Oklahoma Event Summary

January 28-30, 2002: Oklahoma Ice Storm

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Freezing rain is certainly not uncommon in Oklahoma. Almost every winter storm that visits the state leaves a bit of ice as a calling card, along with the obligatory snow and sleet. Ice storms are a different story, however, especially those of the significant variety. They have struck throughout the state's recorded history, with varying degrees of damage. And it is not unheard of to have two occur in rapid succession. Thus, there was little shock when a year after a devastating ice storm struck portions of southeastern

Figure 1. A beleaguered stand of ice-encrusted trees in Kingfisher, Oklahoma, taken on Feb. 1, 2002.

Oklahoma, the northwestern half of the state suffered the same fate with the late-January 2002 event. As the meteorological conditions evolved, it was evident that the classical ingredients needed for a significant ice storm were coming to fruition. The ice storm pounded the state for little more than 24 hours, but its impacts will be felt for quite some time. The storm left over a quarter-million people without electricity and in excess of $100 million dollars in damages, prompting the federal government to declare over half of the counties in Oklahoma as disaster areas. Repairs to the electric power infrastructure have been estimated in months, not weeks. And yet, even as the cleanup continues, we are left with the knowledge that it could have been worse.

The Storm Approaches

The pre-storm environment was decidedly warm, with unseasonable temperatures being reported in the days prior to the event. The high temperatures, lack of moisture, and high winds resulted in a major portion of Oklahoma being placed under a red flag fire alert. The spring-like conditions allowed the relatively bare soil to begin storing heat, demonstrated by the statewide 5-cm soil temperature map from the Oklahoma Mesonet (Figure 2). The 5-cm soil temperatures in northwestern and central Oklahoma had risen into the mid- 50s by the afternoon of January 28th. The air began to grow colder by the afternoon, however, as a very shallow cold front had crept under the warm air, its southward progress halting in central Oklahoma. Temperatures fell into the 30s in northern Oklahoma, but south of the cold front, temperatures had once again soared into the 70s. The front's shallow nature was evident by the warmth lingering at the Mesonet's higher elevation stations of the western Oklahoma panhandle, Kenton and Boise City

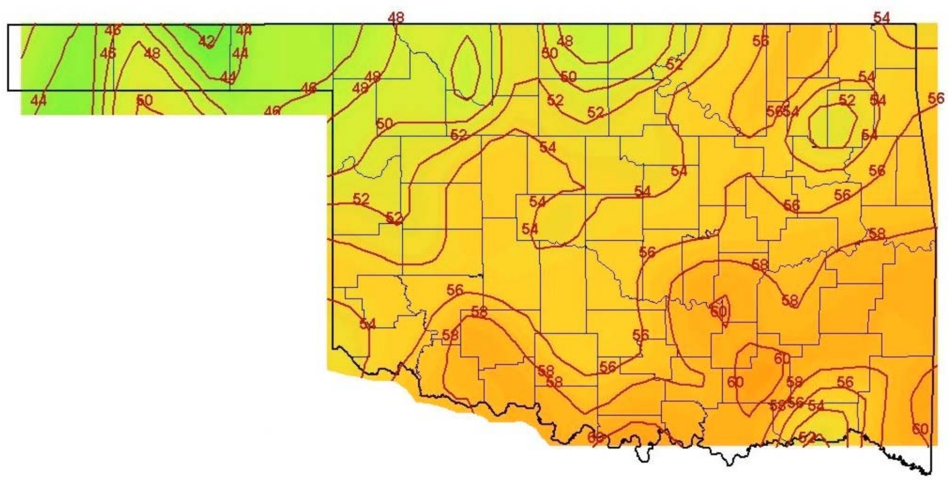

Figure 2. The 5-cm soil temperature values for 1 p.m. on January 28th from the Oklahoma Mesonet.

(both in Cimarron County), as shown in Figure 3. A push of more frigid air began overnight and into the afternoon hours of the 29th, dropping temperatures below freezing from Oklahoma City northwestward. Precipitation began falling in earnest the evening of the 29th, after elevated surfaces had cooled sufficiently, allowing the liquid precipitation to freeze instantly upon contact and begin accumulating.

The warm weather of the pre-storm environment kept ground temperatures unseasonably high, preventing the large-scale travel problems customary with significant ice events. However, it also provided an important ingredient in the genesis of a significant ice storm, rather than an ordinary rain-sleet-snow event.

The key ingredients for a significant ice event are:

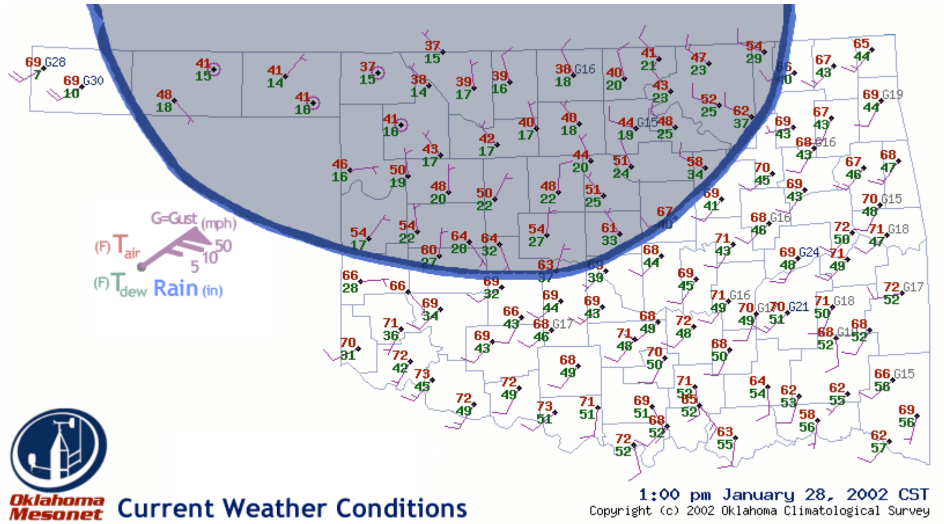

Figure 3. Weather conditions from the Oklahoma Mesonet at 1 p.m. on January 28th. Air temperatures (degrees F) are in red to the upper left of each station model. Approximate southward progression of cold air is shown in the shaded region.

1. A deep layer of moisture above the surface for the formation of precipitation.
2. A layer of warm air aloft, allowing for liquid precipitation.
3. Cold air at the surface, so rain will freeze on contact.

The 6 a.m., January 30th sounding from Norman exhibited classic ice storm characteristics (Figure 4). A deep layer of warm, moist air above the surface was present, so the potential for liquid precipitation existed. In fact, with saturated air at a temperature

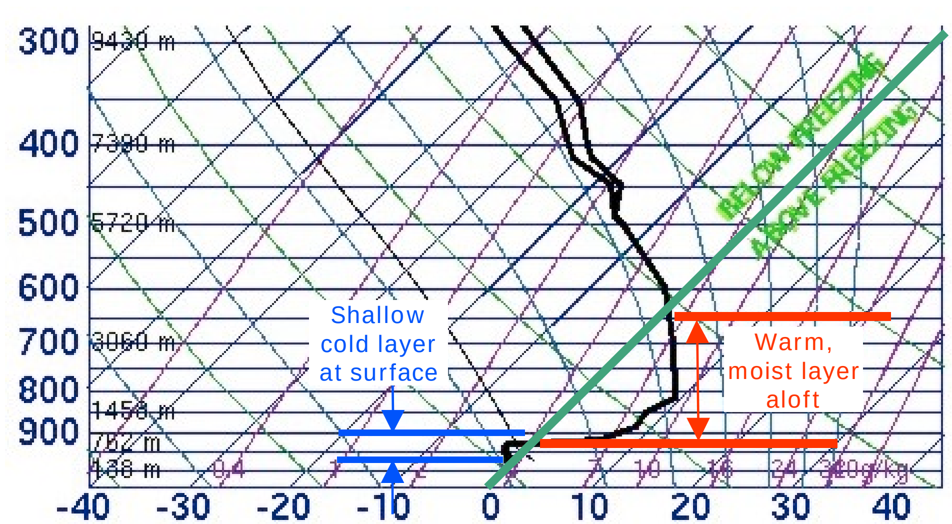

Figure 4. Sounding taken at Norman, Oklahoma, at 6 a.m. on January 30th.

close to 50 degrees at about 5,000 feet above the surface, heavy rain was likely. Add to that a 1,330-foot-thick layer of below-freezing air close to the surface, and all the criteria for a significant icing event were realized. While Norman did not receive any ice due to above-freezing surface temperatures, it was a different matter altogether 50 miles to the northwest, where the surface temperature was below freezing for the duration of the event. As liquid precipitation fell through the freezing layer, it became supercooled, freezing upon contact with elevated surfaces at ground level (i.e. power lines, tree limbs).

A large amount of precipitation fell between the 29th and 30th. Storm-total rainfall from the Oklahoma Mesonet (Figure 5) indicates the severity of the ice storm. The hardest hit areas, a broad swath from Elk City to Pawhuska, running from the southwest to northeast, picked up as much as 3 inches of rain. This contributed to ice accumulations averaging 1-to-2-inches-thick across north- and west-central Oklahoma, with some local accumulations between 4 and 6 inches. Oklahoma City shattered its previous record for January 30th rainfall with 2.13 inches, breaking the previous record of 1.34 inches of liquid precipitation set back in 1982.

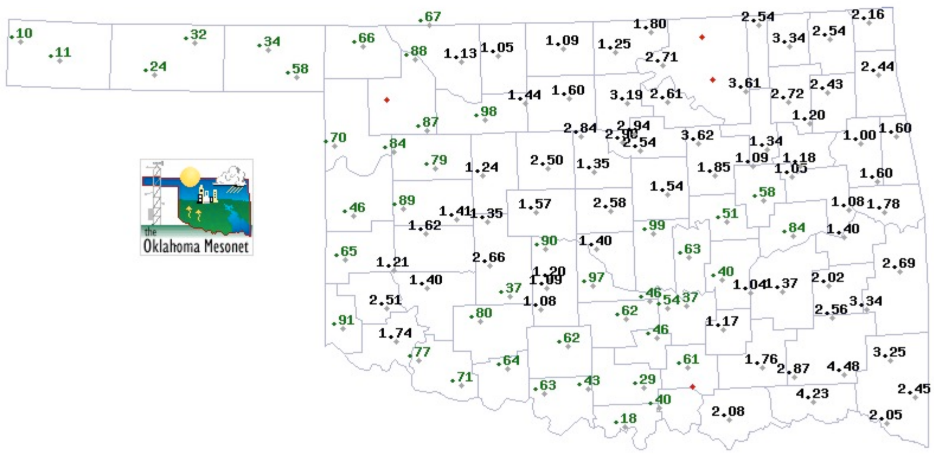

Figure 5. Storm-total rainfall (inches) from the Oklahoma Mesonet for January 29th through January 31st. Amounts greater than 1 inch are in black.

The weather's fickle nature can be demonstrated by observing the fortunes of two closely-located communities: El Reno and Norman. Meteorological conditions at the two central Oklahoma cities were very similar on the evening of the 29th and throughout the day on the 30th, with one small exception: the surface temperature. That small difference in surface temperature resulted in vastly different fates for the two communities. Temperature traces from January 30th for the two locales are presented in Figure 6. Both stations received approximately 1.5 inches of rain in the same 24-hour period. However, at El Reno, where temperatures were below freezing, the liquid precipitation froze instantly on elevated surfaces, resulting in severe tree and property damage and downed power lines and utility poles. Two-thirds of this community of 16,000 was without electricity for several days. In contrast, Norman temperatures hovered between 32 and 33 degrees for much of the same time period, dropping below freezing for only a few hours after the rain had lessened. Thus, Norman was spared the catastrophic damage suffered by its neighbor. This same scenario played out across southwestern, central, and northeastern Oklahoma for the duration of the ice event. To

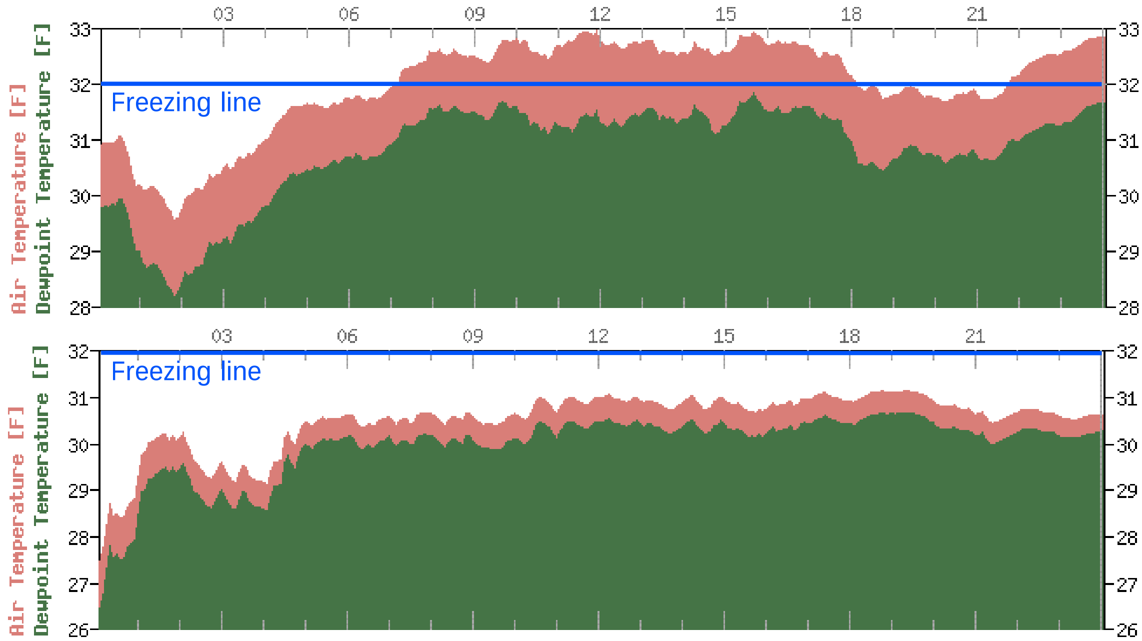

Figure 6. Temperature traces for Norman (top figure) and El Reno (bottom), Oklahoma, for the 24-hour period ending at 11:55 p.m. on January 30th. The freezing line (32 degrees) is marked in blue.

the northwest of the freezing line, accumulating ice and devastation was the norm. Meanwhile, to the southeast, a much-needed soaking rainfall was the predominant experience. The position of the boundary between sub- and above-freezing temperatures at noon on the 30th, as shown in Figure 7, is indicative of the separation between damaged and undamaged locales. Tulsa residents dodged the ice storm's bullet by spending the majority of the storm's stay on the southeast side of the freezing boundary. If the surface temperatures in the state's second most populous city had dropped below 32 degrees, damage and power outage figures would have increased dramatically.

As the upper level storm system that spawned the ice storm began to travel to the east, an

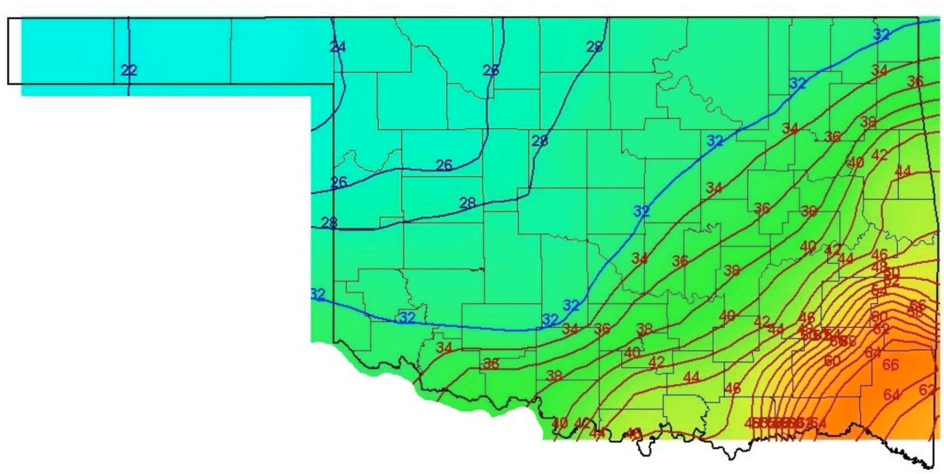

Figure 7. Oklahoma temperatures from the Oklahoma Mesonet at 12 p.m. on January 30th. The freezing line is shown in blue.

expected second bout of heavy freezing rain did not develop. Indeed, even as precipitation ended late Wednesday evening, much of Oklahoma braced for another round of freezing mayhem from the skies. The National Weather Service office in Norman issued heavy-snow and ice storm warnings for overnight on Wednesday. Instead, only intermittent bouts of freezing precipitation fell as a dry incursion of air halted any widespread precipitation.

The Aftermath

This powerful winter storm wreaked havoc on the northwestern half of the state, and none suffered more than the state's power suppliers. The storm left over $100 million of damage in its wake, leaving some 255,000 residences and businesses without power. A week after the icy system exited the state, 39,000 Oklahoma residents were still in the dark as utility companies worked around the clock to replace snapped poles and downed power lines. Enid, a city of 47,000, was entirely without electricity for days. Power companies estimated that power could be lost for up to two months in some rural areas of northwestern Oklahoma. Southwestern Oklahoma State University in Weatherford closed its doors for only the 4th time in its 100-year history. The Oklahoma Association of Electric Cooperatives reported over 31,000 electrical poles destroyed due to the ice. With about 20 poles per mile on an average electrical supply line, that results in over 1,550 miles of destroyed power supply capabilities, enough to stretch from Oklahoma City to New York City. Electric power was not fully restored to all Oklahoma City residents until February 10th, 11 days after the brunt of the ice storm exited the region. Three weeks after the event, 2,320 customers remained without power.

The hardest hit areas of the state occurred along a corridor from west- through north-central Oklahoma (see Figure 8). Most of these areas received an inch or more of ice

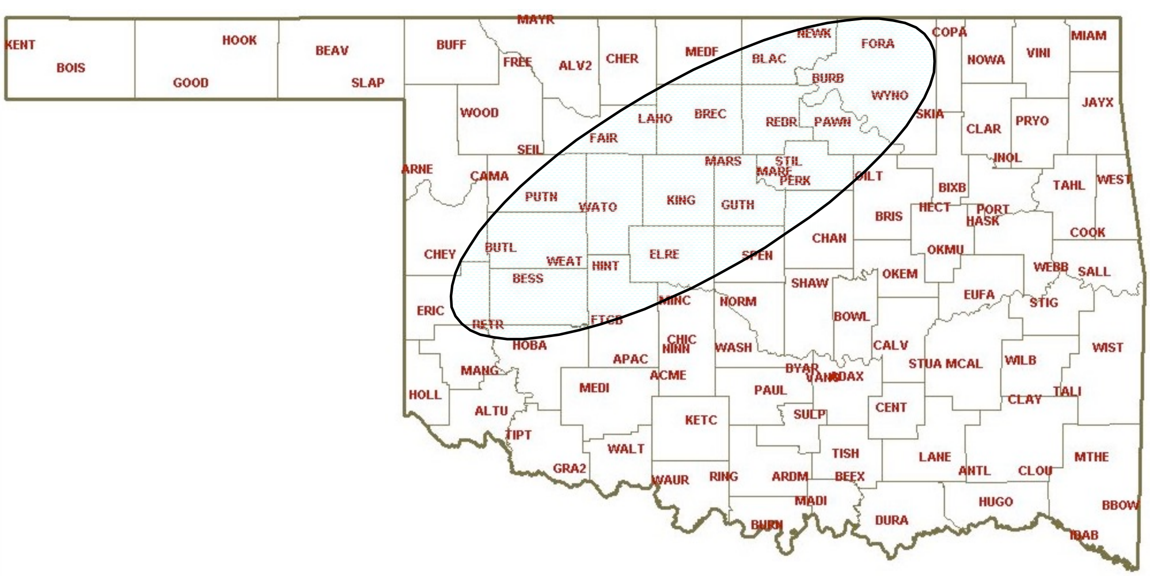

Figure 8. Areas of most-significant damage (shown in blue-shaded region) due to the ice event. Background map lists mesonet stations.

accretion, with some receiving a frozen layer 6 inches thick. These locales, including Kingfisher, Enid, Stillwater, Yukon, El Reno, Mustang, and northern and western parts of Oklahoma City, were included among the 45 counties declared federal disaster areas, shown in Figure 9. The story was the same in many of the rural communities, as the ice accumulated and more electric customers were left in the dark.

Many secondary effects were felt throughout the state due to the ice storm. The Oklahoma Highway Patrol reported fences down in many areas, with cattle "roaming freely at will", disrupting traffic. Downed trees, power lines, and poles also closed many roadways, limiting travel in the affected areas. Without electricity to power water treatment plants, several towns issued mandatory boil orders for residents using municipal water supplies. Numerous fires were reported after power was restored to customers when damaged wiring was discovered too late.

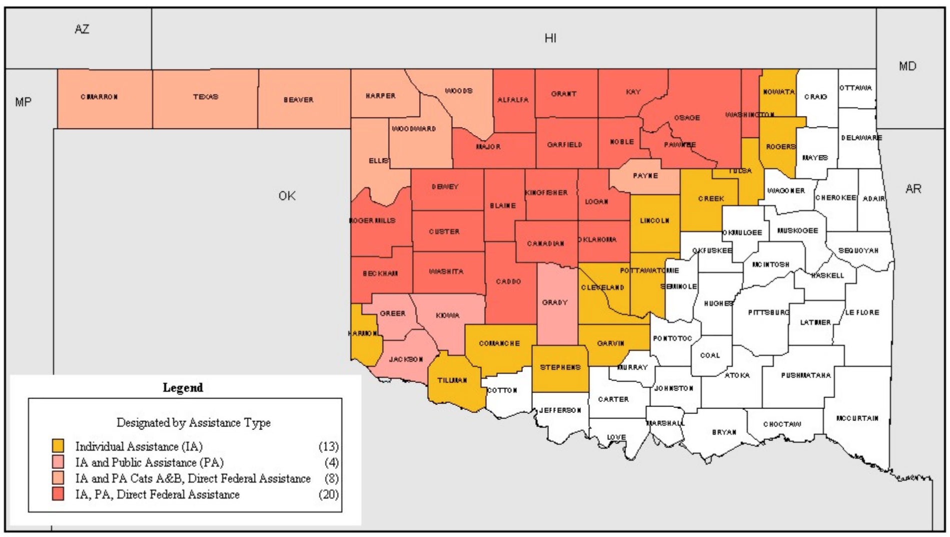

Figure 9. Forty-five Oklahoma Counties designated as federal disaster areas following the January 2002 ice storm, making them eligible for federal aid (map courtesy of FEMA).

The storm affected the farming and ranching communities differently. In the west and north central parts of the state, where winter wheat is the main crop, farmers looked upon the ice storm as an inconvenience in trade for much-needed moisture. Parts of the affected area were in the midst of an ongoing 8-month dry spell, with several places receiving less than half their normal precipitation since June 2001. The ice did not damage the young wheat plants whatsoever. The ranching industry in the area was a different story, however. With power out, many ranchers were unable to pump water to their livestock, forcing them to use portable generators in the field to draw water from wells. On top of that, fences were down across the area, creating havoc with keeping cattle inside ranch properties. Dairy farmers were also hindered by the power outages. Electric milking machines were rendered useless, so generators were utilized to keep the dairy operations going. Most dairy operations were well prepared for such emergencies, however, and had operating generators ready for any disruption in power.

The most serious casualty in the wake of the ice storm, however, was the toll in human lives. Seven fatalities were directly attributable to the effects of the late-January storm. Four died in traffic accidents on the icy roadways, while two others died of asphyxiation while trying to get warm in enclosed spaces. Another resident died when a large tree branch crushed him as he tried to clear his residence of debris.

National Weather Service forecasters provided warning to local and state officials more than 24 hours in advance, so communities had ample time to prepare crews for ice removal from streets. The warm ground, however, prompted work crews to be pulled from ice-clearing duty to tree-clearing duty. As much as 125,000 cubic yards of tree and limb debris existed in Oklahoma City alone, and cleanup for the state was estimated in months, not weeks.

Past Events

Until this ice storm, the top power-disrupting events in state history had been a windstorm in 1995, leaving 175,000 customers without power, and the May 1999 tornadoes when 167,000 customers were left in the dark. But an ice storm provides a distinct challenge to residents and utility companies, in that its damage can continue to occur several days after the event itself is over. Oklahoma has suffered many ice storms, some more notable than others.

The Christmas ice storm of 2000, arguably still the worst in Oklahoma history, was especially severe in the southeastern quarter of Oklahoma. A mixture of sleet and freezing rain created havoc, as travel was disrupted, or in some cases halted, beginning late Christmas Day. Ice collecting on tree limbs and power lines led to power outages in many areas. By one estimate, at least 170,000 homes and businesses, including 90 percent of the residents of McIntosh, Latimer, and Pittsburg counties, lost power as a result of the storm. Power still had not been restored in some areas by the end of December 2000. Several McCurtain County locations reported significant precipitation (liquid-equivalent) over the three-day storm period, most notably: Valliant, 5.56 inches; Broken Bow, 5.14 inches; and Carnasaw Tower, 4.33 inches. Damage to trees from ice build-up was significant throughout the forests of southeastern Oklahoma. Twenty-six deaths were reported in connection with the storm system that brought ice to the region, although not all of those were directly attributable to the ice storm itself. In terms of money, this ice storm takes top billing in state history, with damages and other costs in excess of $200 million. In comparison to the January 2002 storm, this ice storm affected less densely populated locales. The pre-storm environment in this storm was decidedly colder than that of the January 2002 storm, however. The cold air in place before the ice storm allowed soil temperatures to drop near- or below-freezing over much of the state (Figure 10). Thus, when the precipitation began it immediately froze on the roads, contributing to the travel problems and hampering power line repair efforts. The Christmas 2000 storm struck heavily forested areas, enhancing damage due to the sheer volume of falling tree limbs. In all, 67 counties in Oklahoma were declared federal disaster areas (Figure 11).

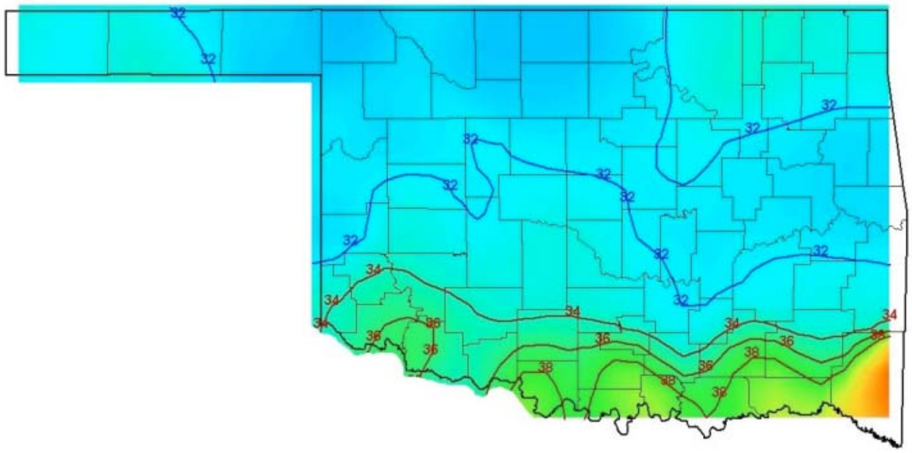

Figure 10. The 5-cm soil temperature values for 1 p.m. on December 24th, 2000, from the Oklahoma Mesonet. The freezing line is in blue.

Another significant ice storm struck on Christmas weekend in December 1987, sparing only the southeastern portions of the state. A 40-mile wide swatch from Duncan to Norman to Tulsa and to Miami received the brunt of the storm. As is the norm in a significant ice storm, tree damage was severe. As many as 114,000 customers were left without power, several thousand for weeks, as transmission lines snapped under the weight of the ice. Will Rogers World Airport cancelled flights when snowplows could not keep up with the freezing rain falling on runways. Hundreds of accidents were reported as roads quickly became slick and hazardous. Numerous traffic fatalities were associated with the treacherous driving conditions. A 1,900-foot-tall television transmission tower collapsed in Wagoner County, knocking station KTUL-TV off of the air. AM radio station KPRW was also knocked off the air when its transmission tower

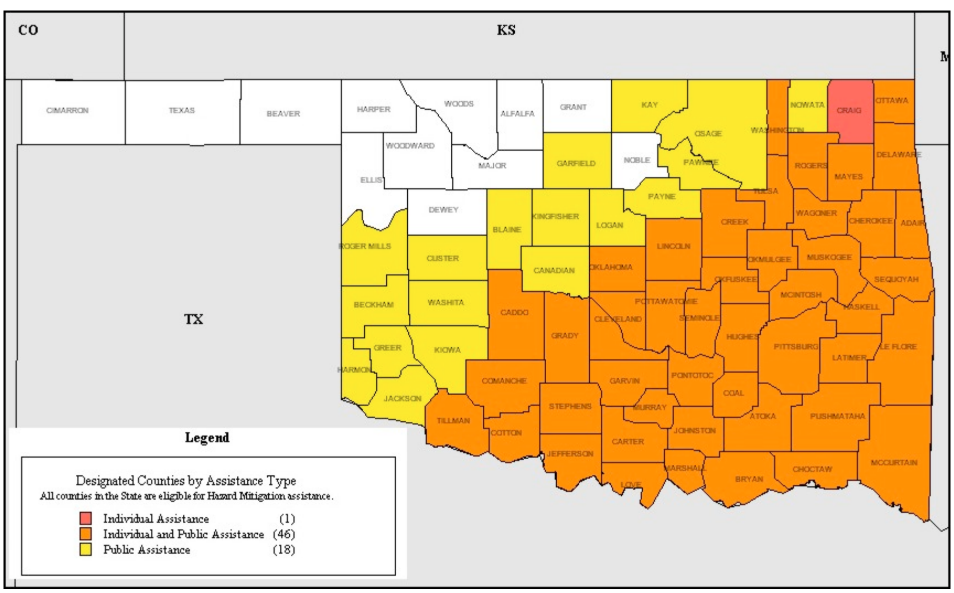

Figure 11. Sixty-seven Oklahoma Counties designated as federal disaster areas following the December 2000 ice storm, making them eligible for federal aid (map courtesy of FEMA).

succumbed to the ice in southeast Oklahoma City. In all, damages to businesses, residences, and electrical equipment totaled $10 million.

A significant ice storm struck southeastern and eastern Oklahoma, a mere 30 years after statehood in December of 1937. Considerable damage was done to trees, shrubs, and electric, telephone, and telegraph wires. Damages were totaled at a then-substantial $250,000. One elderly Muskogee resident claimed of the storm: "Seems like that one lasted a month."

SOURCES:

1) Archived data from the Oklahoma Mesonet
2) Archived information from the Oklahoma Climatological Survey
3) The archives of The Daily Oklahoman, (1982-Current),
4) The archives of The Tulsa World (1989-Current)
5) The National Climate Data Center's (NCDC) Storm Events Database
6) The Federal Emergency Management Agency (FEMA)
7) The National Weather Service (NWS) Forecast Office in Norman, Oklahoma

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