3.10: HAILSTORM

2014 SHMP Updates
• Historical and Recent Hail Events and Losses table was added. • Hail damage and events figures were added. • Based on the hazard ranking process initiated for the 2014 update, Hailstorm was ranked as a low hazard.

3.10.1 Hailstorm Profile

Hail is considered a low risk hazard in New York State. According to the NOAA National Severe Storms Laboratory hail can be produced from many different storm types, but typically it is a cascading effect of a thunderstorm event.

Characteristics

Hazard	Key Terms and Definitions
Hail	• *Hail* – A showery precipitation in the form of irregular pellets or balls of ice more than 5 mm in diameter, falling from a cumulonimbus cloud. • *Hail Index* – An indication of whether the thunderstorm structure of each storm identified is conducive to the production of hail. • *Hail Size* – Typically refers to the diameter of the hailstones. Warnings and reports may report hail size through comparisons with real-world objects that correspond to certain diameters.

There are two ideas about hail formation. In the past, the prevailing thought was that hailstones grow by colliding with supercooled water drops. Supercooled water will freeze on contact with ice crystals, frozen rain drops, dust or some other nuclei. Thunderstorms that have a strong updraft that lifts hailstones to the top of the cloud where they encounter more supercooled water and continue to grow. The hail falls when the thunderstorm's updraft can no longer support the weight of the ice or when the updraft weakens. The stronger the updraft the larger the hailstone can grow.

Recent studies suggest that supercooled water may accumulate on frozen particles near the back-side of the storm as they are pushed forward across and above the updraft by the prevailing winds near the top of the storm. Eventually, the hailstones encounter downdraft air and fall to the ground.

Hailstones grow two ways: by wet growth or dry growth processes. In wet growth, a tiny piece of ice is in an area where the air temperature is below freezing, but not super cold. When the tiny piece of ice collides with a supercooled drop, the water does not freeze on the ice immediately; instead, liquid water spreads across tumbling hailstones and slowly freezes. Since the process is slow, air bubbles can escape, resulting in a layer of clear ice.

Dry growth hailstones grow when the air temperature is well below freezing and the water droplet freezes immediately as it collides with the ice particle. The air bubbles are "frozen" in place, leaving cloudy ice.

Hailstones can have layers like an onion if they travel up and down in an updraft, or they can have few or no layers if they are "balanced" in an updraft. One can tell how many times a hailstone traveled to the top of the storm by counting the layers. Hailstones can begin to melt and then re-freeze together- forming large and very irregularly shaped hail. (NOAA/NSSL)

Table 3.10a provides the typical description: diameter ratio regarding hail. Warnings and reports may report hail size through comparisons with real-world objects that correspond to certain diameters.

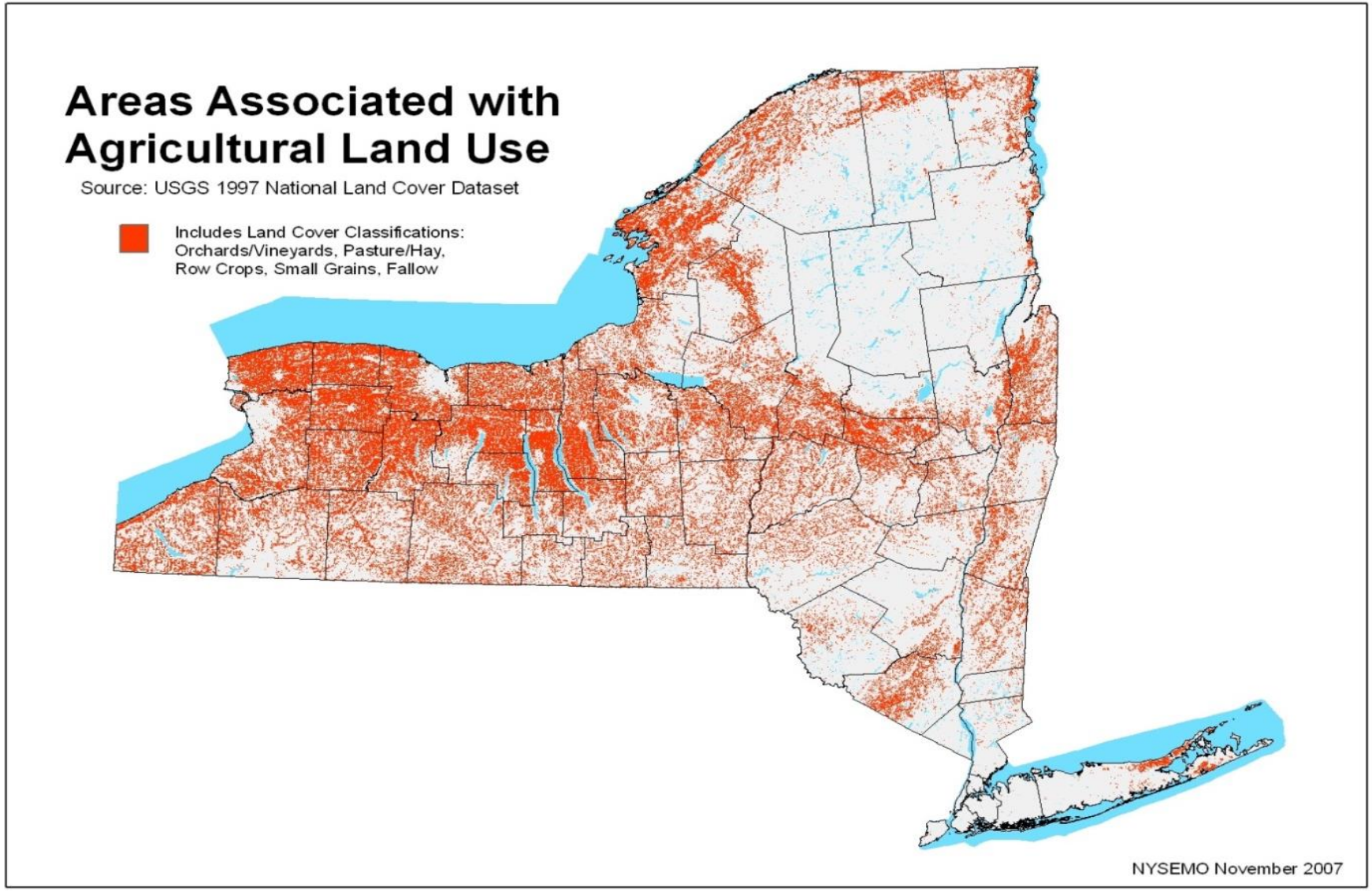
Table 3.10a: Hail Diameter Description

Description	Diameter (inches)
Pea	0.25
Marble or Mothball	0.50
Penny or Dime	0.75
Nickel	0.88
Quarter	1.00
Half Dollar	1.25
Walnut or Ping Pong Ball	1.50
Golf Ball	1.75
Hen's Egg	2.00
Tennis Ball	2.50
Baseball	2.75
Tea Cup	3.00
Grapefruit	4.00
Softball	4.50

Source: National Weather Service

It is estimated that damage from hail approaches $1 billion in the U.S. annually. U.S. Agriculture is typically the most affected by such hailstorms because it causes severe crop damage and even a minor storm with relatively small size Hailstones can have a devastating effect. As well, damage to vehicles, roofs (residential/commercial), and landscaping are the other things most commonly damaged by hail. **Figure 3.10a** portrays the agricultural land use across New York State, was developed in 2007; however, the data set used to create the map was determined to still be valid for the 2014 update. It is recommended that jurisdictions that have agricultural markets and industries take into account the vulnerability of the jurisdiction in regards to the effects of hail. Hail has also been known to cause injuries and occasionally has been fatal. The most deadly hailstorm on record occurred in India on April 30, 1988, killing 246 people and 1600 domesticated animals.

Figure 3.10a: Areas Associated with Agricultural Land Use



Location

Hailstorm events can occur anywhere within New York State independently or during a tornado, thunder or lightning storm event. In comparison to other natural hazards, local jurisdictions ranked hail as a "low" or "moderately low" risk hazard.

Previous Hailstorm Occurrences

New York State Division of Homeland Security and Emergency Services (DHSES) Mitigation staff researched several data sources for historical hailstorm events. According to Spatial Hazard Events and Losses Databases for the United States (SHELDUS), the State encountered 2,320 hail events between 1960 and 2012, causing an estimated total of $33 million in property damage and more than $87 million in crop damage. From 2010-2012 less than half of the counties in NYS were affected by hail events.

Using the historical occurrence, a future probability and average annual losses analysis was determined for hail events. The number of years recorded was divided by the number of occurrences, resulting in a simple past-determined recurrence interval. If the hazard lacked a definitive historical record, the probability was assessed qualitatively based on county history or other supporting data.

Based on a 52 year period historical records found in **Table 3.10b** Historical and Recent Hail Events and Losses, the following can be predicted on average in a typical year in New York State:

- 37 events
- Approximately $1.9 million in property and crop damage combined
- 4 injuries
- Less than .30 fatalities

Table 3.10b: Historical and Recent Hail Events and Losses

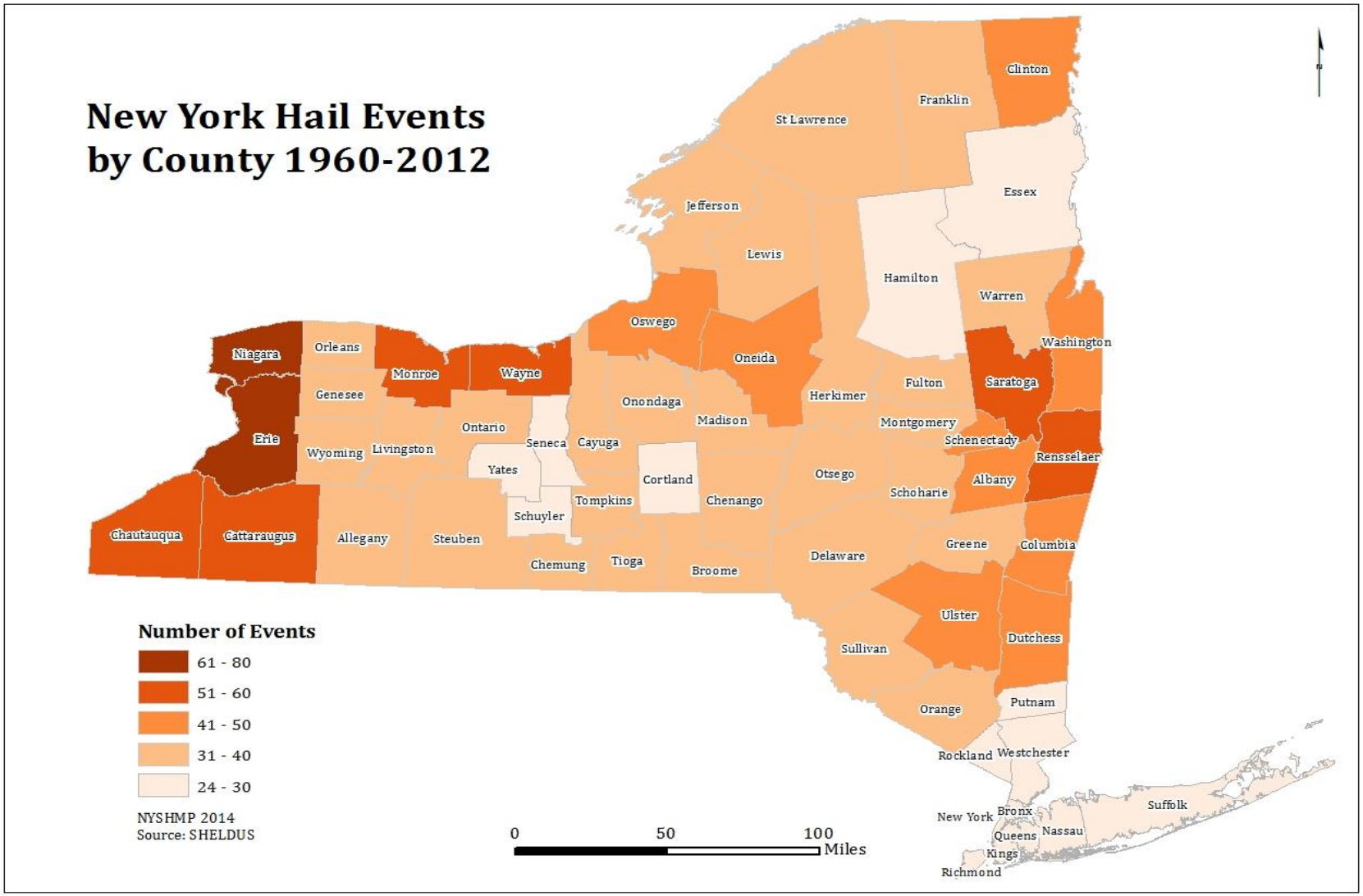
	Historical Record (1960-2012)							Recent Record (2010-2012)				
County	Future Probability %	Recurrence Interval	No. of Events	Fatalities	Injuries	Property Damage	Crop Damage	No. of Events	Fatalities	Injuries	Property Damage	Crop Damage
Albany	81	1	42	0	1	$201,565	$986,301	0	0	0	$0	$0
Allegany	62	2	32	0	1	$118,023	$39,476	4	0	0	$30,000	$25,000
Bronx	50	2	26	0	0	$54,955	$11,896	0	0	0	$0	$0
Broome	71	1	37	0	3	$892,115	$24,987	1	0	0	$250,000	$0
Cattaraugus	104	1	54	0	1	$342,614	$84,567	2	0	0	$20,000	$25,000
Cayuga	77	1	40	0	0	$286,387	$1,079,930	1	0	0	$15,000	$15,000
Chautauqua	112	1	58	0	1	$425,947	$115,234	4	0	0	$28,000	$50,000
Chemung	65	2	34	1	1	$428,532	$4,562	5	0	0	$51,000	$0
Chenango	69	1	36	1	1	$409,275	$21,303	0	0	0	$0	$0
Clinton	81	1	42	0	0	$178,344	$420,813	1	0	0	$50,000	$0
Columbia	87	1	45	1	1	$195,771	$6,510,765	0	0	0	$0	$0
Cortland	56	2	29	0	1	$391,479	$5,928	0	0	0	$0	$0
Delaware	69	1	36	0	1	$425,263	$4,853	0	0	0	$0	$0
Dutchess	88	1	46	0	1	$186,312	$1,102,046	0	0	0	$0	$0
Erie	150	1	78	1	2	$1,349,914	$1,811,567	3	0	0	$20,000	$10,000
Essex	56	2	29	1	0	$80,311	$10,663	0	0	0	$0	$0
Franklin	65	2	34	0	0	$382,591	$27,855	3	0	0	$20,000	$25,000
Fulton	63	2	33	0	0	$144,508	$21,730	0	0	0	$0	$0
Genesee	71	1	37	0	1	$650,997	$10,226,817	0	0	0	$0	$0
Greene	77	1	40	0	0	$255,171	$575,165	0	0	0	$0	$0
Hamilton	54	2	28	0	0	$413,982	$2,793	0	0	0	$0	$0
Herkimer	65	2	34	0	0	$513,203	$55,474	0	0	0	$0	$0
Jefferson	65	2	34	0	0	$408,525	$29,471	2	0	0	$25,000	$0
Kings	50	2	26	0	1	$38,428	$4,261	0	0	0	$0	$0
Lewis	71	1	37	0	0	$389,622	$2,427	2	0	0	$10,000	$0
Livingston	63	2	33	0	0	$153,773	$11,476	0	0	0	$0	$0
Madison	60	2	31	1	0	$335,471	$80,560	0	0	0	$0	$0
Monroe	110	1	57	0	0	$487,773	$960,143	1	0	0	$5,000	$0

	Historical Record (1960-2012)							Recent Record (2010-2012)				
County	Future Probability %	Recurrence Interval	No. of Events	Fatalities	Injuries	Property Damage	Crop Damage	No. of Events	Fatalities	Injuries	Property Damage	Crop Damage
Montgomery	73	1	38	0	1	$172,027	$8,951	0	0	0	$0	$0
Nassau	50	2	26	0	2	$179,208	$4,965	2	0	0	$115,000	$0
New York	50	2	26	0	0	$41,103	$4,521	0	0	0	$0	$0
Niagara	127	1	66	0	1	$1,517,747	$2,675,734	0	0	0	$0	$0
Oneida	88	1	46	3	5	$6,277,292	$257,591	2	0	0	$6,000	$0
Onondaga	69	1	36	0	8	$932,442	$36,736	0	0	0	$0	$0
Ontario	77	1	40	0	0	$329,714	$1,277,611	3	0	0	$18,000	$10,000
Orange	62	2	32	0	3	$877,187	$5,012,446	1	0	0	$750,000	$0
Orleans	75	1	39	0	0	$696,030	$9,085,984	5	0	0	$180,000	$0
Oswego	94	1	49	0	0	$316,986	$123,795	7	0	0	$50,000	$50,000
Otsego	60	2	31	1	2	$334,074	$17,435	0	0	0	$0	$0
Putnam	52	2	27	0	1	$60,520	$6,446	0	0	0	$0	$0
Queens	54	2	28	0	0	$44,428	$4,261	3	0	0	$6,000	$0
Rensselaer	106	1	55	0	152	$2,789,115	$47,351	0	0	0	$0	$0
Richmond	46	2	24	0	0	$34,288	$1,136	0	0	0	$0	$0
Rockland	48	2	25	0	0	$40,470	$4,396	0	0	0	$0	$0
Saratoga	102	1	53	2	1	$388,133	$711,351	0	0	0	$0	$0
Schenectady	81	1	42	0	1	$2,766,321	$8,301	0	0	0	$0	$0
Schoharie	73	1	38	0	1	$200,993	$526,671	0	0	0	$0	$0
Schuyler	56	2	29	0	4	$361,955	$4,874	0	0	0	$0	$0
Seneca	52	2	27	0	0	$68,797	$2,611	0	0	0	$0	$0
St Lawrence	62	2	32	1	0	$370,207	$42,971	1	0	0	$25,000	$25,000
Steuben	63	2	33	0	1	$476,854	$14,739	0	0	0	$0	$0
Suffolk	50	2	26	0	3	$66,223	$4,965	0	0	0	$0	$0
Sullivan	60	2	31	0	10	$182,801	$30,132	0	0	0	$0	$0
Tioga	60	2	31	0	1	$412,963	$35,162	1	0	0	$10,000	$0
Tompkins	63	2	33	0	1	$1,404,863	$4,562	4	0	0	$1,070,000	$0
Ulster	79	1	41	0	1	$128,378	$17,111,496	0	0	0	$0	$0
Warren	73	1	38	0	1	$170,171	$6,301	0	0	0	$0	$0

	Historical Record (1960-2012)							Recent Record (2010-2012)				
County	**Future Probability %**	**Recurrence Interval**	**No. of Events**	**Fatalities**	**Injuries**	**Property Damage**	**Crop Damage**	**No. of Events**	**Fatalities**	**Injuries**	**Property Damage**	**Crop Damage**
Washington	79	1	41	0	0	$413,454	$1,415,751	0	0	0	$0	$0
Wayne	108	1	56	0	0	$896,381	$24,597,611	5	0	0	$21,000	$25,000
Westchester	50	2	26	0	0	$40,720	$4,646	0	0	0	$0	$0
Wyoming	71	1	37	0	0	$188,614	$46,567	2	0	0	$13,000	$5,000
Yates	58	2	30	0	1	$350,338	$55,374	0	0	0	$0	$0

*Source: Spatial Hazard Events & Losses Database for the U.S. (SHELDUS), 2013 (*Future Probability equals the number of events divided by the number of years of record [52], expressed as a percentage.)*

Figure 3.10b: New York Hail Events by County 1960-2012



Probability of Future Hailstorm Events

Hail is a "low" risk hazard in New York State. States that are most vulnerable to hail events are located in freezing levels in high plain areas closer to the ground than at sea level. Nebraska, Colorado, and Wyoming have the most frequent hail occurrences.

Justification for Minimal Vulnerability/Loss Assessment

Hailstorm occurrences are typically localized in scale; and, while past occurrences have resulted in loss of life, the severity is not considered likely to cause a life safety threat to large populations. In addition, there is not a cost-effective method to mitigate future property and crop damage caused by hailstorms. Hailstorm was ranked as "low" with a HAZNY-Mitigation score of 16. Consequently, it is determined that there is not sufficient evidence that Hailstorm has a high level of risk to justify further analysis for the 2014 Plan update.

The information provided in the Risk Assessment sections below serves as guidance for impact and consequence analysis and local hazard mitigation planning.

3.10.2 Assessing Hailstorm Vulnerability and Estimating Potential Losses by Jurisdiction

Table 3.10c provides the annualized losses for hail events. The data used was based on SHELDUS records from 1960-2012, with the exception of hurricane, earthquake, and flood hazards which were derived from Hazus-MH 2.1. For those specific hazards, a probabilistic run was generated to determine the total annual losses for each county found within the State. The information provided by SHELDUS was determined by taking the total economic losses divided by the number of years of record (52) to obtain the losses per year. **Figure 3.10c** illustrates the top ten counties annualized losses with a total of $2,328,811 in hail losses for the entire State of New York.

Table 3.10c: Average Annual Hail Losses by County 1960-2012

County	Hail	County	Hail	County	Hail
Wayne	$ 490,269	Greene	$ 15,968	Otsego	$ 6,760
Ulster	$ 331,536	Schoharie	$ 13,994	Wyoming	$ 4,523
Genesee	$ 209,189	Clinton	$ 11,522	Sullivan	$ 4,095
Orleans	$ 188,116	Herkimer	$ 10,936	Nassau	$ 3,542
Columbia	$ 128,972	Chautauqua	$ 10,407	Montgomery	$ 3,480
Oneida	$ 125,671	Steuben	$ 9,454	Warren	$ 3,394
Orange	$ 113,262	Tioga	$ 8,618	Fulton	$ 3,197
Niagara	$ 80,644	Oswego	$ 8,477	Livingston	$ 3,178
Erie	$ 60,798	Jefferson	$ 8,423	Allegany	$ 3,029
Rensselaer	$ 54,547	Chemung	$ 8,329	Essex	$ 1,750

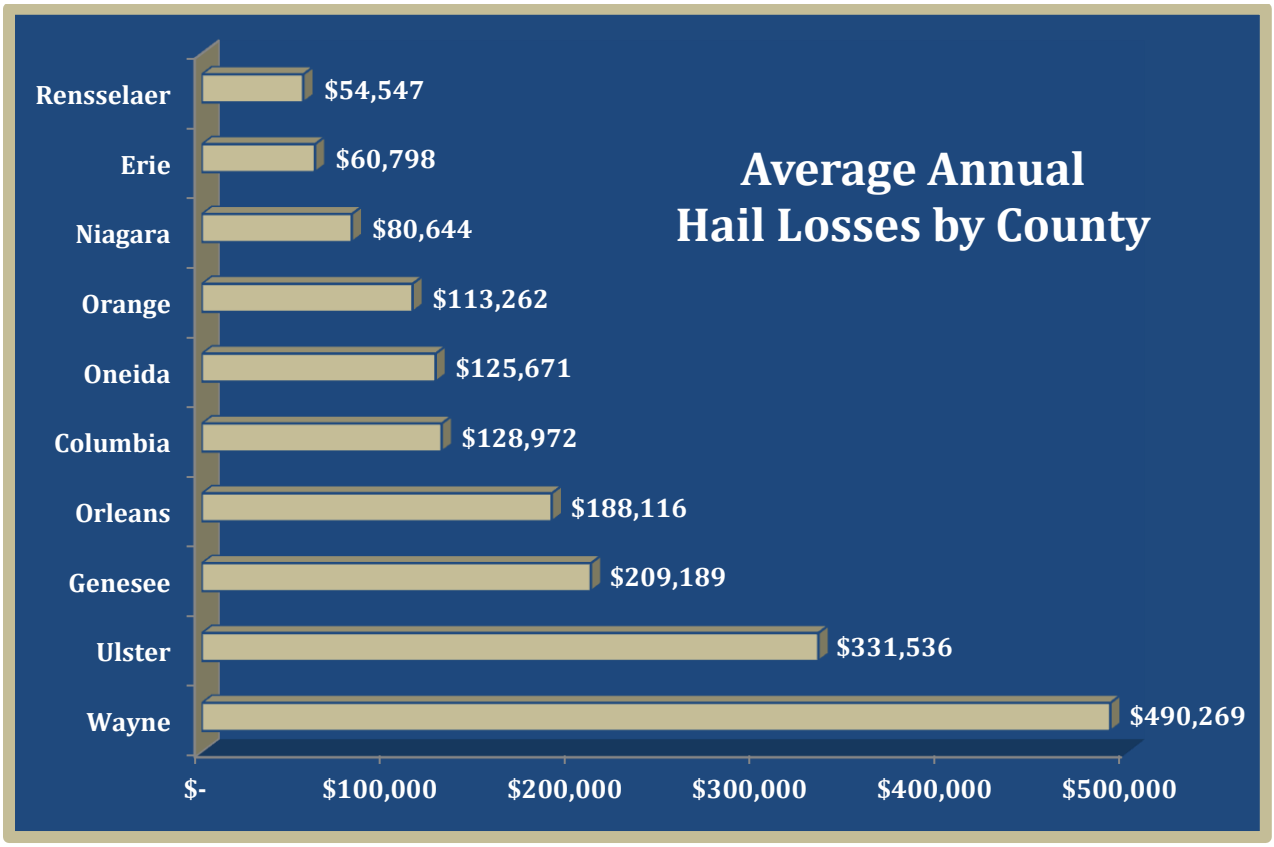
County	Hail
Schenectady	$ 53,358
Washington	$ 35,177
Ontario	$ 30,910
Monroe	$ 27,845
Tompkins	$ 27,104
Cayuga	$ 26,275
Dutchess	$ 24,776
Albany	$ 22,844
Saratoga	$ 21,144
Onondaga	$ 18,638
Broome	$ 17,637

County	Hail
Chenango	$ 8,280
Delaware	$ 8,271
Cattaraugus	$ 8,215
Hamilton	$ 8,015
Madison	$ 8,001
St Lawrence	$ 7,946
Franklin	$ 7,893
Yates	$ 7,802
Cortland	$ 7,642
Lewis	$ 7,539
Schuyler	$ 7,054

County	Hail
Seneca	$ 1,373
Suffolk	$ 1,369
Putnam	$ 1,288
Bronx	$ 1,286
Queens	$ 936
New York	$ 877
Westchester	$ 872
Rockland	$ 863
Kings	$ 821
Richmond	$ 681
Total	**$ 2,328,811**

Source: SHELDUS, 2013

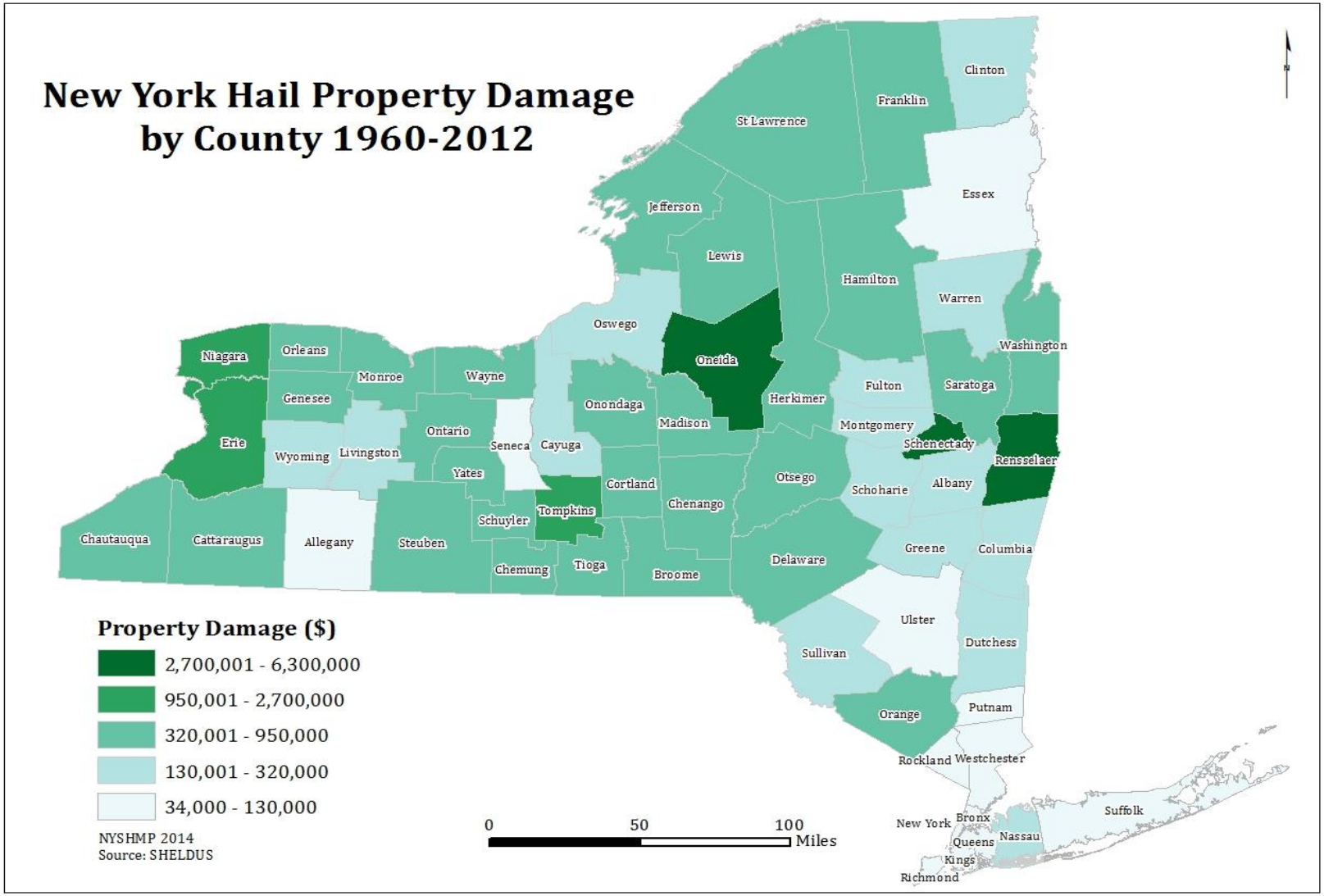
Figure 3.10c: Average Annual Hail Losses by County 1960-2012



Source: SHELDUS, 2013

Over the past 52 years 2,320 hail events occurred throughout New York State. Erie County reported the highest number of events; however, Oneida, Rensselaer, and Schenectady Counties reported the most property damage ranging from $1.5 to $6.2 million in damages according to data provided by SHELDUS. **Figure 3.10d** shows the total cost of property damaged by hail from 1960-2012.

Figure 3.10d: New York Hail Property Damage by County 1960-2012



Based on the historical and recent hail events and losses data assessed by the NYS mitigation planning team all 62 New York State counties have been affected by at least one hail event since 1962. The damage assessment for property and crop is extremely low compared to other natural disaster events that have occurred in the State. The 2014 review of 56 FEMA-approved county hazard mitigation plans indicates that six counties identified hailstorm as a "high" or "moderately high" hazard.

Tables 3.10d: Summary of Hailstorm Hazard Impacts and Rankings by County

Local County Hailstorm Hazard Impacts		
Highest Occurrences	**Highest Fatalities**	**Highest Property Damage**
Erie	N/A	Oneida
Niagara	N/A	Rensselaer
Chautauqua	N/A	Schenectady
Monroe	N/A	Niagara
Wayne	N/A	Tompkins

Source: SHELDUS, 2013

Local County Hailstorm Hazard Rankings	
High	**Moderately High**
Montgomery, Saratoga, Schuyler, and Suffolk	Oswego, Schenectady, and Sullivan

Source: LHMP, 2013

3.10.3 Assessing Hailstorm Vulnerability and Estimating Potential Losses of State Facilities

NYS has no recorded incidence of any damages to state buildings or facilities that have been vulnerable to hailstorms, because they are such a low risk hazard.

Although hailstorms can pose a threat to state buildings, the state has no recorded incidences that damage has occurred; therefore, probability for potential losses to state facilities are insignificant.

3.10.4 Data Limitations and other Key Documents

The Mitigation Plan Development Team researched the hailstorm risk as it affects the State. The contents of this section result from research and outreach including the following sources:

- Federal Emergency Management Agency (FEMA), www.fema.org
- National Oceanic and Atmospheric Administration (NOAA), www.weather.com
- National Severe Storms Laboratory (NSSL), www.nssl.noaa.gov
- National Weather Service (NWS), www.weather.gov
- Spatial Hazard Events and Losses Databases for the United States (SHELDUS)

Please Note: Data obtained from the Spatial Hazard Events and Losses Database for the United States (SHELDUS™). SHELDUS is a county-level hazard data set for the U.S. for 18 different natural hazard event types such thunderstorms, hurricanes, floods, and tornados. For each event the database includes the beginning date, location (county and state), property losses, crop losses, injuries, and fatalities that affected each county. The data derives from the national data source, National Climatic Data Center's monthly Storm Data publications. Using the latest release of SHELDUS™ 12.0, the database includes every loss causing and/or deadly event between 1960 through 1992 and from 1995 onward. Between 1993 and 1995, SHELDUS™ reflects only events that caused at least one fatality or more than $50,000 in property or crop damages.