Air and Space this Week

Item of the Week

Taking the "High Ground" in Fighting Wildfires

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I've been promoting a significant calendar coincidence in A+StW for several installments, about the well-known Great Chicago Fire and the less-well-known-but-much-more-deadly Peshtigo, Wisconsin Fire. ***Both occurred 150 years ago on this coming October 8****. The deservedly-large press coverage of the many wildfires sweeping large areas of our country, make this particular coincidence a great opportunity to discuss how Space-based assets can, and are, being used to mitigate the danger and damage caused directly or indirectly by fires.*

The Great Chicago Fire

The American Midwest in the autumn of 1871 was locked in the embrace of a prolonged drought. Many of the buildings in Chicago were made entirely of wood, and worse, many had highly-flammable tar paper roofs and a construction design that made them prone to rapid fire damage. On October 8, 1871, a great fire broke out, and over the next two days, about 300 people were killed, over three-square-miles of the city was destroyed, and more than 100,000 people were rendered homeless. The fire burned out much of the city's central core and near north sides.

Legend has it that a cow owned by a Mrs. O'Leary kicked over a lantern, starting the blaze. But that is just a story concocted by a reporter. The fire did begin on the southwest side of the city, near the O'Leary place, but the exact site and cause have never been determined. One thing is sure, however. The Chicago Fire Department was already spread very thinly (only 185 men and 17 horse-drawn pumpers for the entire city), and they were exhausted by fighting a number of small drought-caused fires in the weeks preceding. A dispatch error and the failure of at least one reporting alarm helped the fire to gain a big start before efforts could be mounted to fight it.

City planners had figured that the South Branch of the Chicago River would help stop fires from spreading too broadly, but there were a lot of lumber and coal handling facilities there, and the river proved no barrier. Strong ground winds caused by the updraft from the fire caused a *firestorm*, and flames spread even faster when the winds dumped a train car carrying kerosene into the river. The lack of fire fighters and their pumps was bad enough; but on top of that the firefighting water system was completely inadequate for a fire of this magnitude and speed.

The Chicago Mayor declared martial law, and installed General Philip H. Sheridan as commander. He had considerable success in the Civil War in the Shenandoah Valley and it was pursuit by his cavalry that forced the Appomattox surrender. After the Fire, he was instrumental in the establishment of Yellowstone National Park and protecting its resources in the early days.

Rebuilding efforts began immediately (lumber began arriving before the flames were fully extinguished). The city established and rigorously enforced more stringent building codes. Expert advice, including that from noted park architect and building expert, Frederick Law Olmstead, advocated wide use of brick in building construction, and for a large expansion of fire and police departments, and an increase in their training and discipline.

The Fire had a large and lasting effect on Chicago, and on the expansion of other large cities of the time. One of city's most revered landmarks is the Chicago Water Tower, build to house pump machinery two years before the Fire. The Tower survived, while every building around it was incinerated.

The Peshtigo Wisconsin Fire

The drought of mid-1871 created conditions for uncontrolled fires not only in Chicago, but all around the upper Midwest. Chicago may have gotten more publicity, but a 1.2-million-acre blaze along both sides of Green Bay was much more destructive to human life. Called the "Peshtigo Fire" after one of the settlements it consumed, Peshtigo occurred on the same days as the Chicago Fire (and along with many others, including the towns of Holland, Manistee, and Port Huron).

Peshtigo and its neighboring towns were wood-oriented, no doubt. Peshtigo was larger than the others, with a population of a few thousand. It was the home of one of the largest sawmills in the nation, and had the largest woodenware factory in the world. The sawmill was fed by a dedicated railroad and barges.

Forestry practices were rather different in the 1870s from those today. Some parts of the southern shores of Green Bay initially were a scrub forest, unsuitable for lumbering, but ideal land for farming if it could be cleared. The usual method used small, controlled fires; some were underway in October, 1871. Much of the rest of the land contained forests that could provide quality lumber; lumberjacks would fell and trim those trees, leaving a lot of brush and stumps behind. If the clear-cut land was suitable for agriculture, farmers would clear the brush, usually by burning, and burn the stumps.

The Drought of 1871 was particularly punishing in the forest lands. Water was scarce, for trees, crops, and people. Railroad construction in the area was slowed due to a lack of drinking water for the men and animals involved. Vegetation everywhere was drying out and dying, ready to burn. Fires were being used to clear the land, during major drought conditions. Locomotives traversing the area produced a lot of sparks and flaming cinders.

Vegetation withered by drought, strong winds, "small fires" scattered around, and numerous ignition sources – what could go wrong?

A number of the small fires got out of hand, and joined into a complex that became a true firestorm. Surface winds of incredible strength, created by the updraft of the fire, acted like a blacksmith's bellows in intensifying the fire's destructive effects, just as they did in Chicago. A number of communities were obliterated, as were ~2 billion trees. Some of those seeking refuge in the Peshtigo River succumbed to hypothermia. No reliable count of deaths was possible; whole towns and the pertinent records were incinerated; the death toll was likely to be on the order of 2000. The toll of human misery was much higher.

Aside: An Alternative Hypothesis

The coincidence in dates of the two major fires discussed above is striking, but not extraordinarily so. After all, the drought was severe, wide-spread, and then well-known from personal experience. Given the activities and state of building construction, the early autumn of 1871 was bound to have a number of fires, and it did.

Coincidences can attract odd hypotheses, however, and the two great October 8 fires are no exception.

Comets have for millennia been seen by some as portents of disaster, objects of fear. That concern was passed on to meteors when it became clear that some comets were the source of meteors. An example contemporary to the Fires was periodic Biela's Comet, discovered in 1772.

During Biela's perihelion passage in 1846, it was seen that the comet's nucleus had split into two, but one of those was not present during the perihelion passage in 1852. Nothing was seen when the apparitions of Biela should have been observed in 1864 or 1872. Instead, there was a meteorstorm (50+ meteors per minute) on November 27, 1872, when the Earth crossed Biela's orbital path. Those meteors were clearly the remnants of the now-dead comet.

Meteors glow incandescently from frictional heat during their passage through the atmosphere. Could an unseen meteor shower have triggered a number of fires in the Midwest?

Meteors from Comet Biela's breakup, obviously, could not have caused the fires that occurred 14 months before Biela's remnants even got here, but the notion that an unseen meteor fragmented aloft and scattered fire-starting (?) materials was a not-too-unreasonable hypothesis to explain the simultaneity of the October fires, especially for those who had forgotten or not experienced the weather conditions that autumn.

The hypothesis fails, however, based on the thermal conditions in Space and during passage through the atmosphere.

The meteoroid/comet fragment is saturated with the extreme cold of Space. The heating of its surface is very intense when it strikes our atmosphere, but the duration of that heating is very short; the heat "flash fries" the surface, but lacks the time needed to actually heat the interior of the meteor. Ablation of material during reentry also carries away some of the frictional heat being created. Meteorites are cold when they fall, and there has never been a documented case of any fire being started by a meteorite fall. **More proof:** Recall the Item of the Week about the only person actually hit by a falling meteor, Ann Hodges of Sylacauga, Alabama. A

meteor fell through the roof and hit her on the hip, causing a spectacular bruise, but no burn at all, either to Ms. Hodges or the couch she was sitting on!

Wildfires Are Dangerous and Costly

I started with the Chicago and Peshtigo Fires as examples of how costly an uncontrolled fire can be, in both urban and rural areas. Wildfires have scorched over 3 million acres in California to date in 2021, and other areas in the drought-stricken West have also suffered considerable damage. A pall of smoke from the ~8000 fires active this year hangs over much of the land not actually burning. But 2021 is not an outlier; the two preceding years were even worse. Dollar loss estimates are available for 2018 and 2019; overall losses totaled $45 billion for those two years.

Wildfires come with a human cost in addition to lives lost. The Waldo Canyon Fire that hit Colorado Springs in 2012 burned through part of the city, destroying 347 homes and incurring $454.7 million in insured losses. Can you imagine the anguish of the 100,000 or so people who lost their homes and most of their possessions in the Chicago Fire? How about the loss of homes and jobs in Wisconsin? And how about the human suffering and the $25 billion in financial losses to wildfire in each of the last four years?

Clearly, any reasonable thing we can do to mitigate these losses and suffering should be done without delay.

This is especially true as human-caused climate change is making the dangers of wildfire worse every year (and hurricane damage, too).

How Can We Use Space-based Assets to Mitigate Dangers/Costs?

The development of computer databases has revolutionized how we can analyze complex situations. Of particular importance is Geographical Information System (GIS) software, where all sorts of data can be overlain on a map base to provide the analyst with an immediate visual clue to key interrelationships. Think of it as a souped-up version of a paper map showing topography by a color code. Example applications include all sorts of civil engineering projects (road building, utility maintenance) and other geography-based relationships. But the analysis bugaboo from the earliest days of computer data processing – "GIGO: Garbage In, Garbage Out" – is still in play; a GPS-based analysis is only as good as the data being put into it.

Back in my fieldwork days, one of the first things I liked to do when working an area for the first time was to hike up to the local highpoint, a vantage that allowed me to get a "Big Picture" sense of the terrain. The "High Ground" has always been sought for military, commercial, and other advantage, and what better place to acquire GPS inputs could there be than the highest of high grounds, low-Earth orbit?

How does NASA do this? Check out the **NASA Earth Science Applied Sciences Program** section on fires at: https://appliedsciences.nasa.gov/what-we-do/disasters/fires. The ESASP provides "support and funding to help institutions and individuals make better decisions about our environment, food, water, health, and safety." Fires are only one kind of disasters in ESASP's

purview, which also includes heath and air quality, water resources, agriculture, ecological forecasting, and capacity building.

An example of how this would help is as follows. A number of factors affect wildfire growth and the tactics to extinguish it, such as recent rainfall, vegetation type, slope, proximity to roads, etc. Space-based remote sensing allows for many of those factors to be assessed for a given area, and can provide (near) real-time observations of any rapid changes are taking place. A GPS system with these data could help managers predict how a fire might grow and move and orient their mitigation/protection efforts accordingly. After a fire, burn intensity, soil, and topographic data would help reveal where post-fire mudslides would be likely to occur.

The Great Fires of 1871 were terrible things, but good things arose as their consequence, silver linings in the form of better building techniques and codes, better and safer forestry processes, and a better understanding of the process by which fire risks can be mitigated and fire damages can be reduced.

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Wildfire Dangers and Costs

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Congressional Research Service: https://sgp.fas.org/crs/misc/IF10244.pdf

How Can We Mitigate Damages/Costs?

Learn more at: The Science of Wildfires: https://www.jpl.nasa.gov/edu/news/2016/8/22/back-to-school-burn-the-science-of-wildfires.

Fires are not the only subjects of the NASA Earth Science Applied Sciences Program; learn more at: https://appliedsciences.nasa.gov.

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