Review of "Future Global Shocks: Geomagnetic Storms"

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"Future Global Shocks: Geomagnetic Storms," a report authored by CENTRA Technology, Inc., on behalf of the U.S. Department of Homeland Security, analyzes the risks of extreme space weather events in terms of economic, psychological, and social consequences. The report was released in January 2011 and is available at http://www.oecd.org/dataoecd/57/25/46891645.pdf. The document also contributes to the Future Global Shocks initiative of the Paris-based Organisation for Economic Co-operation and Development (OECD). This initiative is intended to identify strengths, weaknesses, and gaps in current international risk-management practices associated with natural events.

The OECD recognizes severe geomagnetic storms as capable of causing extended electric power outages crossing multiple continents, events that would result in enormous economic losses. The report describes a "worst reasonable case scenario" and outlines current initiatives to mitigate vulnerabilities and limit the consequences of a severe geomagnetic storm. The authors conclude that a comprehensive understanding of the risk for these low-frequency/high-impact events remains "elusive" and, further, that the international community lacks a formal geomagnetic storm risk-management system.

Using three notable geomagnetic storms and their associated consequences as examples, the report investigates the present state of risk assessment capabilities, with an emphasis on electric power vulnerability. The report notes that national and international trade of electric power via extended, high-voltage transmission lines is growing, but there is a relatively low level of regulation given the societal reliance on its continuity.

One problem described in the report is that the threat-vulnerability-consequence model used in risk assessments for more familiar events (e.g., earthquakes) is decidedly less cohesive when applied to geomagnetic storms. Contributing factors to this fractured state are: inconsistent terminology and scale in describing severe geomagnetic storms; lack of a framework for effectively comparing geomagnetic storm threats to other types of threats; and gaps in communicating the vulnerability to operators and users of electric power grids. These factors inhibit development of integrated risk mitigation plans. The report attempts to address this problem. It also clearly identifies a critical bottleneck in mitigation efforts: the current inability to replace, in a timely manner, high-voltage transformers that would likely be damaged in a sudden severe geomagnetic storm.

The authors place material from the space weather, power grid, and social vulnerability communities into a risk-based framework. In particular, the graphical representation of first- and second-order critical infrastructure disruptions (Figure 1) provides a way to visualize the cascade effects of power grid disruption on land and space-based communication, energy, information technology, and transport (aviation, mass transit, pipeline, and rail).

The report also presents the concept of the social vulnerability index (SoVI), which will be new and useful to the space weather community. The SoVI attempts to quantify a geographic locality's vulnerability to hazards according to its socioeconomic and demographic profiles. The index thus provides insight into the extent to which a major disruption will affect regional populations.

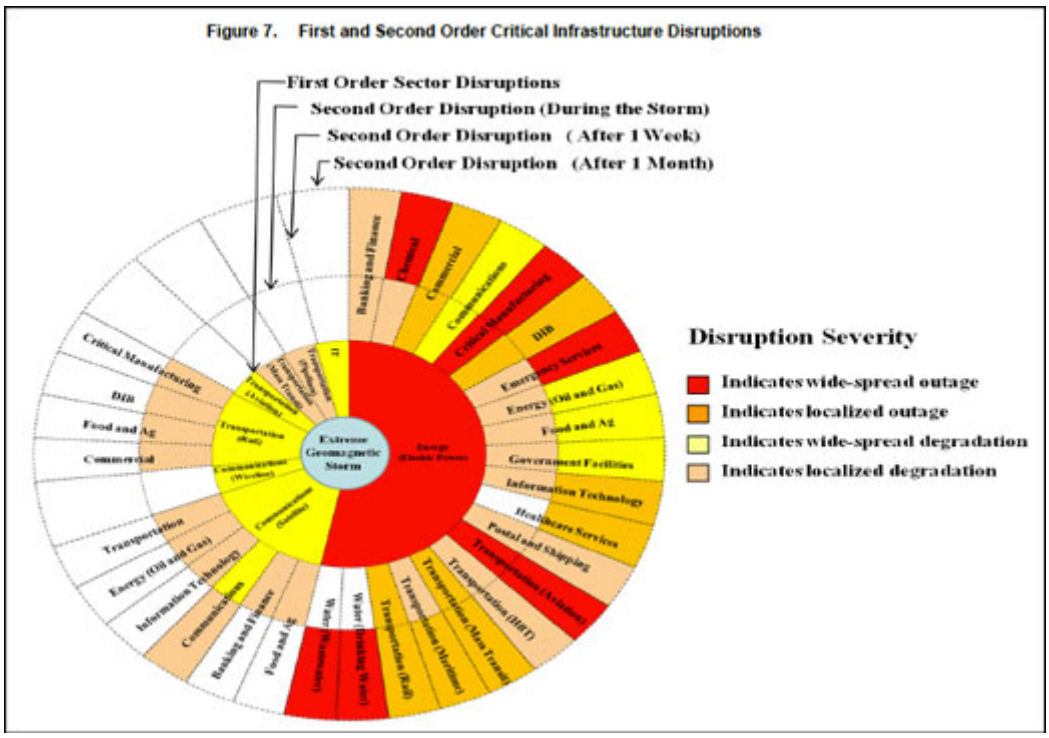

Figure 1. First- and second-order critical infrastructure disruptions created by an extreme geomagnetic storm, as illustrated in Figure 7 from "Future Global Shocks: Geomagnetic Storms." Disruptions in more than a dozen sectors, along with their severity level, ranging from localized degradation (meaning intermittent or substandard service in areas within the affected region) to widespread outage (meaning a failure of service throughout the affected region) are shown. The report examines three phases of outage: during the storm, one week later, and one month later. (OECD (2011) "Future Global Shocks: Geomagnetic Storms, www.oecd.org/futures/risk, http://www.oecd.org/dataoecd/57/25/46891645.pdf")

The CENTRA report concludes with six recommendations for international risk management, three of which (listed here) are relatively low cost/high payoff: (1) mitigate against the risk of a single point of failure in the upstream space weather warning and alert system, (2) improve granularity in the geomagnetic warning and alert system, and (3) encourage power companies to harden high-voltage transformers connecting major power generating assets to electrical grids.

The report is a commendable first effort to explore the risks posed by a severe geomagnetic storm to the international community. Although the report's initial description of geomagnetic indices contains a few minor technical problems, its thorough/wide-ranging presentation of the hazards associated with space storms make it an important resource for those charged with managing large-scale emergency situations. "Future Global Shocks: Geomagnetic Storms," is a valuable companion to *Space Weather Events—Understanding Societal and Economic Impacts (2008) from the U.S. National Academy of Science.* Together these documents create a much-needed primer on policy and risk mitigation for ground-based effects of an extreme geomagnetic storm.

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