2.12 SEVERE SUMMER STORMS

Severe summer storms traditionally precede an approaching cold air mass. In the northern hemisphere, the spin of the earth naturally produces weather patterns affecting North America, which travel from west to east across the continent. Key components to the formation of storms are a low pressure zone, high pressure zone and the jet stream.

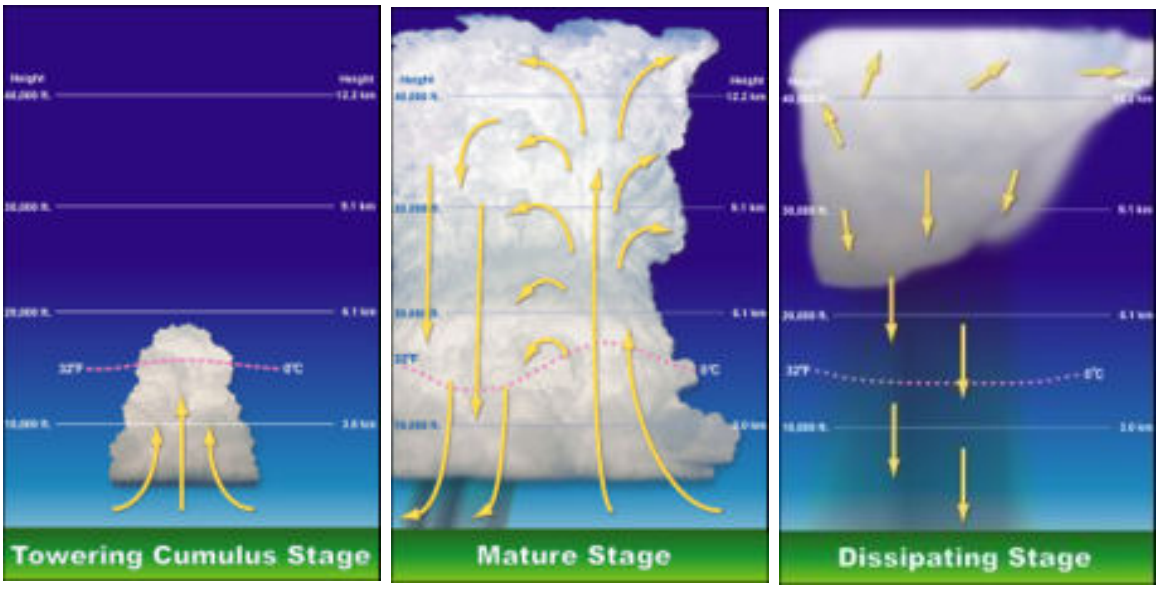
The troposphere is the lowest portion of Earth's atmosphere containing approximately 75% of the atmosphere's mass and almost all of its water vapor. Air at this level is acted upon by the earth surface (land and water) and the heating cycle associated with sunlight. Unlike other portions of the atmosphere which are largely homogenous, at the surface discrete areas or bubbles exist of differing temperature, water vapor content and pressure. Warm areas (low pressure) tend to rise pressing on the borders of surrounding cool areas (high pressure). It is where the pressure zones interface that temperature changes cause water vapor in the air to condense creating percipitation. The warmer the overall temperature of the atmosphere and the greater the volume of water vapor present, the larger the associated perception event.

Jet streams are fast flowing, relatively narrow air currents found in the atmosphere around 11 kilometers (36,000 ft) above the surface of the Earth. They form at the boundaries of adjacent air masses with significant differences in temperature, such as of the polar region and the warmer air toward the equator. These air currents migrate north and south in a snakelike pattern changing their relative location as the planet’s axis tilts with each passing year. These winds act on the high and low pressure zone moving them across the continent and shifting them north and south.

Thunderstorms develop when large differences exist between adjacent zones combined with significant water vapor. As warm air begins to lift, it eventually starts to cool and condensation takes place. When the moisture condenses, heat is released which further aids in the lifting process. If enough instability is present in the atmosphere, this process will continue long enough for cumulonimbus clouds to form, which supports lightning and thunder (see Diagram 2.12.a). As water droplets rise into the colder air, they can freeze. When the velocity of wind becomes great enough, the ice pellets are repeatedly lifted and dropped in the storm adding layers of ice with each cycle. Once the wind cannot support the weight of the ice pellet it falls the ground in the form of hail.

One key component to a thunderstorm is lightning, an atmospheric discharge of electricity. High speed videos (examined frame-by frame) show that most lightning strikes are made up of multiple individual strokes. A typical strike is made of 3 to 4 strokes. The sudden increase in pressure and temperature from lightning produces rapid expansion of the air surrounding and within a bolt of lightning. In turn, this expansion of air produces a sonic shock wave which produces the sound of thunder. Lightning, other storm components, often seeks a path though the tallest object available. Trees, utility line/poles, tall buildings and even humans can be sought as a pathway for the discharging electricity.

Summer storms are considered high wind events by the National Climactic Data Center when surface winds meet or exceed 50 knots or 57.6 miles pre hour. It is possible for winds in strong storms to exceed 100 miles per hours with, gusts even stronger.



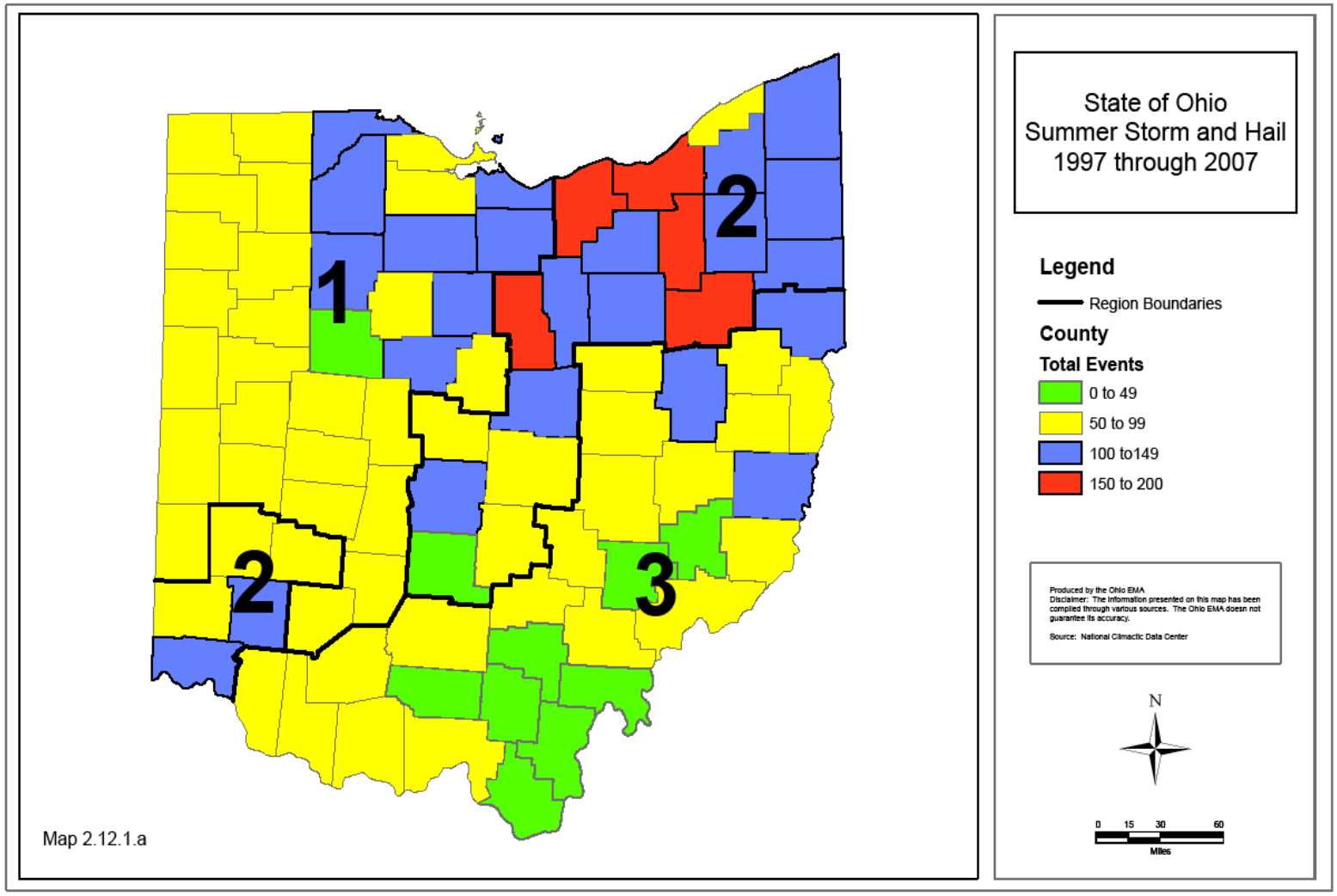
Source: Wikipedia http://en.wikipedia.org/wiki/Thunderstorm

Figure 2.12.a

RISK ASSESSMENT

Location

Severe summer storms and associated high wind / hail events are common throughout Ohio and reported hundreds of times each year. Analysis of number of reported occurrences from 1997 to 2007 by the National Climatic Data Center shows a clear concentration in North-Central and North-East Ohio (see map 2.12.2.1.a) The five counties with the highest number of reported occurrences, 150 to 200 over ten years, are Richland, Lorain, Cuyahoga Summit and Stark counties all in Region 2. Conversely, a concentrated area of low reported occurrences, 0 to 49 over ten years, exists in South-Central Ohio with most in Region 3.


1
2
2
3
State of Ohio
Summer Storm and Hail
1997 through 2007
Legend
Region Boundaries
County
Total Events
0 to 49
50 to 99
100 to149
150 to 200
Produced by the Ohio EMA
Disclaimer: The information presented on this map has been compiled through various sources. The Ohio EMA doesn not guarantee its accuracy.
Source: National Climactic Data Center
N
0 15 30 60
Miles

Map 2.12.1.a

Over one half of the counties in Ohio have between 50 and 99 reported summer storm events over the course of 10 years. These counties are predominantly in the western and central sections of the state. Based on the dispersion pattern generated, it can be reasonably concluded the number of summer storm events in Ohio is influenced by the proximity to Lake Erie.

Past Occurrences

In 2003 the largest recorded event caused $145,000,000 in hail damage to the central Ohio counties of Franklin and Delaware. The area impacted is urbanized with a large number of high valued residences. The largest single county event recorded occurred in 2006 with $100,000,000 in estimated property damage in Licking County. Hail stones 1.75 inches in diameter damaged many homes and vehicles during a 15 minute period. In a similar event the Montgomery County, City of Huber Heights experienced $70,000.000 of damages in 2001. Of the varied forces involved in summer storms, hail is the most destructive.

High wind events are more destructive from the perspective of transportation and utilities. Although the dollar value of the most destructive wind event is reported at $750,000 in Erie county, the downed electric and phone cable along with the inaccessibility of emergency services from uprooted trees and utility poles creates a potentially life threatening situation.

Probability of Future Events

The historical period used for severe summer storm analysis began with April 30, 1997 and closed April 30, 2007 based on statistics tabulated by the National Climactic Data Center. During this period over 5,000 events are documented with over 15,000 documented since 1950. Based on available documented occurrences, severe summer storms are the most prevalent natural hazard events in Ohio.

From January 1997 to August 2007 Ohio has received 19 presidential declarations. Of the declared events, 16 specifically cite severe storms as part of the description. Additionally, the only year Ohio did not receive a federal declaration for severe storm was 1999. Based on past experience, Ohio can reasonably expect at least one storm every two years large enough to trigger a federal declaration, as well as numerous smaller events.

Environmental Impacts

Severe summer storms have little direct impact on the environment. High winds, heavy rains, and hail can damage vegetation and stir up sediment in waterways disrupting the ecosystems.

The impact that severe summer storms have on the environment is through the spawning tornados, flooding, and increased chance of wildfires from lightning strikes. Each of these events then impacts the environment.

VULNERABILITY ANALYSIS AND LOSS ESTIMATION

Methodology

During data development for the thunderstorm/high wind and hail hazard, it quickly became apparent the two must be addressed separately. Hail events, as stated earlier, are far more costly, but also have a much greater financial impact in urbanized areas. Events of the same magnitude can create $10,000,000 worth of damage in an urban setting, or as little $50,000 in forested or agricultural area. Of the 88 counties in Ohio, 22 percent reported no hail loss while 2 counties reported $100,000,000 or more.

The extreme range of the data for hail would skew any useful thunderstorm/high wind analysis. As a result, the vulnerability and loss estimate by county for summer storms considers only thunderstorms/high wind events with hail is addressed by the state as a whole.

The 10-year summer storm losses (1997 to 2007) for each county provided the basis for estimating potential vulnerability and losses. To yield the per capita 10-year damage total for each county, the total damage for the decade was divided by the 2001 population. That figure divided by ten, resulted in the annual per capita damage figure for severe summer storms in each county (in raw dollar unadjusted for inflation). This is the figure that appears in the column on the right.

2.12.3.2 Results

With an annual summer storm loss figure of $1.67 per capita, based on the 2001 population of 11,381,725, Ohio can expect an annual statewide summer storm loss of approximately $19,007,481 in the future. The 10-Year loss includes all residential, commercial, governmental structures, as well as infrastructure and public facilities for each county. Table 2.12.a shows severe summer weather per capita loss.

Table 2.12.a

Estimate of Potential Losses to Summer Storms by Region

Region 1				Region 2				Region 3			
County	2001 Pop.	10-Year Cumulative Summer Storm Losses	Per-Capita Annual Summer Storm Losses	County	2001 Pop.	10-Year Cumulative Summer Storm Losses	Per-Capita Annual Summer Storm Losses	County	2001 Pop.	10-Year Cumulative Summer Storm Losses	Per-Capita Annual Summer Storm Losses
Allen	108,522	$2,307,000	$2.13	Ashland	52,786	$2,476,000	$4.69	Adams	27,225	$768,000	$2.82
Auglaize	46,453	$231,000	$0.50	Ashtabula	102,729	$2,331,000	$2.27	Athens	62,792	$324,000	$0.52
Champaign	39,210	$333,000	$0.85	Butler	335,992	$418,000	$0.12	Belmont	69,605	$539,000	$0.77
Clark	143,969	$380,000	$0.26	Cuyahoga	1,384,252	$5,735,000	$0.41	Brown	43,425	$453,000	$1.04
Clinton	41,277	$1,614,000	$3.91	Delaware	118,215	$367,000	$0.31	Carroll	29,011	$406,000	$1.40
Crawford	46,695	$2,386,000	$5.11	Fairfield	125,109	$479,000	$0.38	Clermont	180,970	$1,181,000	$0.65
Darke	53,178	$482,000	$0.91	Franklin	1,081,784	$915,000	$0.08	Columbiana	111,684	$790,000	$0.71
Defiance	39,195	$218,000	$0.56	Geauga	92,294	$1,735,000	$1.88	Coshocton	36,803	$289,000	$0.79
Erie	79,321	$3,637,000	$4.59	Greene	148,530	$377,000	$0.25	Gallia	30,929	$149,000	$0.48
Fayette	28,387	$291,000	$1.03	Hamilton	838,134	$1,240,000	$0.15	Guernsey	40,899	$849,000	$2.08
Fulton	42,334	$355,000	$0.84	Knox	55,250	$2,663,000	$4.82	Harrison	15,813	$370,000	$2.34
Hancock	71,745	$1,250,000	$1.74	Lake	227,324	$1,827,000	$0.80	Highland	40,875	$300,000	$0.73
Hardin	31,945	$287,000	$0.90	Licking	149,080	$476,000	$0.32	Hocking	28,241	$265,000	$0.94
Henry	29,090	$99,000	$0.34	Lorain	285,798	$4,698,000	$1.64	Holmes	39,539	$2,174,000	$5.50
Huron	59,775	$3,235,000	$5.41	Mahoning	254,810	$1,467,000	$0.58	Jackson	32,743	$567,000	$1.73
Logan	46,115	$241,000	$0.52	Medina	154,718	$2,864,000	$1.85	Jefferson	72,705	$645,000	$0.89
Lucas	454,029	$1,969,000	$0.43	Montgomery	553,579	$671,000	$0.12	Lawrence	62,017	$202,000	$0.33
Madison	40,158	$224,000	$0.56	Pickaway	52,840	$396,000	$0.75	Meigs	22,920	$85,000	$0.37
Marion	65,639	$1,474,000	$2.25	Portage	153,056	$4,405,000	$2.88	Monroe	15,141	$212,000	$1.40
Mercer	40,886	$287,000	$0.70	Richland	128,549	$2,741,000	$2.13	Morgan	14,961	$48,000	$0.32
Miami	99,329	$308,000	$0.31	Stark	378,098	$6,215,000	$1.64	Muskingum	84,783	$461,000	$0.54
Morrow	32,319	$920,000	$2.85	Summitt	542,899	$3,734,000	$0.69	Noble	14,052	$214,000	$1.52
Ottawa	41,036	$5,708,000	$13.91	Trumbull	223,513	$2,432,000	$1.09	Perry	34,212	$254,000	$0.74
Paulding	20,163	$397,000	$1.97	Warren	168,229	$5,035,000	$2.99	Pike	27,982	$137,000	$0.49
Preble	42,344	$310,000	$0.73	Wayne	112,274	$2,759,000	$2.46	Ross	73,437	$424,000	$0.58
Putnam	34,741	$1,138,000	$3.28	**TOTAL**	**7,564,327**	**$53,649,000**	**$28.36**	Scioto	78,428	$271,000	$0.35
Sandusky	61,653	$5,538,000	$8.98					Tuscarawas	91,521	$838,000	$0.92
Seneca	58,314	$2,079,000	$3.57					Vinton	12,953	$68,000	$0.52
Shelby	48,233	$523,000	$1.08					Washington	62,798	$1,321,000	$2.10
Union	40,909	$328,000	$0.80					**TOTAL**	**1,458,464**	**$14,604,000**	**$33.57**
Van Wert	29,432	$503,000	$1.71								
Williams	39,200	$167,000	$0.43								
Wood	121,680	$9,263,000	$7.61								
Wyandot	22,956	$966,000	$4.21								
TOTAL	**2,200,232**	**$49,448,000**	**$84.95**								

The total 10-year cumulative summer storm loss for Region 1 is $49,448,000, which is the highest in the state (annual per-capita of $2.49). Within the region, Ottawa and Sandusky Counties have historically had the highest 10-year loss each exceeding $5,000,000 affecting approximately 102,689 people. Henry County historically had the lowest 10-year loss at $99,000 affecting 29,090 people.

Region 2 has the lowest 10-year cumulative summer storm loss in the state at a total of $53,649,000 (annual per-capita of $1.13). Within the region, Cuyahoga County has historically had the highest 10-year loss at a total of $5,735,000 affecting approximately 1,384,252 people (see Table 2.12.3.2.a). Pickaway County has historically had the lowest 10-year loss at $396,000 affecting 52,840 people.

Region 3 has a 10-year cumulative summer storm loss of $14,604,000, which has affected a population of approximately 1,458,464 persons (annual per-capita of $1.16). Holmes County has had experienced the highest 10-year loss at a total of $2,174,000 affecting approximately 39,539 persons (see Table 2.12.3.2.a). Morgan County has had the least 10-year loss to summer storms at $48,000, which affected approximately 14,963 persons (see Table 2.12.3.2.a).

Hail events cannot be logically assessed by county; however, based on the data, Ohio will experience hail storms generating $25,000,000 or more of damages in developed areas once in a two year period. Predominantly rural areas range from a low of no reported losses in 19 counties to a high of $975,000 in Gallia. Here again the highly sporadic nature of hail events makes county-to-county comparisons misleading. With 2,491 hail events and $463,571,600 in damages over the analysis period, the mean event would cost $186,062. However, the usefulness of such a statistic is highly debatable and is provided for illustration only.

Property damage is not the only loss associated with summer storms and hail. Over the analysis period 13 deaths and 98 injuries were attributed to these events. Of the injuries reported, 20 are attributed to a single event in Franklin County which involved a camp ground.

STATE-OWNED / CRITICAL FACILITIES VULNERABILITY ANALYSIS & LOSS ESTIMATION

Since summer storms are non-spatial hazards and have the potential to affect all state-owned structures and critical facilities in the state, this section defaults to the overall discussion of state-owned structures and critical facilities identified in section 2.1, Table 2.1.a, and Appendix C.