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THE NEXT WAVE IN DISASTER PREPAREDNESS: ADAPTIVE AND AGILE INFORMATION NETWORKS

ADAPTIVE AND AGILE LEADER NETWORK (AALN)
HUMANITARIAN ASSISTANCE AND DISASTER RELIEF

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The power of the wave was absolutely irresistible. It didn't look like a wave one might encounter on the north shore of Hawaii that appears massive at first, but pounds nothing but sand on the shoreline as it exhausts itself only several meters up the beach. And it certainly wasn't some towering wall of water as seen in various Hollywood movies. But the surge of water that struck Japan's east coast on March 11, 2011 masked a cataclysmic, unstoppable force that easily swatted away any manmade fortifications of defense. Several buildings at the Fukushima Daiichi nuclear power station would later show water levels had reached nearly 50 feet above sea level, 5 times what the plant was originally designed to withstand within its seawalls.[1] The wave formed massive rivers carrying cars, houses, boats, and debris miles inland, leaving a path of utter destruction over a vast area of Miyagi and Fukushima prefectures. When the water finally subsided, more than 15,000 people had been killed with over 100,000 structures completely collapsed or destroyed.[2] The Great East Japan Earthquake that precipitated the tsunami was the strongest earthquake ever officially recorded in Japan at a magnitude of 9.0.[3]

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Aftermath of the March 11, 2011 tsunami in Japan.

Unfortunately, the death and destruction from the earthquake and the tsunami were only the first salvoes in what was already a monumental disaster. As the waves easily breached the concrete protection surrounding the Fukushima Daiichi nuclear plant, 11 of the 12 emergency generators designed to carry the plant through a crisis were flooded and knocked off-line. These generators were responsible for providing the power to cool the cores of the nuclear reactors in the event of electricity loss. And the lights were already out.

Over the next several days and weeks, the Japanese government struggled to cope with the crisis which now included a nuclear meltdown at the Fukushima reactors. Japanese officials were having difficulty even establishing a nearby response center. As one study assesses, "the unanticipated problems in establishing a local response headquarters is just one example of the inadequacy of the government's emergency response manuals, which simply didn't anticipate such a large scale disaster."[5] This is surprising for a country that is perched precariously on the edge of the Pacific "Ring of Fire," where volcanoes and earthquakes of significant magnitude occur frequently.[6] Admittedly, a catastrophe such as the one that struck Japan on March 11 represents a decidedly unlucky confluence of events, but as Professor Jeff Kingston of Temple University in Japan notes in his study of the disaster, "Crisis and disaster management officials must respond quickly to mega-catastrophic events and it is important to understand how they react to the pressures of such a situation. . .in order to be better prepared."[7] One way to improve disaster preparedness for any municipality or jurisdiction is to establish an adaptive and agile information network that can provide real-time, relevant data to crisis managers. The "Safecast" paradigm born from the Fukushima incident exemplifies the qualities and characteristics of this type of network, and provides valuable lessons on how a flexible information system might be replicated in other communities.

A Network Responds

Before the Japanese government could effectively cool all the nuclear reactors at the power station on March 20th, the plant had released large amounts of radiation into the atmosphere, as well as contaminating drinking water reservoirs for miles. In the days following the catastrophe an informal network of private-citizen radiation-trackers formed to monitor the precise levels and locations of dangerous radiation. The level of public trust in the government to provide timely and accurate information was low, as bureaucratic officials were overwhelmed with information and hesitant to admit the facts surrounding the disaster. This citizen network became known as Safecast, and eventually formalized into an organization that describes itself as an "international, volunteer-centered organization devoted to open citizen science for the environment."[8]

In the early days of its formation, the founders of Safecast focused on monitoring the radiation levels in and around Fukushima. In addition to the previously mentioned lack of information, the crisis also caused a shortage of supplies to measure the radiation. The small group of researchers who coalesced in reaction to the disaster reached out to their personal networks to solve this issue, and quickly integrated hardware, software, and communications solutions to establish an instrument-enabled data system. The hardware solution was addressed by putting relatively inexpensive palm-sized Geiger counters in the hands of volunteers. These devices provided a level of accuracy commensurate with much larger and more expensive instruments.

To inform the network, readings collected by volunteers were uploaded to a virtual information node, peer-analyzed for incongruity, and then posted to an open-data portal that was accessible to the public. Anyone with access to mobile data could view the information. The instructions on how private citizens could build their own measuring devices were also uploaded

to the Safecast website. This information network grew day-by-day throughout the duration of the disaster, and in fact, has outlived the initial crisis by continuing activities even today. According to its website, Safecast maintains the largest open dataset of background radiation measurements ever collected.[9] A recent National Geographic article noted that as of February 2016, 350 users had contributed 41 million readings using around a thousand fixed, mobile, and crowd-sourced devices.[10]

The Safecast network is expanding both in scope and geographically. The network is adding the capability to measure air quality, and volunteers are activating in Hong Kong and Taiwan. The simple notion of a volunteer and their data collection device, empowering an open information network, is spreading. Conceptually, this network could measure and report a wide variety of data including river water levels, forest fire locations, or the path of tornadoes.

Characteristics of the Safecast Network

It is true that no one system or network is suitable for every situation or culture, but if one focuses on the characteristics of the network, disparate communities may be able to replicate such things as adaptability and agility with the tools they have available.

Safecast is adaptive because it is comprised almost entirely of volunteers, allowing synapses to form and dissolve as necessary in response to information. In his manual on disaster preparedness, University of North Texas Associate Professor David McEntire notes that "when a disaster occurs, you can increase resilience by adapting to the unusual circumstances that inevitably arise during response and recovery operations."[11] While this may seem obvious, the point on adaptability is important, and is precisely what a network like Safecast empowers its citizens to do. The information collection instrument that informs the Safecast network is

independent of the type or severity of the disaster encountered. In fact, in some ways it removes a facet of the preparation variable as a determinant in a community's ability to respond. If a community spends all its limited resources planning on how to specifically respond to a flood, but is then struck by a devastating tornado, one could argue that the flood preparation exercise was a waste of time. Admittedly, the social relationships established during any such disaster exercise (or other type of preparation activity) are valuable to improve overall community resilience, but a network as adaptive and agile as Safecast operates regardless of what natural or man-made disaster strikes.

Safecast is agile because there are low barriers to entry and no barriers to exit. The single most important requirement is accuracy of data, and the network becomes self-policed as data anomalies are quickly investigated and questioned by other members to determine validity. Agility is also manifest in the way Safecast measures data. The network does not assign volunteers to a particular location to measure radiation levels, but "each data contributor is free to measure areas they consider worthwhile."[12] These data contributors are known as Safecasters. When particularly high levels of radiation are reported in a certain region of Japan, squads of Safecasters independently react to the information, deploying to the area to map and define the circumference and intensity of the radiation zone. This phenomenon corresponds to a principle of decentralization described in *The Starfish and the Spider*, a 2006 book by Ori Brafman and Rod Beckstrom.

The Starfish and the Spider lays out six principles of decentralization as it discusses the potential power in leaderless organizations using the self-replicating starfish as a metaphor. The third principle of decentralization presented states: "An open system doesn't have central

intelligence; the intelligence is spread throughout the system."[13] From the description above of how Safecasters react to intelligence, one can easily discern a starfish-like enterprise.

Another important characteristic of the Safecasters is their dedication to gathering the information. Mr. Dan Sythe, a Safecast research engineer who was in Tokyo at the time of the earthquake, recently noted that it's critically important to identify and encourage "people who care" as members of the network.[14] Professor McEntire also advises to "incorporate highly committed members" when establishing a networked preparedness council.[15] Undoubtedly, a certain cadre in the Safecast network are intrinsically motivated to provide reliable and accurate data as some of them still live in the affected zones, but there is another force in play. Conscientious and diligent people are rewarded by the demonstrated reliability of the information provided to the general public. The scenario is similar to the Wikipedia example also described in *The Starfish and the Spider* as the seventh principle of decentralization: "Put people into an open system and they'll automatically want to contribute."[16]

Because Safecast is adaptive and agile within the parameters of its information collection capabilities, the network can customize itself based on the disaster. According to an article on networks in the Harvard Business Review, customized response networks are "best for solving ambiguous problems that need innovative solutions," and network connections "are dense and redundant, both internally and externally."[17] This is clearly the case with Safecast as hundreds of volunteers permeate large areas, and the information collected is widely available and accessible. The open-data concept adhered to by Safecast invites unusual suspects to consider the information and provides a catalyst for ever more connections.[18]

Networks and Preparedness

A variety of research points to internal social relationships and personal connections as a significant determining factor in how well or poorly communities cope with disaster.[19] For some however, this concept may be too amorphous to act upon, and may be highly difficult to achieve in large cities and the urban sprawl that surrounds them. One concrete way local governments can help prepare for a disaster is by studying and building a network like Safecast. Again referring to the work of Professor McEntire, he defines preparedness as "building capabilities to improve the effectiveness of response and recovery operations."[20] It is clear from the discussion above that an information network like Safecast has the potential to improve the effectiveness of response and recovery operations. As noted by researchers who investigated crisis response information networks, "among the key activities. . .is to ensure that resources are effectively and efficiently allocated to affected individuals. In order to properly collect and allocate resources, *responders require detailed ground information* [emphasis added].[21] A network following the Safecast model can provide this detailed ground information. The same article goes on to note that in the past, models where disaster planners and managers have advocated top-down, centralized command and control have failed because existing information channels and routines are often too slow to meet the needs of crisis information flow. Safecast is an example of a highly efficient information network.

Mr. Joi Ito, the director of the MIT Media Lab and co-founder of Safecast, remarked "What Safecast proves is that all the preparation in the world – all the money in the world – still fails if you don't have a rapid, agile, resilient, system." To extrapolate on this statement, the "system" he refers to should be one that provides accessible and relevant information connected to the hazard encountered; in short, a system or tool with the capacity to provide sophisticated

information. This does not necessarily need to be technical sophistication, but sophistication in terms of accuracy and reliability, whatever the technological form the distribution platform takes. In his research on community resilience during disasters, Christopher Atkinson points out that "Failure to communicate within an institution, with public and private sector partners, and perhaps most critically, with the public, can turn a hazard event into a disaster."[22] Any network that replicates the characteristics of the Safecast network would be a valuable tool in preparing for the next disaster.

Make an Information Network the Next Wave

In his letter summarizing the Fukushima nuclear accident investigation, the Chairman of the Independent Investigation Commission concludes, "it is essential that the [Japanese] government learn from the Fukushima accident—during which at times there were debilitating communication problems—and construct systems and technologies to communicate and share large amounts of real-time information and data."[23] The Safecast network, still active and expanding today, is an example of an adaptive and agile information network that is sophisticated enough to address this issue. To build on the Chairman's comments, it is essential for *all* disaster planners to increase their community's preparedness by analyzing the qualities of a network like Safecast. In most areas of the United States, citizens use mobile phones to share information during crisis situations. Municipalities can expand on this simple network concept by establishing a more sophisticated communication structure before a disaster strikes.

A system that incorporates near real-time sharing of complex information, in an open-data format should be the next wave in disaster preparedness. An information network like Safecast

can be a critically important component of a resilient community by increasing preparedness, working in concert with the social relationships that empower people.

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[1] Mindy Kay Bricker, ed. *The Fukushima Daiichi Nuclear Power Station Disaster* (New York: Routledge, 2014), 5-6.

[2] "Damage Situation," National Police Agency of Japan, last modified March 10, 2016, accessed March 11, 2016, http://www.npa.go.jp/archive/keibi/biki/higaijokyo_e.pdf.

[3] "M9.0 – Tohoku, Japan – March 11, 2011," Earthscope Geo Events, accessed March 3, 2016, http://www.earthscope.org/science/geo-events/m9.0-tohoku-japan-march-11-2011.

[4] "Vast Destruction, Crews Searching for Survivors," NBC affiliate KHQ/MSNBC, last modified March 12, 2011, accessed March 3, 2016, http://www.khq.com/story/14232719/massive-deadly-quake-hits-japan-spawns-tsunamis accessed March 3, 2016.

[5] Bricker, 12.

[6] Japan experiences 20 percent of the world's earthquakes of magnitude 6 or greater. See Jeff Kingston reference below.

[7] Jeff Kingston, ed. *Natural Disaster and Nuclear Crisis in Japan: Response and recovery after Japan's 3/11* (New York: Routledge, 2012), 2.

[8] "About Safecast," Safecast, accessed March 7, 2016, http://blog.safecast.org/about/.

[9] Ibid.

[10] Ari Beser, "How Citizen Science Changed the Way Fukushima Radiation is Reported," *Fulbright National Geographic Stories*, February 13, 2016, accessed March 3, 2016.

[11] David A. McEntire, *Disaster Response and Recovery* (Hoboken, New Jersey: John Wiley & Sons, Inc., 2007), 414.

[12] "Frequently Asked Questions," *Safecast*, accessed March 7, 2016, http://blog.safecast.org/faq/.

[13] Ori Brafman and Rod A. Beckstrom, *The Starfish and the Spider: The Unstoppable Power of Leaderless Organizations* (New York: Penguin Group, 2006), 39-40.

[14] Dan Sythe, "Safecast Hardware" (lecture, San Francisco, CA, March 3, 2016).

[15] McEntire, 417.

[16] Brafman, 74.

[17] Rob Cross, Jeanne Liedtka, and Leigh Weiss, "A Practical Guide to Social Networks," *Harvard Business Review* (March 2005): 3.

[18] The "unusual suspects" and "catalyst" ideas are discussed in Ori Brafman and Judah Pollack, *The Chaos Imperative: How Chance and Disruption Increase Innovation, Effectiveness, and Success* (New York: Random House, 2013).

[19] See such articles as Kathleen Stewart, Jennifer L. Glanville, and David A. Bennett, "Exploring Spatiotemporal and Social Network Factors in Community Response to a Major Flood Disaster," *Professional Geographer* 66, issue 3 (August 2014) and Daniel P. Aldrich and Robert E. Smith, "Social Capital and Resilience: Informal Policy Brief for the World Humanitarian Summit," *Policies Studies Organization*, http://works.bepress.com/Daniel_aldrich/31/, accessed March 12, 2016.

[20] McEntire, 440.

[21] Shan L. Pan, Gary Pan, and Dorothy E. Leidner, "Crisis Response Information Networks," *Journal of the Association for Information Systems* 13, issue 1 (January 2012): 33.

[22] Christopher L. Atkinson, *Toward Resilient Communities: Examining the Impacts of Local Governments in Disasters* (New York: Routledge, 2014): 158.

[23] Bricker, viii.