Transportation Rail Incident Preparedness and Response Volume 2: Climate Change

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Frances L. Edwards, MUP, PhD, CEM and Daniel C. Goodrich, MPA, CEM, MEP

MISSION

The *Transportation Rail Incident Preparedness and Response Volume 2: Climate Change* presents critical information on best practices and useful initiatives related to rail hazards associated with climate change in North America. This survey of past events and current practices is intended to help North America's railroads to prepare their personnel, equipment, and infrastructure for the unfolding impacts of climate change, as it is understood in 2024. The US Department of Transportation's Pipeline and Hazardous Materials Safety Administration (PHMSA) has already created a foundational document on the use of the Incident Command System (ICS) on the railroads of North America for hazardous materials response in 2018 (US DOT, 2018). This research builds on this existing training by adding the hazards caused by climate change that relate to safety and security, as well as preparedness and response strategies to cope with the hazards.

BACKGROUND

Scientists have noted that climate change poses a multi-pronged threat to railroads. "Without efforts to adapt to future climate threats, the railway industry will face degrading infrastructure, safety hazards and skyrocketing operations costs" (Campbell, 2022). Climate change is closely related to natural hazards, making rain, snow, and ice storms stronger, hurricanes stronger, and causing sea level rise along all US coasts. Knowing how to manage the emergencies generated by these intensifying hazards is critical for safe operation of the railroads throughout the United States.

Incident Command System

The ICS has been used to manage large-scale events that involve multiple jurisdictions or multiple professions since the early 1970s, when it was invented in California following wildland fires (FEMA, 2018). It is required to be used by federal, state, and local government agencies under the National Incident Management System (NIMS) (FEMA, 2018), but it is important for private entities to also be prepared to join and cooperate with an ICS response to a disaster that impacts the whole community (FEMA, 2018). "Railroad emergency responders are trained and prepared to operate using NIMS/ICS" (US DOT, 2018, p. 30). The freight railroads of the United States are private corporations, but in disaster events they have to partner with local, state, and federal public safety entities for life safety response activities. The ICS/NIMS activities that are used in a hazardous materials emergency (US DOT, 2018) will also be used in hazardous events that relate to climate change.

The ICS will typically be established by local government first responders close to the scene of a hazard-related event. They will size up the event, establish an incident command post (ICP) in a safe location, and create an Incident Action Plan (IAP) to guide the response to the event (US DOT, 2018). When the railroad is involved in the event, the Incident Commander (IC) will typically

request a representative of the railroad to join the ICS as a Subject Matter Expert (SME) within the Planning/Intelligence Section of the ICS. Initially, this would generally be the conductor of any train that is involved in the hazard. If the event will be a prolonged incident, or if the railroad may be a responsible party, the IC may request a railroad representative with more authority to commit resources to the resolution of the event. "The railroad will integrate its response assets into the public safety NIMS structure… it will often be integrated as the Railroad Branch within the Operations Section or Logistics Section" (US DOT, 2018, p. 31).

In some cases the complexity of the incident may require the creation of a Unified Command for ICS (US DOT, 2018). In this case the first responders will be joined in the Unified Command by any other federal, state, or local agencies with specialized knowledge, resources, or funding to assist with the resolution of the event, and any responsible parties with financial responsibility for any element of the resolution of the event. If the railroad's property is part of the hazard incident, a higher level representative may be requested to join the Unified Command as the senior transportation officer (US DOT, 2018). "Throughout the response to an incident, [first responders] should be prepared to integrate railroad personnel upon their arrival in order to have a smooth transition to unified command. While some amount of hazard assessment and initial response may take place, it is critical that responders communicate from the beginning with the railroad and recognize their process, resources, and capabilities" (US DOT, 2018, p. 30).

The Unified Command makes an IAP with a common set of objectives and aims toward collaboration among all parties to resolve the event. For example, if a mudslide has blocked the railroad tracks, a Unified Command might include the fire and rescue agency for the jurisdiction, a public works agency for the jurisdiction, the property owner where the mudslide originated, and the railroad owner whose track has been impacted, and whose operations have been stopped.

Climate Change

Researchers have determined that climate change is occurring related to the change in the Earth's average temperature. FEMA (2023) notes that the rate of climate change has increased rapidly in the 20th century. In 2023 scientists determined that the monthly average temperatures were the highest in the last 150 years (Zhong and Collins, 2024). "Every 10th of a degree of global warming represents extra thermodynamic fuel that intensifies heat waves and storms" (Zhong and Collins, 2024, n.p.), leading to wetter storms, as warmer atmospheres hold more moisture. Hotter weather, bigger wildland fires, and less sea ice all resulted from the increased average temperatures (Zhong and Collins, 2024), which also add to rising seas and hastens the melting of glaciers and ice sheets. "Factors like the emission of greenhouse gasses (GHG) and the increased cover of the Earth's surface by hardscape are both probable contributors to the increase in average temperatures" (Zhong and Collins, 2024, n.p.). By April 2024, the *Los Angeles Times* was reporting ten months of record-breaking temperatures (Editorial Board, 2024).

Climate Assessments

The National Oceanic and Atmospheric Administration (NOAA) performs an annual assessment to track climate change, including a GHG index, sea ice levels, global surface temperatures, and global sea level. FEMA has also raised concerns about the varied impacts on different socio-economic groups, called climate equity (FEMA, 2023).

The United States (US) is divided into ten climate regions in the Fourth National Climate Assessment (NCA4) (Jay, et al., 2018). The impacts of climate change vary notably among the regions due to topography, latitude, and natural land features, among other factors.

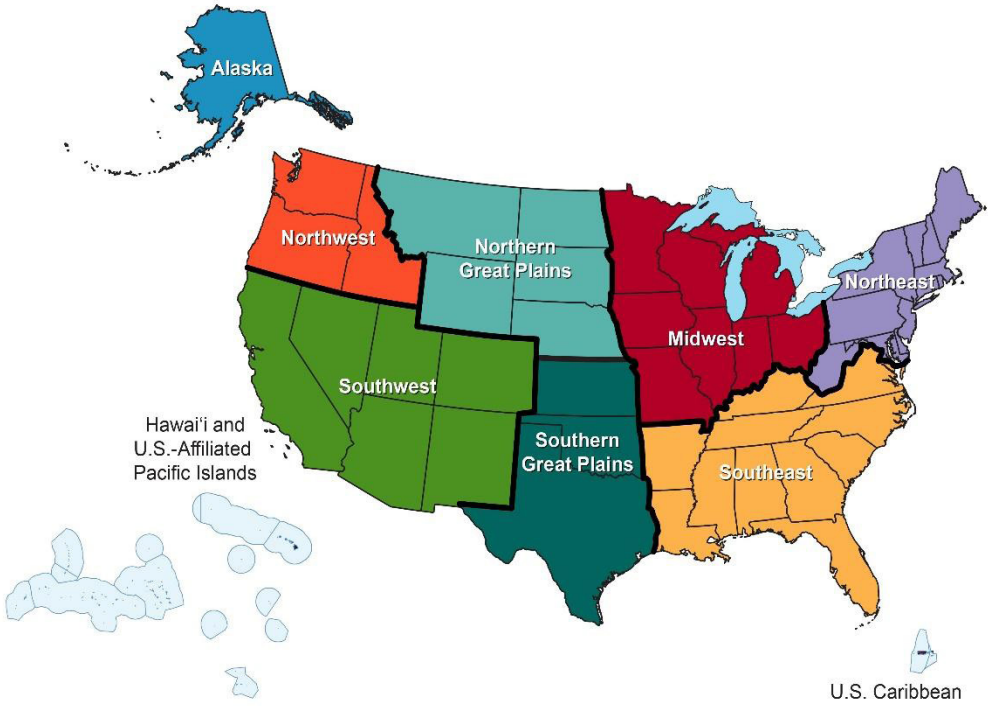

Figure 1. National Climate Regions

Source: NCA4, 2017, n.p.

These varied impacts are presented in the study in regional chapters that evaluate current and future risks from climate change in each region. They highlight adaptation steps that enable communities to live with the changing climate, and steps to mitigate emissions to minimize climate change. These chapters can be useful to railroad facility planners to enable them to incorporate adaptations and resilience into new construction and renovations. Issues like the differences in sea level rise along different coasts and the northern movement of higher temperatures are especially critical factors in infrastructure planning.

The NCA4 analyzes the variety of climate impacts with the following questions:

What do we value? What is at risk?

> What outcomes do we wish to avoid with respect to these valued things?
>
> What do we expect to happen in the absence of adaptive action and/or mitigation?
>
> How bad could things plausibly get? Are there important thresholds or tipping points in the unique context of a given region, sector, and so on? (NCA4, 2017, n.p.).

Dealing with Climate Hazards

FEMA's 2023 climate change planning guidance cites wildland fires and related mudslides, landslides and debris flows, drought, extreme heat, coastal flooding, inland flooding, and hurricanes as major categories of climate change impacts that communities must prepare for (FEMA, 2023a). All of these hazards have the potential to impact the rail system of the US, the world's largest with 140,000 miles of Class 1 track (Chinowsky, et al., 2019).

To the extent that climate-related hazards will impact railroad tracks, rights-of-way and infrastructure, the railroad industry may be increasingly interacting with local agencies to resolve the hazard impacts to its facilities and restore service. For example, the prevalence of wildland fires in the Western United States and Canada has led to the creation of fire trains designed to reach rail infrastructure in remote areas. Burlington Northern Santa Fe (BNSF) Railway has fire trains based in Whitefish, Montana that include several tank cars of non-potable water, a tank of fire retardant, hose lines, and water cannons that can spray for hundreds of feet on either side of the track. Water sprinklers are set up to protect infrastructure like bridges and tunnels. Montana Rail Link and Canadian Pacific Railway also have fire trains in the Great Plains region (Franz, 2023).

These trains represent the close collaboration between local fire departments and the railroad. One BNSF train has a caboose that serves as a command center. Another has a caboose that also has a front end water spray bar and generator. When a wildland fire has to be suppressed, the train picks up local firefighters and transports them in the caboose to the site of the active fire, where they use the equipment to fight fires up to 30 feet away from the track (Rail Talk, 2019). Union Pacific has a fire train in Northern California operated over seven miles of track by its engineering employees. They focus on hotspots, bridges, and tunnels, and escort trains through the areas of active burning (Union Pacific, 2020).

FEMA's guidance on developing resilience against climate change includes the participation of stakeholders like the railroads in the community's annual review of its threat and hazard inventory and risk assessment (THIRA). This assessment leads to mitigation strategies that may reduce the occurrence or frequency of damage to critical infrastructure, including railroads (FEMA, 2023b). Chapter 28 of the NCA4 on adaptation may be most useful to railroad infrastructure planners. Chapter 29 of the NCA4 on mitigation of emissions may be most useful to railroads acquiring rolling stock and equipment.

RAILROADS AND CLIMATE CHANGE: PROBLEM IDENTIFICATION

Wildland Fires

Railroads have been managing wildland fires since the creation of rail lines. In the early days of railroading, sparks flew from the coal-burning steam locomotives and from their steel wheels, setting prairie fires that mimicked the fires set by the indigenous inhabitants. In those times train-lit fires were rejuvenating, benefitting "jackpine forests, oak savannah and prairie" (Allmann, 2023). Today, the Minnesota Department of Natural Resources (MDNR) estimates that trains cause 3% of all human-caused wildland fires in the state. Since 1985 trains have caused more than 2,000 wildland fires that were fought by MDNR assets. Additional fires occurred on indigenous people's lands, federal lands, and local jurisdictions where the community's fire department fought the fire.

At the same time, the 4,400 miles of track in the state are often the last "uncultivated, undeveloped land across large portions of the former tallgrass prairie landscape" (Allmann, 2023). While the preservation of the natural environment is beneficial, the railroad also contributes to ecological change. The National Park Service notes that, "The railroad tracks create an environment of disturbance that encourages the spread of invasive plants. Currently, more than 30 non-native species are found in close proximity to the railroad tracks" in areas like the Grand Canyon (National Park Service, 2016). Non-native plants are more susceptible to burning. Seeds and plant parts are carried on the train parts, which helps to spread the non-native vegetation. Fire mitigation conducted by the Grand Canyon Railway along its right of way includes the use of herbicides to both discourage the growth of invasive species and mitigate fire propagation from wheel sparks along the right of way. The treated corridor also creates a "fire break for fires originating elsewhere in the park" (National Park Service, 2016).

Train equipment can cause fires along the route. On April 14, 2023 the *Rockland County Business Journal* reported that burning embers from CSX equipment caused a chain of brush fires along the tracks during a hot spell in New York. Soot and embers also set fires on private property. The railroad paid out almost $1 million in property damage claims along the route.

California's Dixie Fire in 2021 caused BNSF to suspend service between Stockton, California and Klamath Falls, Oregon. The fire posed a threat to the main rail line and tunnels (Marsh, 2021, n.p.), with several bridges destroyed. Union Pacific's Black Butte subdivision was closed while repairs were completed to a large rail bridge that was damaged in a June wildland fire. Canadian National Railroad lost a bridge from a wildfire in British Columbia (Railfan and Railroad staff, 2021). These are just a few examples of wildfire-caused damage to train infrastructure that interrupted service and impacted the supply chain. With climate change increasing temperatures and drying causing more extreme wildfires (Brown, et al., 2023), wildland fires will likely become even more frequent and more intense.

The railroad is an important partner in managing wildland fires through the west. For example, Washington experienced wildland fires in areas served by BNSF, and its fire trains became an important part of the state's fire suppression capability. The arid rangeland provides fuel. One fire chief noted, "The topography is flat in some sections but with steep, rocky bluffs in others, where fighting fires gets complicated. Given the remote and limited road access, the department

may call BNSF once a month during wildland fire season to ask for an assist" (Rail Talk, 2019). Specially equipped trains provide water and firefighting equipment, as well as transportation for the firefighters to the fire zone, where they use the BNSF equipment to douse flames up to 30 feet away (Rail Talk, 2019).

Mudslides, Landslides and Debris Flows

Areas burned by wildland fires suffer significant after effects that cause additional problems. Heat from the fire will kill microorganisms and sterilize the soil. The intense heat can reduce the porosity of dirt, leading to increased runoff and erosion (Fire Safe Sonoma, 2023). After intense rainstorms, the runoff can lead to mudslides, landslides, and debris flows. Such events can be fatal. In 2018 a debris flow after the Thomas Fire "caused at least 21 fatalities, destroyed more than 100 homes, damaged more than 300 other homes, and shut down Highway 101 for nearly two weeks" (California Department of Conservation, 2024, n.p.). The 2018 debris flow in Montecito, California moved at 10-15 miles per hour, carrying along "boulders as large as a pick-up truck" (California Department of Conservation, 2024, n.p.). Such events along a railroad right of way could damage infrastructure and rolling stock.

Mudslides, landslides and debris flows can also be caused by rainstorms that inundate sloped areas even in unburned terrain. Water drains into the soil, running down sloped areas and carrying mud, vegetation, and other debris. On January 17, 2023 the Altamont Corridor Express (ACE) Train line in Niles Canyon in Fremont, California suffered a mudslide that stopped train service, requiring the evacuation of 225 passengers after a four-hour wait (Fuentes, 2023). The next day another mudslide stopped an ACE train, this time causing minor injuries to three passengers, with dirt and debris pressed against a cracked window. ACE then removed the damaged train and stopped commuter service until the following Monday to give time for Union Pacific—owner of the track—to clear the tracks of mud and debris and evaluate the stability of the area (Fuentes and Howland, 2023b). Post-storm mudslides can be unpredictable, such as these events that occurred days after the storm had passed.

Drought

As climate change advances and weather changes, hot and dry periods are longer and more extreme. Forests receiving less precipitation have more dead trees that provide fuel to carry blazes to the forest canopy where it is harder to suppress. Railroads may be victims of these fires, which have occurred in multiple states. In 2019 BNSF equipment was involved in fires across portions of the West that were caused by lightning or human activity where drought and high winds have increased extreme fire behavior. Droughts also dry out soil and cause subsidence, which can deform the land's surface and cause railroad tracks to misalign (Campbell, 2022).

"The United States has spent an estimated $249 billion on 26 major droughts in the last 30 years that have affected two-thirds of the continental United States" (CISA, 2021). Although climate change may not be directly responsible for all droughts, the lack of natural irrigation for wildlands leads to die off of plants that become tinder for wildland fires. Trees suffering from drought conditions are more susceptible to bark beetle and other destructive pests, leading to increased fuel loads during a wildland fire and can serve as ladder fuels for canopy fires. Fire in the canopy

is hard to fight, leading to hotter and more widespread wildland fires such as California has experienced in the 2020s. As noted above, such fires have damaged railroad infrastructure like bridges, tunnels, signals, and wayside monitoring equipment.

Drought can also lead to a deeper frost line in cold areas. This can result in water pipe breaks, many of which run along railway rights of way. Drought can also limit available water for fighting fires in more remote areas. During normal wildland firefighting in California, the reservoirs are a resource for helicopters that dip their buckets there to acquire firefighting water. During recent droughts, the state's largest reservoirs became more shallow, with little water available for the helicopters. Likewise, remote streams and ponds may be too low to draught water for firefighting. The lack of water may make protecting rail infrastructure difficult under wildland fire conditions (FEMA, 2023a).

Extreme Heat

"Over the past 60 years, heat waves have increased in duration, frequency, and intensity, and research shows that the trend toward longer and more intense heat waves will continue" (FEMA, 2023a). Hot temperatures are also moving northward, bringing temperatures close to and above 100°F to the Great Plains and midwestern areas that have not seen sustained heat in the past. Railroads operate on steel rails whose metallurgy is designed for the climate in which they are placed, with a very narrow temperature range. Furthermore, many rails are over 100 years old, representing older construction standards that may not withstand the new heat experience (Campbell, 2022).

Heat can also lead to derailments through rail deformation. Rails that are overheated experience "sun kinks" that cause the tracks to buckle. Trains passing over these tracks at top speed can ride up over the kink and derail. To adapt to the high heat challenge the railroads reduce the operating speeds of the trains, but this comes at a cost. As Campbell (2022) noted, "delays from temperature-related reductions in speed limits could cost the U.S. rail network up to $60 billion by 2100 (n.p.)."

Another operating challenge may be created by changes in transportation system operations. Heat may lower water levels in major waterways through evaporation, and over a long term this could lead to changes in transportation, such as shifting food transport from river barges to trains (Campbell, 2022).

Heat also stresses the power grid. The *New York Times* has noted that "periods of high heat carry an elevated risk of power outages, as energy demand spikes and impairs the ability of utilities to generate and transmit power" (Selig and Howard, 2024). While few freight lines rely on electricity to power the locomotives currently, electrification has been suggested as one mitigation for climate change. While installing overhead lines as the British have done is very expensive, electric trains could be run on batteries and regenerative braking that can produce clean power (Barnard, 2023) that operates with only indirect impact from availability of the grid for recharging.

Electricity is also essential for the operational systems of the railroads. Signals that control train traffic are operated from the local electric grid. Along the way sensors such as those to detect overheated bearings operate on locally provided electricity. Positive train control (PTC) devices also rely on the local grid for the broadcasting elements and radio equipment. Crossing gates, warning lights and audible warnings for grade crossings all operate on locally generated electricity.

The deputy director of California's Office of Emergency Services reported to a professional research group that the loss of electric power during a public safety power shutoff (PSPS) during wildland fire season caused severe public safety problems for the rail lines operating in the area of the shutdown (Edwards, et al., 2021).

Widespread power outages caused by a heat-overloaded electrical grid could stop rail traffic in the impacted area. The Federal Railroad Administration (FRA) requires backup power for all signals and warning devices that use electricity from the grid (FRA, n.d.), but back-up power may be sapped by the heat, may malfunction for other reasons, or the batteries may run out before the electric grid is restored. Thus, extreme heat may disrupt rail operations through the cascading impact to the electric grid.

Hurricanes

Hurricanes used to be seasonal and regional, with landfalls limited to Gulf of Mexico and southern Atlantic Ocean locations in the continental US. As the atmosphere heats, the air holds more water, increasing hurricane-related rainfalls by 10%-15% (FEMA, 2023a). A hurricane requires warm ocean water—79 degrees or above—to develop the energy needed for the winds and rain that define the phenomenon (NOAA, 2023), so coastal areas with cold ocean water did not experience hurricanes. In 2012 Hurricane Sandy demonstrated that hurricanes and tropical storms can reach northern portions of the Atlantic coast. Hurricane Ida caused coastal flooding that closed the Amtrak Northeast Corridor for a whole day in 2021 (Campbell, 2022).

In 2022 Category 4 Hurricane Ian damaged rail infrastructure in the Florida Gulf Coast. Six railroad bridges were washed away, and 100 miles of rail line were lost, disrupting access to Fort Myers and Naples, Florida. The Seminole Gulf Rail Line lost three bridges into the Caloosahatchee River, and its railyard was under water. The railroad delivers the propane to the area, and also carries plywood, drywall, and materials for making concrete that will be needed for community rebuilding. Thousands of homes were damaged along the coast. It will require four tractor trailer trucks to carry the materials usually moved in one rail car. The I-75 route they would have to take was immediately jammed with the vehicles of residents, tourists, and delivery trucks going to the devastated area (Sowers, 2022). CSX suffered a loss of use of its track, and the resulting delay of customer deliveries (CSX, 2022).

On the west coast historically hurricanes were limited to Pacific areas below the US border. However, in 2023 Hurricane Hilary reached California as a tropical storm, following a watch being issued for Southern California. It generated tropical rainfalls and high winds in what is usually California's summer dry period. Los Angeles received 7 inches of rain, while the inland areas of Riverside County got 11.7 inches in the mountains and San Bernardino County got 13.5 inches (Ruffalo, 2023). NOAA scientists predict that while the number of hurricanes will probably stay the same, the number of category 4 and 5 storms will rise. The higher storm surges are likely to increase the death tolls, since most hurricane-related deaths come from drowning, and coastal populations have increased by 40% between 1970 and 2010 (FEMA, 2023a).

Railroad property is also subject to hurricane damage. In 2023 Hurricane Hilary damaged Union Pacific tracks and bridges, closing service for days. In the Coachella Valley the hurricane's rain flooded the Whitewater River Channel, causing one derailment and two trains to be buried in mud. Eight empty cars on a siding were washed off the tracks. While service was restored in two days, complete repairs required two weeks. Work was delayed by the closure of I-10, limiting access to the derailments, demonstrating the interconnectedness of the transportation system in times of emergency. This Union Pacific Railroad route runs from the Ports of Los Angeles and Long Beach through the San Gorgonio Pass and the Coachella Valley to the national freight system rail lines, carrying mainly consumer goods and automobiles (Damien, 2023). Mud covered ballast and panels had to be replaced, and in other places tracks had to be repaired. The Yuma and Mojave subdivisions, which also carry transcontinental freight, including trains of cargo containers, were reopened after 2 days, while the Lone Pine subdivision required longer track restoration work (Union Pacific, 2023).

On August 22 Tropical Storm Harold hit the Gulf Coast in south Texas. Five miles of track near Corpus Christi were submerged (Union Pacific, 2023). Losses from these hurricanes include not just rail infrastructure damage but also the cost of delays in the delivery of goods. Union Pacific noted that it would take days to get the backlog of trains through the damaged area (Damien, 2023).

Property damage from hurricanes will also accelerate as flooding spreads. Infrastructure damage will increase. For example, FEMA estimates that 269 Southern power plants could be flooded by storm surge in a Category 5 hurricane, and electricity generating plants could be taken offline from flooding (FEMA, 2023a). Flooded rail lines along the Gulf of Mexico and Atlantic Ocean coasts could halt passenger and freight service for hours to weeks as tracks, bridges, and signaling equipment are inspected and repaired or replaced. Such a cascading event could lead to loss of electricity and diminished diesel refining capacity, also impacting railroad service.

Coastal Flooding and Erosion

Coastal flooding and erosion come from multiple sources. Sea level rise across the globe comes from warming and expanding oceans, and melting glaciers add to the expansion of seas. Since 1900 global sea levels have risen 7 to 8 inches, while NOAA scientists anticipate a 10-12 inch rise by 2050. Higher sea levels give storm surge a higher starting point that reaches farther inland (FEMA, 2023a). Winter storms and hurricanes generate higher waves that wash against cliffs and cause erosion, leading to loss of coastal structures that support railroad infrastructure (Sandag, 2024). With 40% of the US population living along the coasts, the risk to life is increasing as a result of coastal flooding (FEMA, 2023a).

Hawaii and the Pacific Islands are of particular concern for sea level rise and coastal flooding. Coastal erosion is requiring the relocation of population groups. The western US and Alaska also anticipate significant impacts, with California alone estimating that $100 billion in coastal property value is at risk from increased flooding over the next 100 years (FEMA, 2023a). The Los Angeles/San Diego coastal train route is already impacted by sea level rise in several locations where the tracks run close to the shore. The San Diego Association of Governments (Sandag) has a study that shows where the coastal tracks that carry both local commuter and international freight traffic will have to be relocated inland to save the route. Some tracks are already inundated

or being undermined during storms (Sandag, 2024). This route is critical because it connects US markets to Mexico, and it serves Vandenberg Air Force Base and United State Marine Corps Camp Pendleton. The Eastern US and Gulf coasts have the highest incidence of coastal flooding, with significant increases since 2000. The Great Lakes have actually seen a slight decrease in water levels (FEMA, 2023a).

In 2012 Hurricane Sandy created a significant storm surge in the New York Metropolitan Area. The New York subway system had to pump out 75 million gallons of water out of stations and tunnels to begin to restore service (Campbell, 2022). Rail bridges and tracks were destroyed by the storm surge in The Rockaways area on Long Island, removing the only rail link to the mainland (Gannon, 2012).

Energy generation, transmission and distribution would be damaged by sea level rise, as many power plants are located close to the coast to benefit from cooling water from the ocean. Fiber optic cable is often buried, and while water resistant, is not designed to be submerged. Thus, power and communications capabilities critical to railroad operations could be lost to coastal flooding (FEMA, 2023a). A recent study suggested that Boston's rail system might see a 40% reduction in its operations due to coastal flooding.

Inland Flooding

Inland flooding has several possible causes. As was seen in the discussion of Hurricane Hilary, hurricane and tropical storm rain can fall far from the coast. It can cause rivers to overflow, cause flash flooding across urban and desert terrain, and cause storm drains to overflow when rainfall exceeds the level the system was designed to handle. Urban storm drain systems are designed to drain into a water course, and when that river or creek rises above the storm drain outlet, a protective flap closes to prevent the river from running into the town. Thus, the water in the storm drain no longer has an outlet, and the storm drain inlets along roads begin to back up and flood adjacent streets and properties. In 2021 a storm that killed 22 people led to a lawsuit against CSX for failure to properly maintain a culvert that captured debris and was alleged to have led to a "tidal wave" that inundated property and killed several of these people (Satterfield, 2022). In 2022 inland flooding in Eastern Kentucky and West Virginia resulted from a thunderstorm that dropped 4 inches of rain per hour over five days, equaling 600% of normal. The flooding led to 39 deaths and the destruction of homes and infrastructure (FEMA, 2023a), including the loss of bridges and inundation of rail lines (Kelley, Rojas and Robertson, 2022) .

Inland floods can also be caused by snow that melts too quickly and overwhelms rivers and other drainage courses. Climate change causes the warmer atmosphere to hold more water, making cold weather storms produce more snow. Rain on snow storms in spring are a primary cause of extreme snow melt (FEMA, 2023a). Climate change also results in hotter temperatures in the mountains in the spring, causing early and abundant snow melt (FEMA, 2023a). Snow melt was responsible for the Great Flood of 1997 in Grand Forks, for example (Macek-Rowland, 1997).

Changes to topography also cause inland flooding (FEMA, 2023). Agricultural areas absorb rainfall, with water percolating into the ground and finding its way to the aquifers, leaving little runoff. Once the land is developed for housing or other urban uses, there is much less absorption, leading to

greater runoff. Today most states require retention basins for large developments to give the rain runoff a place to accumulate harmlessly. Until the 1980s these basins were not required, and the runoff from many urban and suburban developments is carried to watercourses by a drainage system that may become overwhelmed with heavy rains, causing inland flooding. Delivery of urban runoff by the storm drain system can also cause rivers and creeks to overflow their banks, causing flooding outside of the normal water courses.

Inland flooding is a threat to railroad infrastructure in large open flat areas, like prairies and deserts, and along rivers. The mile long Union Pacific train that was derailed after Tropical Storm Hilary in Coachella Valley is an example of damage from inland flooding. In May, 2024 Texas experienced multiple storms, with heavy rain, winds, and hail. Multiple railroads prepared for the storm with maintenance work to prevent damage. Union Pacific installed 75 generators and raised 3.5 miles of track. Storm damage impacted several railroads. BNSF had a track washout and Union Pacific had 24 cars derail in west Texas (Texas Rail Advocates, 2024).

In June of 2024 BNSF suffered infrastructure damage in its Midwest service areas. A bridge spanning the Big Sioux River at the Iowa/Nebraska border collapsed, but had been closed due to safety concerns after inspection, so it was empty. Other tracks were covered with flood debris and damaged, requiring rerouting of trains to maintain service. Related road closures inhibited the railroad's ability to move restoration equipment and personnel to the damaged areas (BNSF, 2024).

Natural Hazards and Rail Operations

A variety of natural hazards related to climate change can impact rail equipment, infrastructure and service. The railroads will be cooperating with state DOT to get road access to areas where trains need repairs or rerailing. They will be working with local emergency managers for access to power and communications systems. They may need to coordinate with fire personnel to work with the railroads' fire trains to mitigate damage to rail infrastructure and equipment from wildland fires. Understanding and using ICS will make the multi-jurisdictional events easier to manage, and communication with emergency responders clearer.

ICS, CLIMATE CHANGE AND RESPONSE

ICS for Rail Course

A course of study has been prepared for rail personnel to teach them the critical aspects of ICS and the roles of rail in climate change-related natural disasters. This course is designed to build on the existing training available for using ICS in a hazardous materials emergency. Its guidance is intended to be used primarily in natural disaster events when multiple jurisdictions must collaborate to resolve a problem.

An activity related to the course is building a Supervisor's Kit to support the use of ICS at the scene of a natural hazard event. The kit is made from a cardboard moving box and packing sleeves. It contains the most commonly used ICS forms, an ICS Field Operations Guide, and a set of cards designed to provide guidance for the activities of the first 15 minutes of an event if train crews or maintenance of way teams are the first responders on the scene.

Roles for Rail Personnel

Role of SME

An emergency that occurs on railroad property will usually result in the assignment of an immediately available rail staff member as the Subject Matter Expert (SME). If it is an event involving a train, the conductor would normally be the SME, as they have documentation about the train, its operations, and its consist. This position is part of the Planning/Intelligence Section and provides information about rail operations and cargo, including rail resources that might be available to help during the event. This person's role is to provide advice and railroad knowledge that will assist the Incident Commander in making good decisions about handling the event.

Role of senior transportation officer

The senior transportation officer is the railroad's official representative to the Incident Command. This person is usually a senior manager in the region and would be dispatched from their normal work place at the time of need, so their arrival might take an hour to several hours. This person may be part of the Operations Branch, or may be the railroad member of a unified command structure. This person is empowered by the railroad to make decisions and commitments on their behalf. This person might commit rail equipment, personnel and resources to the resolution of the event.

Operations and emergency response equipment

The IC might request the use of railroad equipment to resolve the problem. This might include fire trains for wildland fire response, train cars to help moving essential supplies or heavy equipment, or the use of trains to access remote locations.

Logistics and supporting resources

In past events railroads have provided many emergency response resources to benefit communities, businesses and government agencies. For example, railroads have transported essential response supplies like water, food, and fuel and managed ICS communications services using railroad resources.

Operational considerations for rail

Most first responders have little knowledge about how trains operate or the larger rail system. Some fire departments have received training from rail personnel on working safely on the rail property, but few know how the cars operate, including how brakes and doors are powered and controlled. It is critical that rail personnel are available to guide the Operations Section Chief in managing a response that includes the track, right of way or rail equipment.

Priorities and objectives for rail

The primary objective for rail representatives is to ensure safe operation on or near rail property. The second priority is supporting the community that is experiencing the disaster event. The AAR notes rail's commitment to help people in need by using its resources to bring the event to

a timely close. AAR notes that railroads are resilient to climate change because they constantly prepare for these events.

Railroad personnel include civil engineers and skilled trades people who can repair infrastructure efficiently. Inspectors set priorities for repairs and replacements. Drone operators collect information about the disaster, especially from areas that are unsafe or inaccessible for humans. “It is not just their own infrastructure that railroads rebuild; they care deeply for the communities their trains travel through and will often bolster local relief efforts by delivering food and water, removing debris, transporting evacuees or donating to relief efforts” (AAR, n.d., n.p.).

Assuming IC for Rail

In some instances a disaster may occur on the railroad’s property that involves life safety issues. In that case the IC will normally be the local fire department, which will oversee rescue and medical care. Once all life safety issues have been resolved, the law enforcement department will determine whether there is a need for a criminal investigation or protection of evidence. When both of those areas of concerns have been resolved, the IC will usually be turned over to the senior railroad manager present. That person will carry forward the response and recovery, using ICS as long as there is a multijurisdictional element to the event. Once only rail personnel are involved, the railroad may continue using ICS to organize the activities, or may resume its day-to-day operational system.

About the Authors

Frances L. Edwards, MUP, PhD, CEM, is Deputy Director of the National Transportation Security Center at the Mineta Transportation Institute. She also teaches courses for TSA Surface Inspectors through ENSCO. She is a Certified Emergency Manager with more than 20 years’ field experience.

Daniel C. Goodrich, MPA, CEM, MEP is a Senior Transportation Security Scientist with the Mineta Transportation Institute. He is a Certified Emergency Manager, a Master Exercise Practitioner, a Professional Continuity Practitioner and a Certified Security Specialist. He is a FEMA-certified instructor for the ICS course suite.

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