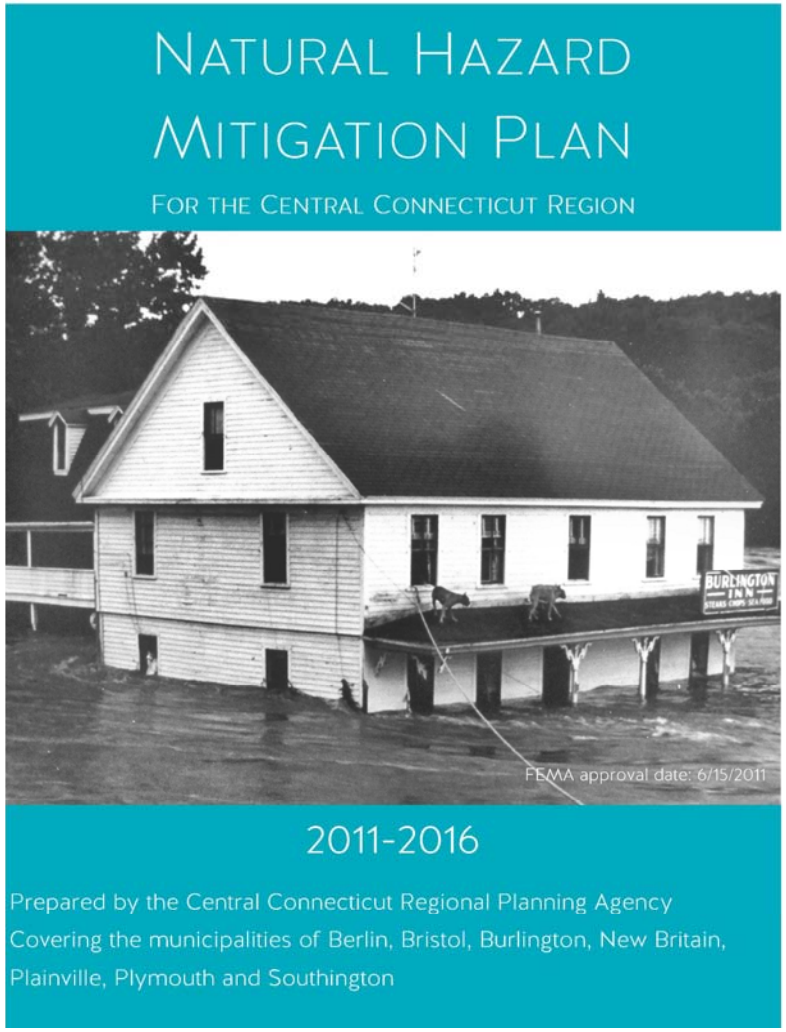


Figure 30: *The Central Connecticut Regional Hazard Mitigation Plan is currently being updated and will include an economic impacts section.*

state or municipality may reduce the costs and resources used to recover from a disastrous event. These grants could allow eligible businesses to hire consultants to evaluate their current preparedness and aid them in the creation of preservative plans, which would reduce damage from disasters and help these businesses bounce back faster.

Indicators of Success

- The establishment of a business continuity planning grant program;
- Small business enrollment in the program.

Goal 4: The region will be prepared for natural disasters through a program of infrastructure hardening, disaster mitigation regulations, and ensuring adequate resources are available for immediate disaster needs.

Action 1: Assess the availability, location, and preparedness of shelters and emergency response facilities.

When planning for disasters, it is important municipalities assess the location of shelters, responders (fire, police, EMS, etc.), and other critical supplies to ensure all residents in the municipality have access to resources during disasters. For instance, there are multiple fire stations located throughout Berlin. This is particularly important because flooding often divides the town, however the location of the fire stations ensures all sections of town are guaranteed to have adequate

coverage. Other municipalities in the region should assess the location of supplies and assets and strategically locate supplies throughout the area to ensure coverage. If this is not possible, municipalities should engage in cooperative arrangements with adjacent municipalities for assistance. Approaching emergency resource distribution form a regional perspective may make financial and logistical sense.

Indicators of Success

- Increased instances of inter-municipal infrastructure sharing;
- Reduced number of neighborhoods that could be cut off from an emergency shelter or responders due to a weather event.

Action 2: Include an analysis of business locations and economic centers in FEMA-approved Hazard Mitigation Plans.

Every municipality must have a FEMA-approved Hazard Mitigation Plan to qualify for federal disaster mitigation assistance. To ensure that economic resiliency continues to be a priority, these plans should include an analysis of business locations and economic centers. This will allow local leaders to identify and prioritize mitigation measures that will increase the resiliency of the local economy. The Central Connecticut Hazard Mitigation Plan is currently being updated and will include a discussion of economic impacts.

Action 3: Use local regulatory authority to ensure that development patterns do not exacerbate vulnerability to natural or man-made disasters.

While municipalities are unable to prevent many disasters, they can mitigate the effects of some disasters, specifically flooding. In many municipalities, flooding is intensified by the increase in impervious surfaces. Therefore to reduce flooding impacts, municipalities should adopt low impact development practices in key areas and encourage the use of pervious surfaces to allow for the absorption of rain water. This will reduce the amount of runoff entering water bodies and thus help reduce flood events. Regulations should also be adopted that restrict the locations of potentially hazardous land uses.

Indicators of Success

- Proportion of new development that utilizes low impact development standards;
- Reduced number of employees in flood zone;

Figure 31: *This road in Bristol was washed out following Hurricane Irene.*

» Reduced number of businesses in flood zone.

Action 4: Work with utilities to seek funding to harden electrical infrastructure in strategic locations.

The region has experienced widespread power outages in recent years. To harden the system and minimize outages, Connecticut Light and Power has undertaken a resiliency program. The resiliency program includes structural hardening where CL&P installs new, stronger utility poles that can withstand severe weather and electrical hardening in which CL&P replaces wires with thicker wire that is more weather resistant. CL&P should continue this work, prioritizing wire replacement and reinforcement in business areas and locations that serve population centers (see the map on Page 18 for suggested locations). Furthermore, while burying wires is expensive, a feasibility study should be conducted of burying wires in key business clusters and downtowns.

Indicators of Success

» Increased miles of new electric lines;

» Increased miles of buried power line.

Action 5: Create a traffic divergence plan for key business areas.

For businesses to return to full operating capacity as quickly as possible following a disaster, it is important plans are put into place to keep roads that serve the businesses open. This plan will allow both workers to reach their jobs and also enable the transport of supplies and goods to and from the businesses. Important routes within the Central Connecticut Region are discussed Geography and Transportation within the Profile of the Region (page 17). Of these critical routes Route 72 has potential for increased disruption in the case of a road failure due to limited traffic divergence options. *Figure 31* displays potential problem sites in the region along with business clusters shown in pink.

A: Travel between Plymouth and Bristol can become problematic if Rt 6 suffers a road failure or wash out. Since the maximum height for freight trucks in Connecticut is 13'6" (CTDOT), if truck traffic is shifted to Rt 72, there is potential for vehicles taller than 13'3" to cause bridge strikes. Current divergence options would push freight trucks onto narrow residential roads, also creating less than ideal driving conditions.

B: Is a critical traffic choke point from Plainville to New Britain. This site includes 3 routes, Rt. 72, Rt. 536, and Rt. 372. New Britain is also an end location for

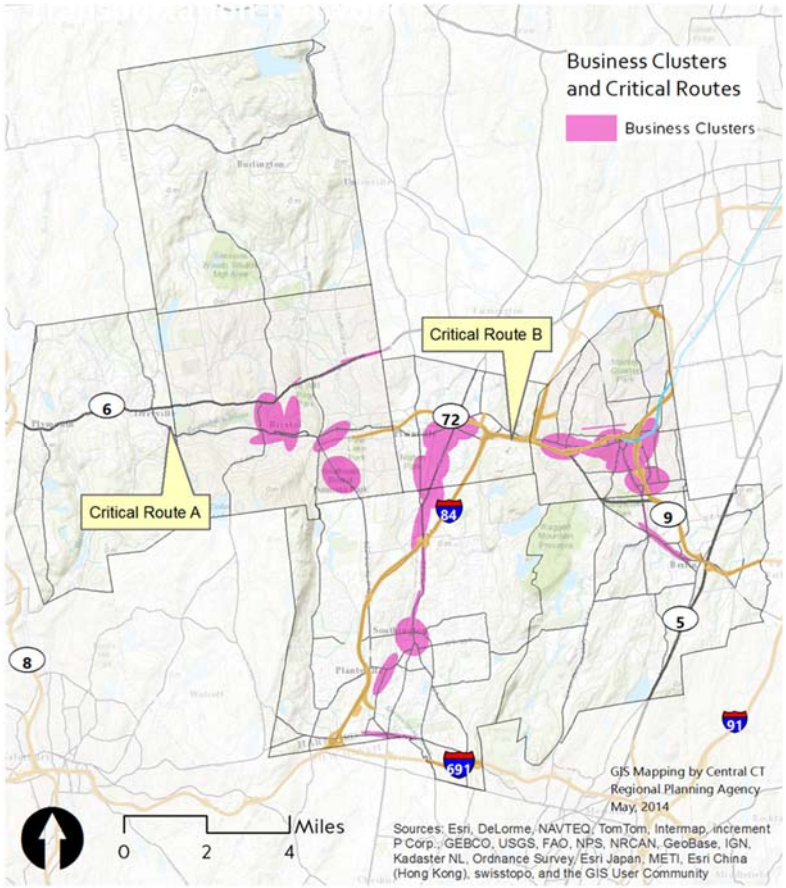


Figure 32: Forced closure of a critical route can cut a business off from its suppliers and customers.

the CT Fast Track. These routes are vital to connect New Britain to the rest of the region.

Action 6: Work with state and regional partners to upgrade, repair, or replace critical transportation infrastructure.

New Infrastructure Recommendations

- The train bridge in Plymouth on Route 72 by School Street should be modified to handle truck heights of 13'6";
- Except Burlington, all towns in the region have access to train tracks. The tracks are a potential alternative transportation opportunity, which could provide freight access for industries in the region.

Action 7: Consider disaster mitigation and resiliency when prioritizing infrastructure projects in the regional Long-range Transportation Plan and Comprehensive Economic Development Strategy.

While many mitigation projects are funded through FEMA grants, other sources of funding are also available. By ensuring that disaster mitigation and economic resiliency are considered when prioritizing projects for other funding sources (such as Surface Transportation funds from FHWA and Public Works funds from EDA), a greater number of projects can be implemented.

Action 8: Seek funding for a regional/municipal mobile incident logging system.

When public works staff are out surveying damage immediately after a storm, a timely response to a dangerous situation can be a life or death matter. It can also significantly reduce damage and lower costs. The region and its municipalities should investigate a mobile incident logging system that response staff can use to send information about downed power lines, fallen trees, flooded buildings, closed roads, and other conditions that develop as a result of a disaster. This system will help responder organize their efforts, reduce redundancy, and track incidents to ensure that nothing falls through the cracks.

Conclusion

While the Central Connecticut region has been fortunate in avoiding catastrophic events, natural and man-made disasters are inevitable, and even small interruptions can gravely impact businesses. From the analysis, it is apparent that there are vulnerabilities within the region that must be improved to ensure business continuity in the face of disasters. With this knowledge, it is imperative that the business owners and the municipalities of the region make a concerted effort to improve economic resiliency in the region. It is the hope of CCRPA that with the previously outlined measures beginning steps will be taken to create a safer and more prosperous region.

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Appendix 1: Resources

The old adage that an ounce of prevention is worth a pound of cure holds true in the field of disaster resiliency. Unfortunately it is often not possible or financially feasible to protect oneself and one's business completely from all forms of disaster. Therefore the list below of free emergency preparedness resources available to all businesses is accompanied by a list of organizations that help in disaster recovery following a natural or man-made disaster. With these resources community and business leaders are able to prepare for the worst and access resources necessary to quickly recover.

Planning Ahead

Ready.gov/business

Launched in February 2003, Ready.gov and its Spanish counterpart Listo.gov are a national public service advertising (PSA) campaigns designed to educate and empower Americans to prepare for and respond to emergencies including natural and man-made disasters. The goal of the campaigns are to get the public involved and ultimately to increase the level of basic preparedness across the nation.

Ready Business will assist businesses in developing a preparedness program by providing tools to create a plan that addresses the impact of many hazards. This website and its tools utilize an "all hazards approach" and follows the program elements within National Fire Protection Association 1600, Standard on Disaster/Emergency Management and Business Continuity Programs. NFPA 1600 is an American National Standard and has been adopted by the U.S. Department of Homeland Security.

The Ready program comprises five steps: program management to organize develop and administer a preparedness plan, disaster and business information gathering to facilitate planning, implementation of a plan, plan testing and disaster exercises, and program improvement based on testing and exercises.

Red Cross ready rating

The American Red Cross developed Ready Rating to help leaders plan for the longevity of their organization. This free, self-guided, service is designed to help businesses, schools and organizations

prepare for emergencies. Ready Rating walks members through an assessment, helping them identify strengths and weaknesses in their current planning. The program then offers tools, tips and best practices to help them improve their level of preparedness. The program is aligned with the federal governments PS-Prep (Private Sector Preparedness standards).

IBHS Open for business

The Insurance Institute for Business and Home Safety created a comprehensive preparedness tool, Open For Business (OFB), and a streamlined version for small businesses (OFB-EZ). Both programs have been designed with the expressed interest of helping businesses prepare for disasters and reopen their doors for business as quickly as possible following a destructive man-made or natural event. Leaders can choose an appropriate level of preparedness by selecting from among the three toolkits: OFB-EZ for small businesses who may not have the time to complete an extensive plan, the OFB Basic toolkit comprising 16 units that can be completed in full or by unit, and the OFB Advanced which addresses the process in six tracks: supply chain, vulnerability assessment, logistics and resources, financial controls and resiliency, incident management and crisis communications, and employee awareness, training and exercises.

Prepare my business.org.

PrepareMyBusiness.org is co-sponsored by the SBA and Agility Recovery Solutions. The site provides business assistance in disaster planning to speed recovery and reduce expenses, educational tools and webinars to engage business leaders in the disaster planning process, disaster testing to ensure businesses and staff are ready for any disaster big or small, and disaster assistance to help businesses find the resources they need following a disaster.

Agility Recovery is a recovery provider that began in 1989 as part of General Electric. They saw a need for businesses to have plans and resources to recover from disasters, natural or man-made. In the beginning, this service was only available to the largest corporations. For a subscription fee, they provide emergency office space with desks and chairs; power generators for businesses; phone and internet connectivity; and computers, printers, servers and fax machines for business of all sizes.

FloodSmart.gov

FloodSmart.gov us the official website of the National Flood Insurance Program (NFIP). Since standard insurance does not cover flooding, NFIP offers protection from the floods associated with hurricanes, tropical storms, heavy rains and other conditions that impact the U.S. In 1968, Congress created the NFIP to help provide

a means for property owners to financially protect themselves. The NFIP offers flood insurance to homeowners, renters, and business owners if their community participates in the NFIP. Participating communities agree to adopt and enforce ordinances that meet or exceed Federal Emergency Management Agency's (FEMA) requirements to reduce the risk of flooding.

Society for Human Resource Management (SHRM)

The Society for Human Resource Management (SHRM) is the world's largest HR membership organization devoted to human resource management. On their website, SHRM has collected several documents on a variety of subjects relating to disasters and business continuity, such as pay, leave, and labor laws, as well as environmental disasters, and an employer's responsibility in the wake of a natural disaster. The website also features examples of severe weather policies and evacuation programs. http://www.shrm.org/communities/volunteerresources/resourcesforchapters/pages/disasterpreparednessresources.aspx

Centers for Disease Control (CDC)

The CDC, while not directly a disaster mitigation organization, provides resources for businesses in the event of an emergency. Their website uniquely focuses on terrorism-related events, and includes emergency management and planning guides, guidance on facility protection, and a list of emergency contacts. http://www.cdc.gov/niosh/topics/emres/business.html

Resources for Recovery

Federal Emergency Management Agency (FEMA)

FEMA's mission is to support our citizens and first responders to ensure that as a nation we work together to build, sustain and improve our capability to prepare for, protect against, respond to, recover from and mitigate all hazards.

Once the governor has declared a state of emergency and requested aid from the president and the federal government both public and individual assistance can be made available. Public assistance is for public entities to engage in emergency and permanent infrastructure work as a direct result of the disaster. Individual assistance it available to households for housing assistance, including rental, repair and replacement assistance caused as a direct result of the disaster. FEMA aide is not given to businesses, *see SBA*. However FEMA has compiled an online library of resources to help businesses better prepare for a disastrous event. The library can be found here: https://www.fema.gov/media-library/resources-documents/collections/357

SBA.gov

The Small Business Administration (SBA) is a United States government agency that provides support to entrepreneurs and small businesses. The SBA provides disaster recovery assistance in the form of low-interest loans to homeowners, renters, private nonprofits and businesses of all sizes.

A combination of 25 homes and businesses must have major uninsured damages in order for SBA physical disaster loans to become available. If this is the case, businesses of all sizes located within the impacted towns can apply for Business Physical Disaster Loans. These low interest loans can be for up to $2 million* for repair or replacement of real estate, machinery, equipment, or inventory.

Once disaster has been declared, businesses of all sizes located within the impacted towns can apply for an Economic Injury Disaster Loan. These low interest loans can be for up to $2 million* for the payment of fixed debts, payroll, accounts payable and other expenses that could have been paid had the disaster not occurred.

*A business may be granted a loan up to $2 million from the two programs combined.

CT Department of Economic and Community Development

The DECD is responsible for the distribution of federal money to individuals in areas impacted by disasters. Through a variety of programs residents are able to request funding to repair and replace structural elements of their home or business, mitigation assistance to elevate houses to reduce risk, grants for working capital, equipment, inventory, training or relocation. DECD also provides grant money to state, local governments and regional planning agencies for infrastructure projects.

IRS

Tax law provisions may help taxpayers and businesses recover financially from the impact of a disaster. Individuals and businesses in a federally declared disaster area can get a faster refund by claiming losses related to the disaster on the tax return for the previous year by filing an amended return.

Assistance includes:

- Able to claim disaster-related casualty losses on their federal income tax return for this year or last
- Taxpayers have until Feb. 1 to file most tax returns or to make tax payments
- IRS will waive usual fees and expedite requests for copies of previously filed tax returns for affected taxpayers

Local organizations:

Central Connecticut State University's Institute for Technology and Business Development (ITBD)

The CCSU ITBD provides business owners with technical training, skill development, industrial modernization, marketing, financial and networking opportunities. In cooperation with the Central Connecticut Regional Planning Agency and Travelers, CCSU ITBD hosted a disaster preparedness and disaster recovery workshop where speakers from Travelers, Connecticut Light and Power, the SBA, the American Red Cross and representatives from the Connecticut state government highlighted plans for more resilient businesses and communities.

Chambers of Commerce

The chambers of the region are committed to helping local business owners find the resources they need to prosper. This includes helping them find assistance and workforce training programs but will vary from one Chamber to another. Local Chambers of Commerce include: the Central Connecticut Chambers of Commerce, the New Britain Chamber of Commerce and the Greater Southington Chambers of Commerce.