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**The Fukushima Nuclear Disaster: A Case Study**

**A. Introduction:** The Fukushima nuclear accident was the last in a series of cascading disasters preceded by the Tohoku earthquake (still the most powerful earthquake ever recorded in Japan) and the resulting tsunami. The failing of cooling systems at the nuclear power plant caused burns and other injuries to dozens of power plant workers affected by explosions from the melt down. The release of massive amounts of radioactive steam and hydrogen for miles around the plant and into the atmosphere forced the evacuation of 150,000 people from their homes and has rendered communities and large stretches of land uninhabitable for decades.

**B. Facts of the Case:** On March 11, 2011, a 9.0 magnitude earthquake struck off Japan's east coast. The quake was so forceful that it shifted the earth off its axis and triggered a tsunami that killed more than 18,000 people, wiped entire towns off the map, and displaced thousands of others.[11] The coastline was devastated by waves 45 feet high and water flooded the nuclear reactors at Fukushima's power plant. Radiation levels reached 20 times the norm and the Japanese government evacuated homes for 12 miles around the plant. Over 1,000,000 buildings were damaged, destroyed or abandoned and with 40 percent of Tokyo's electricity supplied by the Fukushima nuclear power plant and the catastrophe causing a 25 percent shortfall, it forced rolling blackouts. The total economic losses from the earthquake and tsunami are estimated at $270B US and the loss just from the Fukushima nuclear accident is estimated at $60-$70B[2].

**C. Epidemiological aspects of the event:** At least 1.9 million homes had no water supply and the army had to be deployed to distribute bottled water, food and blankets. Environmental health hazards and associated risks included contaminated air, water, soil, food, and waste with long term impacts on plants, animals, fisheries and forests. Food and agricultural exports were banned from Japan and imports by other countries were restricted. Citizens of Japan's coastal and rural areas suffered measurably physically, psychologically, and culturally, with farmers and fisherman living in coastal communities in houses and on land inherited from their ancestors forced to migrate to cities, many never to return. At the power plant, workers knew that PPE did not and would not protect them from radiation gamma rays and that there was high likelihood of radioactive materials seeping in through masks they were given to wear while serving as part of the emergency response team. These heroes put their lives at risk to save others and worked around the clock under threat of injuries burns, respiratory distress, and longer-term diseases like cancer.

**D. Management of the event:** The Tokyo Electric Power Company had installed backup diesel generators that were supposed to cool the nuclear power plant reactor system and prevent fuel rods from melting, but what later would be realized as a significant design flaw, the generators were placed in the basement of the buildings and destroyed by the tsunami. With fuel rods generating intense heat, no way to get water under the fuel to keep it from melting, and no instruments to measure what was happening inside the reactor core, power plant workers got

creative and used car batteries to get monitoring instruments to work. The meters made clear they had to vent the reactors, but without electricity the only option was to do so by climbing into the base of the reactor and turning a manual wheel to open the vents in temperatures exceeding 100 degrees with radiation levels so high and the risk of fire and explosion so high, it was considered a suicide mission. Japan's Prime Minister brought in the Japanese Defense Force and the US military to dump water in the reactor pools from the air, similar to what was done by Russia in Chernobyl (many workers later died from radiation exposure). Despite that effort, radiation levels did not come down. Fire fighters were brought in to hook up massive hoses to suck water from the sea to be sprayed into the pool feeding the reactors. When it appeared to work, miles of pipes were laid to continue feeding water to the reactor cores. This brings to mind a passage from an article I read for another course that is apropos in this doomsday scenario: *"The need for integration intensifies as the number of organizations engaged in response operations increases and the range of problems they confront widens".* Intensification is the inflection point at which routine, linear, hierarchical systems fail and adaptive systems must be applied to dynamic and extreme conditions. We know from research that auto-adaptive systems must be flexible and require timely, valid information and search, exchange, absorption, and adaptation of that intel to develop a basis for action. Humans serve as inputs to the auto-adaptive system and also determine the fate of its outputs. *"The distinctive advantage of human organizations is that the individuals within them are able to learn."*[3]

**E. Communications of the event:** Communication systems in Japan were devastated; two-thirds of Japan's mobile base stations were dead and it took months to bring them back online. The most resilient feature of Japan's communication infrastructure was its internet connectivity which proved crucial to emergency response efforts.

**F. Summary:** Japan's hierarchical disaster management system was designed to handle one event at a time. Despite significant investment in seismic monitoring and emergency alert systems, the system proved wholly insufficient and replete with weaknesses that led to a complete and cumulative breakdown in the face of the Tohoku trifecta catastrophe. With radiation a long sensitive subject/safety concern in Japan given the disease and death to its people from the atomic bombings in Hiroshima, the cascading catastrophe resulted in Japan's and in fact a global reconsideration of the safety of nuclear power[2]. We have to rethink disasters in the ever-changing world where we are at increased risk for cascading events, and these catastrophes reinforce the continual need for targeted investments to be made in systems that harness the power of data and innovations being contributed through collaboration amongst diverse groups-civilians, scientists, industries, not for profits and government agencies. Technology and artificial intelligence can be leveraged to stress test and run iterations of multiple, complex what if scenarios that can be visualized with data driven dashboards to drive decision making. Human capital within organizations are then positioned to design better systems, develop better policies and create emergency management strategies and practices that both protect and benefit the public good-the best measure of return on investment.

## References

[1] BBC News, “Fukushima Disaster: What happened at the nuclear power plant?” https://www.bbc.com/news/world-asia-56252695, March 10, 2021
[2] *Khazai, B.; Daniell, J.; and Wenzel, F.*; 2011: The March 2011 Japan Earthquake, Analysis of Losses, Impacts, and Implications for the Understanding of Risks Posed by Extreme Events, pp. 22-33
[3] *Comfort, L.; Okada, A.; Ertan, G.* (2013). Networks of Action in Catastrophic Events. 29(S1):S387-S402