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Featured in This Issue

About the Cover: Communities assume certain levels of risk every day from threats that originate from space, from other people, or from the Earth itself. The challenge is finding the right balance between acceptable risk and preparedness actions. (Source: ©iStockphoto/CharlieAJA)

Balancing Risk – Understanding & Preparing for Catastrophes

By Catherine L. Feinman

Space weather, nuclear, and catastrophic natural disasters are just lying in wait for the right combination of conditions. Although it is not possible to plan specifically for every type of threat – imaginable and unimaginable – it is necessary to weigh the risks associated with various threats and take sufficient actions to mitigate the devastating effects.

On 27 April 2016, William (Bill) Murtagh, assistant director for space weather at the Office of Science and Technology Policy, Executive Office of the President, addressed leaders from government and industry to share updates on the National Space Weather Strategy and Action Plan and the related tasks and subtasks that are now being assigned to various federal agencies. The strategy urges all community stakeholders to plan and exercise for long-term regional and nationwide blackouts, which would have profound implications for business continuity and disaster planning. Successful mitigation requires a higher level of local community sustainability, especially in lifeline infrastructures such as power, communications, water and sewer, healthcare, emergency management, and law enforcement. High-impact incidents may make it unlikely for outside help to arrive within four days. Forty or 400 days may be more likely.

Developing a National Strategy

Drivers behind the new strategy include: societal and economic impacts; and implications related to losing technology, electric power, and GPS because of the nation's reliance on such technology. After 10 months of development by space weather scientists, preparedness professionals, and policy subject matter experts, the National Space Weather Strategy and Action Plan were introduced in October 2015. However, Murtagh acknowledged that developing the strategy and action plan was the easy part, implementing them will be much more difficult. Therefore, the following six goals were created:

- Establish benchmarks with actionable numbers for space weather events such as induced geo-electric fields, ionizing radiation, ionospheric disturbances, solar radio bursts, and upper atmospheric expansion
- Enhance response and recovery capabilities
- Improve protection and mitigation efforts, such as public information templates for warning messaging
- Improve assessment, modeling, and prediction of impacts on critical infrastructure such as vulnerability assessments of communication systems

- Enhance space weather services through advancing understanding and forecasting
- Increase international cooperation (international effects make it different than typical disasters; effects on magnetic field affect places around the world)

Following Murtagh's presentation, a panel of subject matter experts shared their perspectives from various disciplines on how the strategy and plan will affect business/government continuity and disaster planning.

Healthcare Impacts

Terry Donat, M.D., is the co-chair of the InfraGard's Electromagnetic Pulse Special Interest Group (EMP SIG) Health Advisory Panel and described healthcare as "an indoor sport," with the objective of keeping people healthy. Although space weather may not seem to have a direct effect on healthcare, there are vulnerabilities such as the industry's reliance on infrastructure, technology, fixed facilities, electronic medical records access, and global supply lines. He stated that limited contingent communication between facilities is a significant vulnerability that is often overlooked as circumstances leading to its use are deemed unlikely. As such, it is critical that healthcare providers understand how space weather could affect them directly.

He described two coordinating entities: the sector coordinating council of the U.S. Department of Homeland Security and U.S. Department of Health and Human Services, which released its sector-specific plan in May 2016 to specifically include space weather; and the joint commission on health coordination, which mandates a 96-hour power supply in many areas or aligned with each state's regulations for healthcare facilities. However, space weather is not included in the risk assessment vulnerabilities, and the secondary and tertiary effects are not addressed. The joint commission and other medical organizations, particularly those engaging healthcare executives would help promulgate any necessary information for planning.

Donat explained that, although this problem is unfamiliar to many in the healthcare industry, some measurable factors could be used to inform healthcare workers – for example, threatening space weather conditions that could lead to greater impact. Murtagh reminded attendees that, before the 2010 volcanic eruption in Iceland, many in Europe were unaware of any local threat.

Mental Health Impacts

Dr. Judith Boch is a clinical psychologist at the University of Colorado, Colorado Springs, Trauma Health and Hazards Center and addressed the psychological effects of warnings and public messaging. She emphasized that people are a resource that require psychological resilience. If people are not functioning, then the physical infrastructure around them does not have as much significance. Preparedness and resilience for the human factor requires conservation of intangible resources, such as self-efficacy, problem-solving ability, social support systems, and knowledge. Individuals are part of a bigger system, so systemic issues require support in order to sustain the ability to garner existing or remaining resources for survival. A smartphone is not needed in order to help someone else.

Although the mental health sector cannot inoculate people, it can help them prepare for such events by practicing in advance with small- and large-scale exercises. She pointed out that human resilience needs a clear way to approach the space weather issue and psychology has a lot that it can contribute to the resilience discussion. For example, when telling the public about space weather, the warning information needs to be clear, with a plan attached, with expectations of the public and of the agencies. As people adjust to new ideas and concepts, the topic becomes part of the language and the mitigation efforts a way of life.

Private Sector Impacts

In the private sector, Daniel Gregory is the chief executive officer for Pos-En, a microgrid developer. Over time, the perspectives on space weather effects have changed, with a lot of infrastructure now being protected against non-extreme events. He pointed out that people make 20-year investments, so they need to design the infrastructure to withstand 20 years of potential threats. Unfortunately, he added, many people do not adequately plan for electromagnetic and cosmic events, even though such incidents can have devastating consequences.

He suggested addressing issues with the public in a cost-effective manner in order to be meaningful. With technology that can protect the electric grid, reboot equipment, and provide sufficient back-up power when hit with an electromagnetic pulse, he said the problem is solvable. Attendee William Kaewert suggested finding ways to raise public awareness of this critical issue by leveraging popular media such as climate change activists have since the 1990s to force the spending of billions to avert a potential catastrophe far in the future. In contrast, no monies have been spent to protect the U.S. power system from EMP and space weather, the effects of which would be immediate and castastrophic. The destructive power of each these effects is massive, and has been measured and documented.

Public Sector Impacts

El Paso County Colorado Commissioner Peggy Littleton addressed the space weather issue from a public sector perspective. Her "You're On Your Own" (YOYO) message helps her county better prepare for any possible catastrophic incidents. She encourages communities in her area to remember that they are their own first responders. Ways to do this include an annual zombie run with educational tools – for example, what to do for power, communication, medication, connection to family and friends, etc.

Other programs used by community members in her area include: Lighthouse Prime, which is a community-driven initiative to establish communication within the community; and SNAP (Seattle Neighbors Actively Prepare (SNAP). For catastrophic long-term incidents, resilient communities cannot become too dependent on first responders and military; businesses, organizations, and individuals must find ways to continue operations despite infrastructure failures. Littleton mentioned the Great American Campout and school initiatives (engaging parents through their children) as ways to get preparedness to the local level and help community members learn how to prepare.

Military Impacts

Captain Arthur Glynn is the Command Center Director for NORAD and USNORTHCOM, where aerospace defense is a daily concern because space weather affects the sensors protecting North America and the ability to respond to threats such as missiles, cyberthreats, etc. With the primary mission of protecting the homeland, the U.S. Department of Defense (DOD) has developed a keen ability to plan well, especially for crisis action planning. This ability could be used to facilitate planning efforts within communities.

With solar weather being a major concern, Glynn mentioned some solutions that the DOD is currently implementing, such as: cyber-secure smart grids; and islanding of military bases, with renewable energy, diversified resources, and back-up generators. Lessons should be taken from the DOD's experience to apply such best practices to civilian areas. It is difficult to determine the exact implications of a long-term outage that lasts months or more.

As the chief executive officer for Jaxon Engineering and Maintenance, which performs electromagnetic pulse (EMP) testing, Randy White has observed significant changes and solutions develop over the years – for example, from missile warnings and communication technology to the ability to shoot missiles out of the sky. Being able to survive an EMP, solar flare, or other incident that disables the electric grid for long periods requires that equipment and technology be properly protected.

Public Policy Impacts

William Harris, J.D., is the attorney and a director of the Foundation for Resilient Societies and chair of the EMP SIG Legal Advisory Panel. As an international lawyer specializing in arms control, nuclear non-proliferation, energy policy, and continuity of government, Harris described the cost-recovery opportunities by hardening the electrical grid and implementing standards to require protected transformers. By providing more robust opportunities for cost recovery, more regulatory authority, and more reliable environmental impact statements, communities will become more resilient.

From a legal perspective on healthcare, Harris mentioned how recent studies have shown the effects of solar weather on health hazards, but public policy is challenged because some health studies show increased cardiac and blood pressure visits to emergency rooms during solar storms; whereas other studies show reduced cardiac stress indicated by patient-worn cardiac monitors. Meta-analysis could provide better statistics for space weather consequences – for example, to determine whether there would be an influx of patients with cardiac and other health issues when power is lost during solar storms.

Legislation enacted in 2015 includes:

- The Fixing America's Surface Transportation Act (FAST Act, H.R. 22, Public Law 114-94), which vests emergency powers in the President and Secretary of Energy, pertinent to grid restoration during solar storms; and

- Section 1089 of the National Defense Authorization Act for FY2016 (S. 1356, P.L. 114-92), which re-establishes the Congressional Commission on Electromagnetic Pulse (EMP) and requires assessment of both manmade and solar-derived electromagnetic pulse hazards.

A Global Challenge

Working closely with the United Nations for global standards on space weather and creating a national risk assessment that includes space weather, the U.S. federal government and other planning partners are introducing new space weather legislation to inform the private sector on what actions need to be taken. The new National Space Weather Strategy and Action Plan help communities build actionable items to address significant threats. Even though some people may not care about space weather, they should care about the consequences of space weather. Emergency response planning requires dependable predictions in order to make sound decisions. The global challenge now is to inform policy makers and leaders of partner nations to coordinate an international strategy through federal and nonfederal stakeholder collaborations.

In This Issue

Charles Manto leads this issue of the *DomPrep Journal* with an article about how the new strategy and action plan have created a historic shift in emergency preparedness planning – from short-term to long-term. Joshua Sparber and Benjamin Dancer, who attended the Space Weather Conference in April, each share some key takeaways from the event: space weather models, effective research tools, and electrical systems protection. Dana Goward shares some concerns about electric grid and global positioning system vulnerabilities, with a suggestion for a possible solution.

The final two articles in this issue address other incidents that could have similarly devastating consequences for critical infrastructure, leading to long-term recovery efforts. Jerome Kahan shares a follow-up article to expand on issues concerning nuclear proliferation in the Middle East. Arthur Glynn closes the issue with a looming threat that will cause severe destruction in its path if communities are not fully prepared. Space weather incidents, human-caused disasters, and natural hazards all have the ability to cause long-term consequences, so planning efforts must begin now.

A special thanks goes to Charles (Chuck) Manto for organizing the EMP-SIG space weather discussion, and to all the participants, authors, and sponsors who contributed to this edition of the DomPrep Journal.

Catherine Feinman joined Team DomPrep in January 2010. As the editor-in-chief, she works with subject matter experts, advisors, and other contributors to build and create relevant content. With more than 25 years of experience in publishing, she heads the DomPrep Advisory Committee to facilitate new and unique content for today's emergency preparedness and resilience professionals. She also holds various volunteer positions, including emergency medical technician, firefighter, and member of the Media Advisory Panel of EMP SIG (InfraGard National Members Alliance).

Space Weather – A Historic Shift in Emergency Preparedness

By Charles (Chuck) Manto

For the first time since the demise of the civil defense program of the Cold War, the federal government has made one of the most significant modifications to its emergency preparedness message. A three-day emergency kit is no longer sufficient to prepare for emerging threats, whether coming from Earth or from space.

Instead of implying that U.S. communities can always count on being rescued from any disaster in four days – requiring three days of food and water to stay comfortable – the implication now is that local communities might not always receive assistance for a much longer period of time. The source of this change is the new Space Weather Strategy and Action Plan, which were released on 29 October 2015 and explained again at an April 2016 Space Weather Workshop.

The NOAA Space Weather Prediction Center hosted its annual Space Weather Workshop in Broomfield, Colorado, the week of 27 April 2016. This year was special because of the intimate involvement of the White House Office of Science and Technology Policy, which provided keynote addresses and the 2015 promulgation of the National Space Weather Strategy and Action Plan.

Of special interest to the emergency management community is the second of six goals of the strategy that contain the following four elements:

- "*Complete an all-hazards power outage response and recovery plan:* for extreme space weather events and the long-term loss of electric power and cascading effects on other critical infrastructure sectors.
- Other low-frequency, high-impact events are also capable of *causing long-term power outages on a regional or national scale*.
- The plan must *include the Whole Community* and enable the prioritization of core capabilities.
- *Develop and conduct exercises* to improve and test Federal, State, regional, local and industry-related space weather response and recovery plans: Exercising plans and capturing lessons learned enables ongoing improvement in event response and recovery capabilities."

Historic Shift in Emergency Preparedness

Long-term national outages of power and other infrastructures that depend on them – including water, sewer, communications, and healthcare institutions – could mean that

the entire country might undergo a catastrophe and might not be able to quickly mobilize resources to help many communities. So, unlike the cases of Hurricanes Katrina or Sandy, where help could come within a week or so, help might not arrive in 40 days, or even 400 days.

As awful as that sounds, there might actually be good news for the preparedness community. In the past, having a three-day supply of food and water to some may have seemed a waste of time since they would be rescued in four days anyway. Placing the day-to-day normal disruptions in the context of something much larger and very likely to occur during their lifetimes may motivate them to reconsider this strategy and take greater responsibility to be resilient.

"An extreme space weather event – like, the 1859 Carrington event – could create a continental-wide disaster according to the National Strategy, and has a 6 to 12 percent likelihood of occurring every decade."

An extreme space weather event – like, the 1859 Carrington event – could create a continental-wide disaster according to the National Strategy, and has a 6 to 12 percent likelihood of occurring every decade. That is a significant likelihood for such a calamitous occurrence. Including high-impact threats in overall disaster planning scenarios provides a sense of importance and immediacy that should compel the whole community to get involved, rather than simply hoping for someone to rescue them.

Preparedness Rhetoric – Beware of Pre-Traumatic Stress Syndrome

Merely discussing high-impact threats can also have a paralyzing effect if not approached properly. When someone is faced with an overwhelming scenario from any high-impact threat, it may seem easier to give up and not even think about the problem let alone begin to plan or take action to mitigate it. The response that causes a shutdown could result from emotional, financial, legal, or political reasons. A new phrase "pre-traumatic stress disorder" could be used to describe the bias many people have toward bad news. For this reason, it is important to provide a sense of hope while conveying a high-impact threat message. It is best to do that within the first minute of conveying the message to avoid having the listener minimize or block the entire conversation.

It helps to mention this problem upfront when discussing plans and conducting workshops or tabletop exercises. It also helps to warn the participants that a given planning exercise might be intended to push the plan to a failure point. In this way, the plan – rather than the participants – fails, which can be an important step in the process for improving plans.

Although the Space Weather Strategy focuses on space weather, it mentions that there are other high-impact threats that can cause similar disasters – for example, manmade electromagnetic threats, cyberattacks, or coordinated physical attacks. When presented together for consideration as an all-hazards collection, the likelihood of any one event in

the collection occurring is significantly higher. In the case of natural disasters, preparation can improve the odds of passing through the disaster with less loss. However, in the case of manmade threats, being at least partially prepared could lessen the likelihood of experiencing the disaster in the first place, since bad actors will be tempted to go after easier targets. Conversely, not taking basic precautions can actually increase the odds of a problem. Having unprotected critical infrastructure is like leaving a sign in front of a house asking people not to come in and take the pile of cash from the table, and then leaving the door open.

Military Warning About Manmade Electromagnetic Threats

In October 2015, the Defense Threat Reduction Agency (DTRA) made a similar request for help in its Small Business Innovation Research Program request for proposal (RFP). In the RFP, DTRA declared that electromagnetic pulse from small nuclear devices detonated in the upper atmosphere or attacks by high-powered microwave devices driven in panel vans could render civilian power grids inoperable where restoration may take weeks, months, or "may not be possible."

This Department of Defense (DOD) RFP further states that, "Such methods should aide in the development of islanding at DOD sites to ensure survivability to *geographically large [electromagnetic] threats*. These methods may also be applied to the *commercial sector and other areas of the government: hospitals, civilian infrastructure, businesses, etc.*" The declaration of DOD is clear: military bases and the civilian institutions that they depend on are overwhelmingly vulnerable to their own near complete reliance on unprepared civilian power grids. The DOD has already started the process of changing by developing distributed energy systems under their own control. However, due to minimal funding, these systems rarely have power storage such as batteries to provide resilience in case of a grid collapse and are even less likely to have EMP protection. This RFP signals a change in this overdependence on extremely vulnerable systems.

This RFP also goes beyond operational and disaster recovery procedures that try to indefinitely work around the problem of no power. Instead, it calls for practical EMP-protected microgrids as a solution to the problem. As a result, this RFP provides hope that individual institutions and communities can in fact protect themselves as part of a prepared whole community approach. However, it also reinforces the message that local communities must become more resilient and not merely wait to be rescued.

High-Impact Threat Assessment & Planning Support

In May 2016, the U.S. Department of Homeland Security (DHS) published Regional Resiliency Assessment Program findings that show similar vulnerabilities of the entire cyber industry (internet, telecommunications facilities, and data centers) to power grid vulnerabilities such as EMP. Two of its key findings include:

- "Data center and content providers may not have a pathway to contribute to resilience efforts and/or communicate criticality during an emergency" – conducting a workshop for the data center community would facilitate communication needs and access to critical resources.
- "Data centers and network providers should consider electromagnetic pulse (EMP) and radio frequency (RF) generator effects in developing resilience and protective measures plans" – conducting additional workshops would facilitate information sharing for EMP/RF threats, protection, and risk management.

In December 2015, the InfraGard National EMP Special Interest Group (SIG) presented copies of its Triple Threat Power Grid Exercise program to leadership of DHS, FEMA, and the National Guard. This program takes an all-hazards approach to high-impact disasters by looking at cyber, space weather, and manmade EMP threats that could result in a 1-, 3-, or 12-month national power outage. Since then, emergency management leaders at the local, state, and federal levels have begun to conduct these high-impact threat workshops nationwide.

InfraGard EMP SIG leaders in the private sector are working with the DHS Office of Infrastructure Protection and National Guard leaders to assist states and local governments in hosting workshops and tabletop exercises to test their disaster and recovery plans in light of these high-impact threats. Local protective security advisors of DHS, EMP SIG, or other InfraGard leaders can be contacted to obtain copies of the program including read-ahead material, a PowerPoint presentation, and customized versions of the facilitator's guide.

Later in 2016, the EMP SIG is expecting to release a "cookbook" of planning assistance that can help communities improve their plans. DomPrep readers are welcome to participate in these discussions and tabletop exercises by checking the DomPrep Calendar for events such as the tabletop exercise of the Society for Disaster Medicine in Maryland in late July, the InfraGard National Congress in Orlando, Florida, the week of September 12, the INCOSE/ NASA/InfraGard Energy Tech Conference tabletop exercise in Cleveland on November 2, and the EMP SIG sessions of the Dupont Summit on December 1-2.

Charles (Chuck) Manto is chief executive officer of Instant Access Networks LLC, a consulting and research and development firm that produces independently tested solutions for EMP-protected microgrids and equipment shelters for telecommunications networks and data centers. He received six patents in telecommunications, computer mass storage, and EMP protection and has another one pending for a smart microgrid controller. He is a senior member of the IEEE and founded and leads InfraGard National's EMP SIG. He can be reached at cmanto@stop-EMP.com

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Preparing for Everything Under the Sun

By Joshua Sparber

The Space Weather Conference in Broomfield, Colorado, on 25-29 April 2016 focused on improving space weather models and exploring more diverse and effective research tools. Current U.S. policy has shifted in favor of more research and funding, which can only be accomplished through better cooperation between the public and private sectors.

A bright future awaits those whose interest is modeling solar events and the vulnerability of technology to solar events. Attention from the White House has stimulated increased funding, awareness of a need for improving modeling capabilities, and the need for joint government to industry partnerships. Latest policy updates are the Space Weather Research and Forecasting Act (S2817), the October 2015 National Space Weather Action Plan, and the October 2015 National Space Weather Strategy. The commercial sector will assist with increased research and technological operations, including small businesses conducting independent research. The United States Geological Survey has also been given a $1.7M increase in funding.

Status of Space Weather Research

The conference had a strong focus on increasing insight into the current sunspot Cycle 24, the sunspot cycle the sun has been undergoing since 2009. The year 2020 is the anticipated beginning of Cycle 25. Each morning, a prediction of the day's space weather was advanced. The subjects of many of the talks were about advancements in Cycle 24 event predictability. These predictions would include sunspot counts, size and speed of coronal mass ejections and solar winds, Earth-based magnetic and electric fields, interactions of Earth and solar fields, and geoelectric sensing for individual power grid stations.

The following solar-scanning satellites will become available in the near future. The National Oceanic and Atmospheric Administration's (NOAA) Deep Space Climate Observatory (DSCOVR) will be operational in June 2016. DSCOVR will be NOAA's first deep space observatory, a "space buoy" with a National Space and Aeronautics Administration (NASA) four-megapixel charge-coupled device camera. This satellite, deploying a million miles out, will enable scientists to assess better data on how solar storms impact Earth's ozone, aerosols, cloud height and phase, vegetation properties, surface hotspots and Ultraviolet radiation.

NASA's Solar Probe Plus should launch in July 2018. This satellite's ultimate 3.7 million mile proximity from the sun should at least assist existing instrumentation to gather better solar data. Geostationary Operational Environmental Satellite-R Series (GOES-R), a collaborative program of NOAA and NASA, has a launch date of 13 October 2016. Through a United States-Taiwan partnership, Constellation Observing System for Meteorology, Ionosphere, and Climate (COSMIC-2) is being readied; however, funding is not yet available.

These latter two satellites will more intensively gather actionable data on solar events affecting Earth's weather.

Other satellites study the solar "architecture" that leads to solar effects. The Solar and Heliospheric Observatory (SOHO), launched in 1995, now shares this duty with at least two other satellites. The Solar Terrestrial Relations Observatory (STEREO) employs two satellites to stereoscopically image coronal mass ejections, and the Solar Dynamics Observatory (SDO) takes helioseismological measurements.

Many government agencies are involved in data gathering and preparing for Earth weather and space weather extremes: NOAA, the United States Geological Survey, the 557th Air Force Weather Wing, Federal Energy Regulatory Commission, the National Energy Reliability Corporation, the National Research Laboratory, the Air Force Research Laboratory, the European Space Agency, and the Advanced Physics Laboratory of Johns Hopkins University. NOAA is now planning memorandums of understanding (MOUs) between itself and NASA, and itself and the National Science Foundation. These MOUs should help mold the give-and-take relationship between research and research's operational implementation: research to operations; and operations to research.

On 28 April 2016, international speakers also described the space weather programs of Japan, Korea, Mexico, Australia, and Ethiopia – all of which are unique in their own ways – and contributed an assortment of viewpoints and measurements to the existing pool of information. One good example is the Australian Energy Market Operators (AEMOs) that protect critical Australian power infrastructure. AEMOs have installed geomagnetic-induced current sensors to help quantify impending solar storm risks to existing Australian power grids.

Another example is the Japanese development of realistic 3-D models of solar flares and a whole atmosphere model called the Ground-to-topside model of Atmosphere and Ionosphere for Aeronomy (GAIA) model. There was also room for a discussion of the historical development of solar observation. The changes in sunspot counting through history and the history of the founding of the NOAA center in Boulder were also highlighted. A side room was reserved for an international crowd of investigators and researchers to display their projects. There were over 60 posters and displays from sources of worldwide scope. One display showed an iPhone application with a 3-D display of an Earth Aurora space weather model.

Touchstones of Progress

A salient point of the conference was the search for a "money chart," a depiction of the danger of a space weather event so crystal clear that decision makers could consider it "actionable." A Hurricane Sandy depiction was an example, showing the landfall pattern within a tolerance band. Space weather instruments could piggyback on a larger satellite. These "CubeSats" would save the fuel and the expense of a separate satellite. Retired Admiral Thad Allen (who led the Coast Guard's efforts following Hurricane Katrina and currently

serves as executive vice president for Booz Allen Hamilton), retired Admiral Conrad Lautenbacher (now chief executive officer for GeoOptics), and others debated pathways to the space weather "enterprise." Conference takeaways included:

- Improving data will evolve understanding from space weather into space climate.
- A part of future capability should be "now-casting" as well as forecasting.
- Joint government/academic/commercial ventures will contribute significantly to scientific advances in the United States during times of limited federal budgets.
- The White House is concerned with space weather and will assist worthy projects.
- Successfully addressing highest impact concerns involves international partnerships.
- Better models will enable more research pushes from users (operations to research).
- Models are being linked together for a more comprehensive view of effects.

The NOAA Boulder Space Weather Prediction Center

The tour of the NOAA Boulder Space Weather Prediction Center (David Skaggs Center) features a downstairs monitoring center, several floors of offices, and a large suspended spherical projector upstairs, named Science on a Sphere. The glassed off solar weather monitoring control room hosts multiple rows of multicolored depictions of daily solar behaviors, with controls underneath. In the visitor area, a large screen transmits these same dynamics. On weekdays, monitors check portions of solar activity and clone information received into daily reports. On weekends, weekly reports are compiled.

In a darkened room, Science on a Sphere displays dozens of projected Earth, sun, planetary, and exoplanetary scenarios in color. These displays result from the projection automation of four computer-controlled cameras. A small sampling of Earth displays were 3-D mappings on the sphere of earthquakes, auroras, hurricanes, wind directions, ocean currents and acidity, carbon dioxide parts per million, worldwide disease vectors, and global air traffic (see Figures 1 and 2). These depictions can time-sequence into the future, rotate on the sphere in any direction, overlay latitude-longitude, and juxtapose attribute labels on the sphere itself – for example, the greatest height of a tsunami based on predictions of the expanding wave. Solar projections capture solar flares, coronas, coronal mass ejections, magnetic fluxes, sunspots, and coronal holes. Downstairs, a large 2-D touch screen mimics these 3-D projections. The 3-D projections can be rotated in any direction by a continuous motion of two fingers placed on the screen itself.

Radiation Experimentation

During the banquet on 27 April 2016, Earth to Sky Calculus, a group of young students led by instructor Dr. Tony Phillips, showed how inexpensive (crowd-funded) experiments

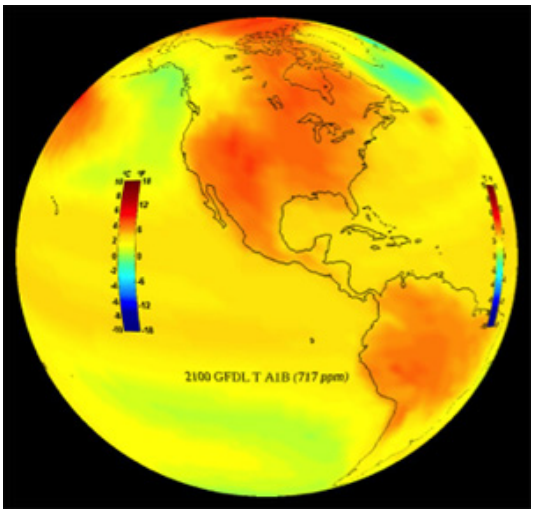

Fig. 1. Worldwide carbon dioxide effects on temperature. (*Source:* NOAA, 2010)

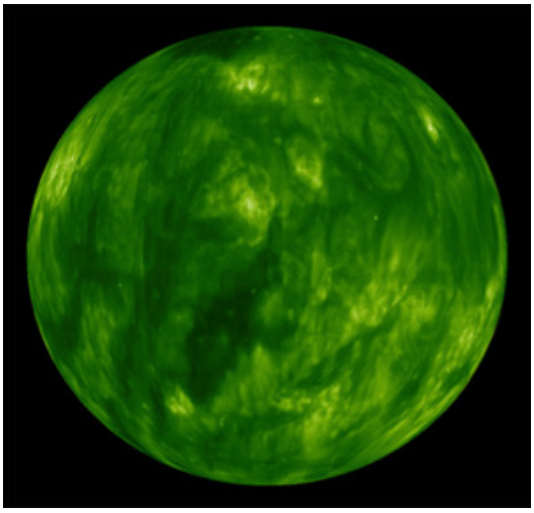

Fig. 2. Composite six-year map of solar active regions based on SOHO extreme ultraviolet observations. (*Source*: NOAA, 2010)

could form the basis for careers that will be needed in future space science and meteorology by agencies like NOAA. Their experiments yielded exceptional results for understanding the space weather/Earth weather nexus. As an example of an of this type of experiment, this group examined how solar radiation effects on the Earth and Earth life forms can be measured relatively simply and with a minimum of expense. Using a minimal set of instruments, they send weather balloons into the ionosphere, monitor them, and retrieve them after the balloons burst and the lunch box instrumentation gondolas parachute back to Earth.

They have also traveled by plane, comparing radiation dosages to their instrumentation per height and latitude-longitude. By coordinating their work with microbiologists, the group measured the effects of upper atmosphere radiation on single-celled Halobacteria and yeast. Although the uppermost ionospheric reach of the balloons (before bursting and falling) is similar to the surface of Mars, organisms with a radiation-resistant genotype heartily survived the whole journey. Under radiation, Halobacteria, fortunately also turn a yellow color, which grows darker with greater radiation dosage. A future research avenue could be providing visible checks on air pilot radiation dosage. In the future, it may be critical to know the extent of radiation dosage pilots receive during solar storms and solar flares.

Joshua Sparber, after receiving Air Radar training in the U.S. Marine Corps, spent 20 years in the electronics industry. After earning an MSEE from Cal State Fullerton, he has been 15 years with the U.S. Department of Defense, and is involved in system engineering for the government. He has been a member of the International Council on Systems Engineering since 2005 and received his Certified System Engineering Professional certification in 2007. He has been an active and interested member of various environmental groups and has persisted in a lifelong interest in environmental issues. He has just recently completed a masters in environmental policy and management, in which his thesis centers on the impact of naturally occurring electromagnetic pulses on the U.S. national grid and a search for possible system solutions.

Space Weather & Electrical Grid – GPS, the Weakest Link

By Dana Goward

Among the many important, yet weak, satellite signals that can be disrupted by space weather, the Global Positioning System (GPS) is undoubtedly the most important and the weakest. Two recent public discussions have highlighted the challenges this poses for the national electrical grid, both today and going forward.

In March 2016, the MITRE Corporation released information on "Smart Grid Use of GPS Time." The posted presentation stated that, "(The) Power Grid has a vital dependence on precise time for:

- Time-stamping of operational data (e.g., supervisory control and data acquisition – SCADA)
- Wide area situational awareness
- Synchronization of operations
- Grid management and control
- System and asset protection"

MITRE's most recent effort built upon a 2013 paper that specifically enumerated all the places where GPS timing information was used by electrical grids such as fault detection, substation control, and in SCADA systems.

In May 2016, Alison Silverstein of the North American SynchroPhasor Initiative (NASPI) spoke to the National Space-Based Positioning, Navigation, and Timing (PNT) Advisory Board. As part of a presentation with Netinsight, Silverstein downplayed the use of GPS time in the grid today, but indicated that it was going to be increasingly important going forward. She did acknowledge, though, that the grid is critically dependent on telecommunications and information technology networks, and that those networks are critically dependent on GPS time. Several examples of problems with the GPS signal, such as the January 2016 SVN23 anomaly (when half of the GPS satellites' time transmissions were off by 13.7 microseconds) and faulty installations – and their impact on electrical grids – were discussed. Going forward, she said, the electric power industry would be looking for more reliable, stable sources for wide-area synchronized time signals.

"Going forward, the industry would be looking for more reliable, stable sources for wide-area synchronized time signals."

At the same PNT Advisory Board meeting, Andy Proctor, lead for satellite navigation at Innovate UK and chair of the UK Government PNT Group, mentioned that his country was keeping eLoran on the air to provide timing for critical infrastructure and other uses. The idea is to combine eLoran, GPS, and Europe's Galileo satellite navigation and timing system signals as a way of providing trusted time to electrical, telecommunications, and information technology networks.

Pairing eLoran and GPS signals has currency in the United States as well. In December 2015, Department of Defense Deputy Secretary Robert Work and Department of Transportation Deputy Secretary Victor Mendenz told the U.S. Congress that the administration would build an eLoran timing system to help protect critical infrastructure. Unfortunately, little appears to have been done so far.

Dana A. Goward is president of the Resilient Navigation and Timing Foundation, chairman of the Association for Rescue at Sea, and a retired Coast Guard captain. He also is retired from the federal Senior Executive Service.

Electrical Systems & 21st Century Threats

By Benjamin Dancer

One leading researcher shares his insights into the existential threats that the electrical infrastructure faces. He proposes that a superhighway with electrical systems protected at multiple points is not only feasible, but it could help reduce carbon emissions, build electromagnetic resilience, and address major space weather events that could threaten the life and health of human populations.

Alexander MacDonald, the former director of the National Oceanic and Atmospheric Administration's (NOAA) Earth System Research Laboratory, gave a talk on 27 April 2016 entitled, "Create a 21st Century Electric System," at the Space Weather Workshop in Broomfield, Colorado. The workshop was co-sponsored by the NOAA Space Weather Prediction Center, the National Science Foundation Division of Atmospheric and Geospace Sciences, and the National Aeronautics and Space Administration Heliophysics Division.

MacDonald's talk was a presentation of a study that he published on 25 January 2016, in the journal Nature Climate Change. He laid out a plan to build an underground, high-voltage direct current (HVDC) superhighway by 2030 that could, "solve the two greatest problems the U.S. faces: the threat of human-induced climate change and the threat of massive homeland destruction from electromagnetic pulse (EMP) or solar ejections." This HVDC superhighway would be the backbone of a multi-point protected electric system (see Figure 1).

Reducing Carbon Emissions

A NOAA supercomputer was used to calculate future electrical costs, demand, generation, and transmission scenarios. The computer also crunched billions of bits of data from the country's weather history. The study concluded that an HVDC transmission infrastructure that uses converter stations to move power to the present AC distribution points could reduce energy loss and allow weather-driven renewable resources to supply 70 percent of the nation's electricity

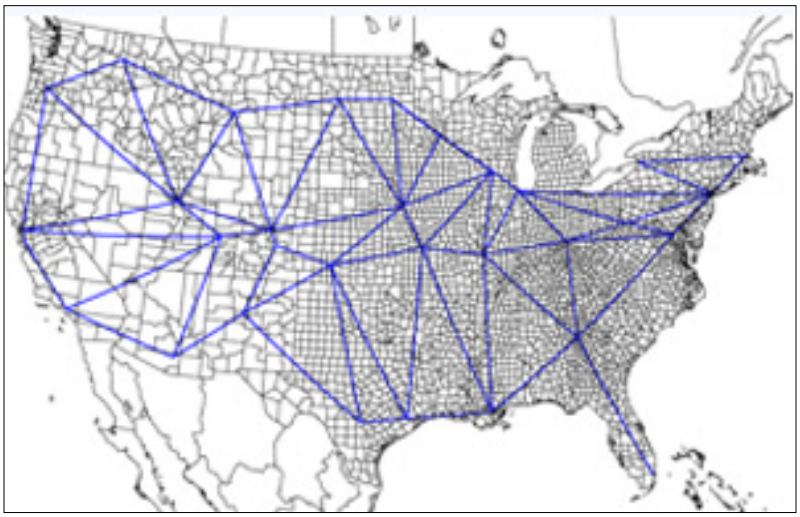

Fig. 1. An HVDC "Superhighway for Electrons." (*Source:* Alexander MacDonald, 2016)

without raising costs to the consumer. Moreover, implementing the plan would dramatically cut greenhouse gas emissions from power production.

"Our research shows a transition to a reliable, low-carbon, electrical generation and transmission system can be accomplished with commercially available technology and within 15 years," MacDonald said.

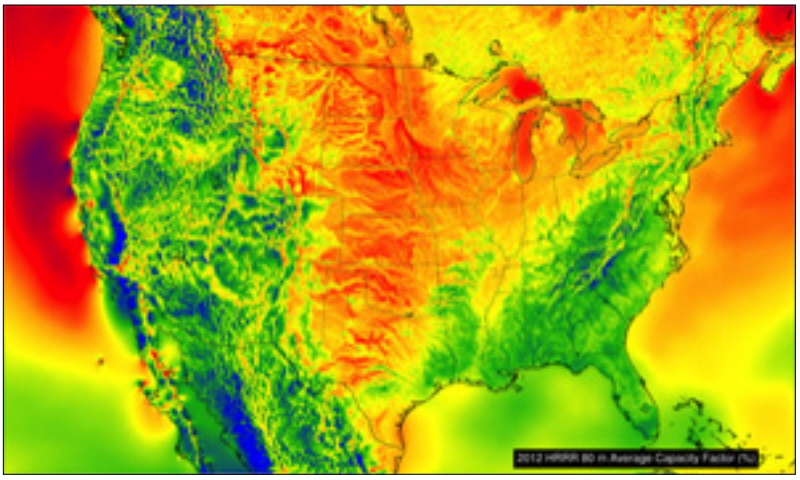

Fig. 2. A high-resolution map based on NOAA weather data shows a snapshot of wind energy potential across the United States in 2012. (*Source:* NOAA, 2016)

Because energy is available in the United States from solar or wind sources (see Figure 2), the solution to the problem of intermittent renewable generation is to ramp up the renewable energy generation system to keep pace with the scale of the country's weather systems. One of the greatest obstacles to a transition to renewable energy has been the problem of storage. A large and strategically placed renewable generation system solves the problem of energy storage by allowing electrons generated in one part of the country to be immediately transmitted to any other. This type of efficient transmission is not possible with the current infrastructure.

When describing the HVDC grid, MacDonald employed the analogy of the interstate highway system, which revolutionized the U.S. economy in the 1950s. "With an 'interstate for electrons,' renewable energy could be delivered anywhere in the country while emissions plummet," he said.

Building Electromagnetic Resilience

Citing the Report of the Commission to Assess the Threat to the United States from Electromagnetic Pulse (EMP) Attack, MacDonald concluded that the U.S. civilian infrastructure is essentially unprotected from an EMP attack. An EMP weapon could create an electromagnetic energy field that would damage critical components of the electric grid, including large transformers and supervisory control and data acquisition (SCADA) systems. The potential for damage is so catastrophic that an EMP attack poses an existential threat to the United States. "Today there are rogue states with specially designed EMP nuclear weapons," MacDonald said. "Tomorrow these weapons will be available to terrorists and any small state with a grudge and a balloon."

Addressing Major Space Weather Events

MacDonald also cited space weather as a potential threat. A coronal mass ejection the size of the 1859 Carrington event, or bigger, could pose a threat to the United States on the

same scale as an EMP attack. The Carrington event was a massive solar storm that caused telegraph systems all over the world to malfunction or fail.

The design of the proposed underground HVDC network would include protecting it from EMP. The cable system would be protected by an outer sheath that would function much like a faraday cage (a grounded metal screen surrounding a piece of equipment to shield it from electromagnetic influences). Moreover, the cable itself would be grounded at every junction. The converter stations would also be EMP protected.

"An important point," MacDonald said, "is that a protected HVDC network by itself is not enough. We would also have to take action to protect the backbone of the AC distribution system – maybe 5 percent of the AC system would have shields and very rapid response circuit breakers."

In a subsequent interview with the author on 25 May 2016, MacDonald described the importance of protecting the homeland from EMP. There are several mechanisms of destruction that have the potential to disable the power grid, including cyberattack, EMP attack, and space weather. When asked which of the threats caused him the most anxiety, MacDonald said EMP.

Over the course of the last 100 years, society has unwittingly evolved to become dependent on a vulnerable critical infrastructure. People 100 years ago did not need electricity to feed the population or to provide clean drinking water. Today they do. An EMP attack could disable the power grid and create an economic catastrophe on a scale unprecedented in human history. A sophisticated attack has an enormous potential for human casualties. Dr. Peter Pry, a member of the Congressional EMP Commission and executive director of the Task Force on National and Homeland Security, testified before a congressional subcommittee in 2014 that "a nuclear EMP attack ... could kill 9 of 10 Americans."

"The general idea is that a limited set of electric transmission and distribution should be protected," MacDonald said. "In the most likely scenario, where a large geographic area is impacted (e.g., the 10 most western U.S. states by a bomb above the Pacific off of California), there would be a large area with no services – no food, no heat, no fuel, no ability to provide medical or law enforcement, no drinking water, etc. Social breakdown occurs when large numbers of people become desperate and fight among themselves."

MacDonald concluded, "The idea of a robust system is that, if electricity can be made available at key points, services can be available that enable the larger, unharmed part of the U.S. to deliver aid. On the other hand, if the airports and gas stations aren't functional, and the ability to keep public roads, food, and water available are gone in a large area, the disorder and violence can become self-feeding fairly rapidly."

Benjamin Dancer, who works as an advisor and mentor at a Colorado high school, is the author of the literary thriller Patriarch Run, which explores the vulnerability of the nation's critical infrastructure to cyberattack. He also writes about education, parenting, sustainability, and national security. More about the author and the vulnerable critical infrastructure can be found at BenjaminDancer.com.

Nuclear Proliferation in the Middle East

By Jerome H. Kahan

Now that the Iran nuclear deal is in effect, it is worth exploring whether this agreement will in fact: (a) constrain Iran's efforts to build nuclear weapons and inhibit nuclear proliferation in the region; or (b) have unintended negative consequences that the United States and its negotiating partners did not or could not foresee.

"If Iran crosses the nuclear threshold, Saudi Arabia will follow suit, [...because the Kingdom] will not live in a world where Iran has a nuclear weapon and [...we do not]."
—The Wall Street Journal, 22 June 2011

As negotiations for the nuclear deal – officially called the Joint Comprehensive Plan of Action (JCPOA) – progressed, key Middle East nations waited while the United States, the four other permanent members of the United Nations Security Council, and Germany sought to reach agreement with Iran. Curtailing Iran's nuclear weapons programs, though, comes at the price of releasing a broad pallet of sanctions imposed by the United States, the United Nations Security Council, and the European Union that had hurt Tehran's faltering economy.

View From Saudi Arabia

With the promised JCPOA now in effect, pressure on the Saudis to gain a nuclear weapons capability has been reduced, but by no means eliminated. A still relevant analysis made by a congressional committee in February 2008, entitled "Chain Reaction: Avoiding a Nuclear Arms Race in the Middle East," concluded that, "an Iranian nuclear weapon frightens the Saudis 'to their core,' and would compel the Saudis to seek nuclear weapons." Even with constraints placed on Iran's nuclear program, increased worries by Saudi leaders over Washington moving closer to Tehran are not only straining bilateral relationships, but also contributing to Riyadh's nuclear weapons interests. Notwithstanding assurances that the United States is not weakening its security commitment, the Kingdom is considering a peaceful nuclear energy program that could provide a basis for developing nuclear weapons in 15 years, when Iran is free from the major JCPOA limits and could threaten the Saudis with nuclear arms.

The Kingdom does not currently have the technical knowhow, manufacturing infrastructure, or human expertise to develop a nuclear weapons capability – whether through a peaceful program that could provide the foundation for developing a bomb or a dedicated clandestine nuclear weapons effort, as assessed by David Albright in "Iran's Nuclear Program," originally published by the U.S. Institute of Peace in 2010 and updated in September 2015. In any event, seeking nuclear weapons through either of these routes would take many years and inevitably be discovered by the International Atomic Energy Agency (IAEA) as well as U.S. intelligence sources, and result in Saudi Arabia violating its commitments under the Nuclear Nonproliferation Treaty (NPT).

Private approaches could be made by Saudi leaders to their counterparts in Pakistan, China, or North Korea for assistance in making bombs or purchasing nuclear weapons. This extreme option was discussed by University of Southern California Professor Najmedin Meshkati, in "Atoms for Peace in the Persian Gulf: The Vital Byproduct of P5+1 Nuclear Agreement With Iran," which was published in the *Huffington Post* on 7 January 2014. Any indications that this might happen, however, would surely cause the United States and many other Nuclear Nonproliferation Treaty parties to press the Saudis not to go down this path. Such actions would result in the proud Kingdom being treated as a nuclear pariah in ways that would harm rather than help its security.

View From Neighboring Countries

Egypt did not favor the nuclear deal. Some believe Cairo might be pursuing its own nuclear option under the guise of a newly formed plan to increase peaceful nuclear energy programs if concerns continue to rise over the prospect of Iran repealing the JCPOA or Tehran being able to get out from under its constraints. However, most analysts believe this is unlikely due to financial problems, Egypt's membership in the NPT, and Cairo's position of leadership in the movement for a Middle East Nuclear Free Zone. If the Saudis were to show signs of wanting to obtain a nuclear weapons capability, however, this would certainly lead to Cairo reviewing its nuclear policy. In fact, with assistance from the USSR Egypt had an early interest in nuclear energy for peaceful and potentially weapons-related-purposes, but all such efforts were halted following the 1967 defeat at the hands of Israel.

While Turkey is situated in a notoriously "dangerous neighborhood," as described by the Nuclear Threat Initiative on March, 2016, it has relied on the security guarantees provided by the North Atlantic Treaty Organization for more than half a century. As a NATO member, Turkey would presumably evoke Article V of the Treaty if threatened by a future Iranian nuclear weapons capability, which should trigger actions by the three nuclear powers in the alliance – United States, United Kingdom, and France – to individually or collectively protect Turkey. With this option available, it would seem to be unnecessary for Ankara to acquire independent nuclear weapons.

Bahrain, Jordan, and the United Arab Emirates are among the other Middle East nations that have set overly ambitious goals for developing peaceful nuclear energy programs, which *TIME Magazine* correspondent Karl Vick characterized as an "emerging atomic derby," on 23 March 2015. If these programs come to fruition, which is problematic at best, they would provide a basis for some of these nations to breach their Nuclear Nonproliferation Treaty commitments and seek to acquire nuclear weapons – even though the near-term danger of a nuclear-armed Iran seems to have been averted. This explains why *NCR Today* on 22 February 2016 reported that, "Israeli sources are now raising the alarm that a nuclear arms race is beginning in the Arab world. The competition is fueled by fear of a resurgent and expansionist Iran and mistrust, especially on the part of the Saudis, of American policy in the region." Meanwhile, Israel is struggling to come to terms with the fact that the nuclear deal, which Tel Aviv strongly opposed, has gone into effect.

View From Israel

Reversing his extremely negative stance, Prime Minister Benjamin Netanyahu welcomed the JCPOA's comprehensive constraints on Iran's ability to develop nuclear weapons.

Additionally, the former head of Israeli Military Intelligence, Amos Yadlin, no longer sees Iran as his nation's foremost threat. On 20 July 2015, Yadlin stated that, "For at least the next ten years, the threat of nuclear armament in Iran has been reduced." Following the signing of the nuclear agreement and the lifting of sanctions, and after Israel responded to a series of Iranian-executed rocket attacks launched from Syria late in the day on 20 August 2015, the Israeli Defense Minister Moshe Ya'alon summarized the ambivalent feelings among Israeli leaders to this event, "What we've seen tonight is the prelude of things to come."

Not surprisingly, negative views toward the nuclear deal still influence Israel's domestic politics, driven by continued denouncements by Iranian Supreme Leader Ayatollah Ali Khamenei of the Jewish nation's right to exist and threatening it with annihilation, as in the *Slate* on 9 November 2014. These may just be inflammatory words, but in the event Tehran reinstates its nuclear weapons program by abrogating the JCPOA or after the stringent restrictions and transparency measures expire, the undeclared Israeli nuclear weapons force has the capacity to dissuade and, if necessary, respond to Iranian nuclear threats. Tel Aviv also will be able to launch preemptive conventional actions to destroy the nuclear infrastructure of Iran or any other Middle East nation that shows signs of heading down a nuclear weapons path. Yet, Israel will need U.S. military aid more than ever, given the volatile sectarian battles consuming the region and the likelihood of Iran using at least some of the billions of dollars unfrozen by the nuclear deal to incite proxy wars and conduct terrorist activities that can cause even greater instability in the region.

The Next Step for the United States

Praising the nuclear deal as a means of effectively curbing Iran's nuclear weapons program for at least a decade, President Barack Obama should reassure the Saudi leadership that the United States has no intention of trying to build relations with Iran at the expense of its longstanding relationship with Riyadh. Further, Obama should reassure the Kingdom as well as its Gulf allies that the U.S. pledge to safeguard all members of the Gulf Corporation Council from threats by Iran or any other nuclear-armed adversary remains credible. Finally, Obama needs to reassure all allies in the Middle East that the United States will help them to acquire the conventional arms and anti-terrorist capabilities needed to deal with any dangerous moves from Iran, even if Tehran stays bound by the JCPOA.

With U.S. assistance, Israeli vigilance, and efforts among allies in the region keeping Iran at bay without their own nuclear weapons, hopefully, Iran will be able to lose what has been jokingly referred to as its "most evil nation" status. More pointedly, given the constraints in place preventing Tehran from crossing the nuclear threshold, Saudi Arabia will avoid being put in the uncomfortable – and dangerous – position of living "in a world where Iran has a nuclear weapon" and the Kingdom does not!

Jerome Kahan is an independent analyst with over 40 years of experience on national and homeland security issues, including senior positions in the Foreign Service, the Brookings Institution, and the Homeland Security Institute. In addition to his publications, he has been an adjunct professor in the graduate school at Georgetown University and a member of the Council on Foreign Relations, with BS and MS degrees from Columbia University.

Cascadia Catastrophe – Not If, But When

By Arthur Glynn

A 9.0-magnitude earthquake off the Washington and British Columbia coast along the 700-mile Cascadia Subduction Zone (CSZ) – followed by a tsunami with 90-foot or more wave surges in some areas – is possible based on geological factors and historical accounts. Communities in and around the CSZ, and those with interconnected waterways, need to be prepared for the inevitable.

The last time an earthquake of this magnitude occurred in the region dates back to 1700, when a tsunami reported in Japan was attributed to CSZ seismic activity. According to the U.S. Geological Survey (USGS), movement of the Earth's tectonic plates where the Juan de Fuca plate intersects the Pacific plate generates enough pressure that, when the plates become immovable, the pressure builds until it is released via a very large earthquake (see Figure 1). Historical modelling indicates this occurs approximately every 200-500 years.

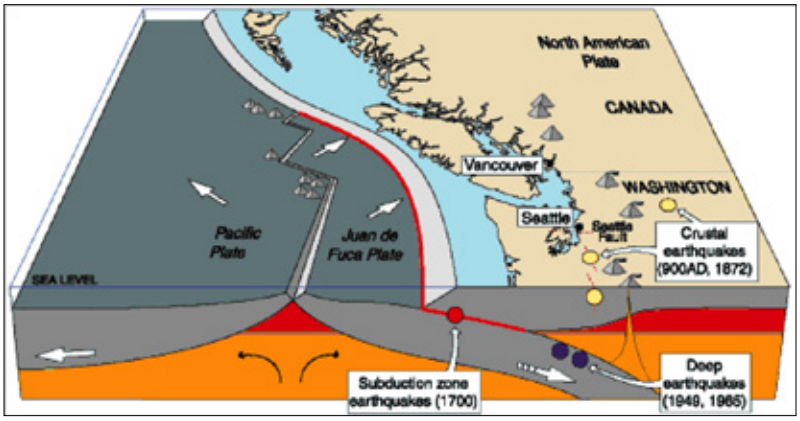

Fig. 1. Map of the Cascadia Fault and related past earthquakes. *Source:* USGS (2000).

Although tsunami warnings along the British Columbia, Washington, and Oregon coastal regions would help people respond appropriately and move to higher ground, inland waterways such as Puget Sound and the Columbia River basin may be less aware of the threat. A comparable scenario was presented 7-10 June 2016 for the Cascadia Rising exercise, which was sponsored by: the Federal Emergency Management Agency (FEMA); Region 10; Washington Military Department, Emergency Management Division; Oregon Military Department, Office of Emergency Management; Idaho Military Division, Idaho Bureau of Homeland Security; United States Department of Defense U.S. Northern Command (USNORTHCOM); United States Department of Defense U.S. Transportation Command (USTRANSCOM); and FEMA National Preparedness Directorate-National Exercise Division, and the Office of Response and Recovery.

Disasters in the Pacific

Recent devastating earthquakes around the Pacific "Ring of Fire" – for example, Indonesia in 2004 (9.1 magnitude, nearly 228,000 fatalities), Chile in 2010 (8.8 magnitude, more than 500 fatalities), Japan in 2011 (9.0 magnitude, more than 18,000 fatalities) – make planning

for such an event within North America a necessity. Such earthquakes, coupled with 34 active volcanos (of 40 globally) along the Ring of Fire, mean that everyone in the public and private sectors should be prepared for a cataclysmic earthquake and resulting devastation.

Under FEMA Director Craig Fugate's guidance, FEMA has instituted a permanent catastrophic planning effort to stabilize a catastrophic event within the first 72 hours. This is reflected in FEMA's mission statement, "To support our citizens and first responders to ensure that as a nation we work together to build, sustain and improve our capability to prepare for, protect against, respond to, recover from and mitigate all hazards." However, this does not mean that the federal government will be able to rescue everyone, which is why FEMA emphasizes that everyone following a disaster is a first responder. Due to shear logistical challenges, the success (or failure) of surviving a catastrophic event during the first 72 hours may depend on citizens within the local community.

It may take some time for federal resources to be made available to ease the agony of a catastrophic earthquake that the Cascadia Fault may produce. The normal response following a catastrophic incident is an outpouring of emotional support from across the country and from allies. Promises of support are made, but frankly, it is up to first responders (remember, everyone is a first responder) to take care of themselves individually. Then, and only then, can the individual be part of the greater response.

Preparing Communities With Actionable Plans

Although people have little control over what happens to them, they have complete and utter control of how they respond to what happens to them. Even in the most unlikely events, people can prepare for the unknown, be resilient, and set themselves up to be survivors. The determination to be a survivor, as an individual or a community, is probably the greatest factor determining success or failure – especially during the first 72 hours after initial impact.

When a catastrophic earthquake occurs along the CSZ, whole communities will be cut off from the rest of civilization for a significant amount of time. Lines of communication and electrical transmission cables will be severed; bridges and critical infrastructure destroyed; water contaminated; and access to life-sustaining supplies will be severed. Even large cities – for example, Vancouver, British Columbia; Seattle, Washington; and Portland, Oregon – accustomed to having on-demand resources, will find themselves completely without basic needs. At first, there will be shock and dismay with a consensus sentiment of "How could this happen to us?" Those who have access to communications will hear of outside efforts to help them, but it will take time. And time, is a commodity in short supply.

There will be patience for a little while, especially for those who are not severely affected. For those who are significantly impacted, there may be anger against first responders or those who are less affected. Anger then could escalate toward local, state, and federal civic leaders regarding the delay in disaster response. Even when FEMA and the federal government (including the military) are doing everything within their power to respond, delays are inevitable. Questions will arise about the nation's vast military capability and its response. Although the Department of Defense (DOD) – through USNORTHCOM and USTRANSCOM – has Defense Support of Civil Authorities (DSCA) and logistical support missions respectively, its primary mission is Homeland Defense. In times of major disaster, the nation's adversaries – both state sponsored and nonstate sponsored – have opportunities

to take advantage of a perceived national weakness and may initiate attacks to further cripple the United States and gain geopolitical advantage. It is here that the DOD must focus its attention and critical resources during times of national emergency. Though the DOD will do everything in its power – repurposing its vast capabilities to save lives, mitigate human suffering, and prevent great property loss during a national emergency – recent budget cut backs have forced the DOD to focus on their primary mission, homeland defense.

The Next "Big One"

Throughout history, mankind has had many opportunities to mitigate potential disasters but, unless they occur frequently, it is human nature to unknowingly accept an exceedingly high level of risk and be oblivious to warning signs. The nation has received many such warnings in the form of earthquakes near the 9.0 magnitude along the Ring of Fire in Indonesia, Chile, and Japan. Nobody knows where the next 9.0-magnitude earthquake will strike, but the Cascadia Rising exercise was a great first step in preparation for such events. However, the question remains, "Will we be ready when the 'Big One' hits or was this merely an exercise in futility?"

CAPT Arthur Glynn, U.S. Navy (Retired), passionate for effective leadership and national defense, has devoted his professional life to ensuring that the American way endures, whether while in uniform or while developing technologies to bolster technological advantages and mitigating national level threats. He recently retired from the United States Navy, where he served as a North America Aerospace Defense Command (NORAD) and United States Northern Command (USNORTHCOM) command center director. Previously, he served as a Navy emergency preparedness liaison officer to USNORTHCOM and FEMA District VIII. He has served as: president/chief executive officer of a manufacturing firm; technology, mergers, and acquisition consultant; emergency management advisor; and financial advisor. He is currently an independent consultant to industry, helping to protect the U.S. critical infrastructure.

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