Hurricanes Send Signals for the Future of Emergency Preparedness

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ABSTRACT

Trends over the past decades, when coupled with recent disaster events, call into serious question whether our typical reactions to natural disasters will be sufficient for what we can expect in the future. This paper summarizes current events and scientific understanding of our planet to provide insights of the authors into what should be the basis for future policies and plans.

Keywords

Hurricane, Puerto Rico, Climate Change, Disaster Preparedness, Disaster Recovery

INTRODUCTION: CLIMATE CHANGE AND NATURAL DISASTERS

In the 2017 hurricane season, there were five hurricanes in the Atlantic by the end of September that reached scales of levels 4 and 5. For the one that hit Houston, the U.S. president referred to it as a 1 in every 500 years natural disaster event. Since we have been recording Atlantic hurricanes, there has not been this many level 4 and 5 hurricanes in one season (Astor, 2017). The 2017 season seemed unique and occurred a year after a fairly mild hurricane season in 2016.

With tropical storm Ophelia's transition to hurricane Ophelia in October 2017 (Astor, October 12, 2017) this became the first year in more than a century—and only the fourth on record—in which 10 Atlantic storms in a row reached hurricane strength. The last time for 10 storms reaching hurricane strength was in 1893. There were also 10 hurricanes in 1878 and 1886. However, there is not good data for how strong these prior 10 storm seasons were. In 2017, two storms reached level 5 and two reached level 4. The number of named storms of 10 hurricanes and 5 tropical storms has made the 2017 Atlantic hurricane season one of the busiest on record.

We have good models for where a hurricane will go once we detect its birth and measure its properties and those of the surrounding ocean. However, we have no model of the Atlantic Ocean that predicts the birth of a hurricane. We also have evidence that there are some interactions between the various oceans that can influence disasters. A recent study shows that differences in water temperature between the Pacific and the Atlantic oceans together with global warming impact the risk of drought and wildfire in southwestern North America (Chikamoto et al, 2017). However, we have no models that measure the interactions between the oceans and the creation of hurricanes, let alone the properties of some of the strong currents that intersect the various paths of hurricanes. Our climate and its interactions with all the properties of the earth involves a great many complex variables:

- Carbon Dioxide content of the atmosphere
- Ocean water temperatures, salt content, currents, interactions with fresh water bodies
- Ocean currents and special areas (e.g. El Niño, the Caribbean, Artic, Antarctica, glaciers,
- Rainfall, air currents, air temperatures, storms, tornados, cyclones, hurricanes, humidity
- Volcanos, earthquakes, relative position of the moon and other planets,

The earth is a very complex system. To be able to predict the future of the earth in terms of all the above variables and really predict changes and resulting disasters we would have to have a model that integrated all the above factors and understood how they affected one another to be able to predict things like the occurrence of hurricanes and their strength.

The 2014 launch of the Orbiting Carbon Observatory-2 Satellite started monitoring of the comings and goings of CO2 from the atmosphere. Scientists knew that El Niño was a factor that caused more CO2 to build up in the Earth's atmosphere. El Niño is the appearance of unusually warm water in the Pacific Ocean off the coast of South America, recognized by local fisherman as early as the 17th century. El Niño tends to lead to drying in parts of the tropics, resulting in less photosynthesis and less uptake of carbon dioxide (Thompson, 2017). The new satellite detected a large 2015-2016 El Niño which helped to cause the biggest year-over-year jump in global CO2 concentrations on record. The new satellite detector also allows the observation of higher CO2 levels over urban areas verses rural areas. The satellite also picks up the decline in the difference during the summer due to plant growth.

The calibration of a sensor in the first of several satellites launched to measure the height of the sea surface using radar had a problem that seemed to show that the rate of sea-level rise was holding steady or even declining (Tollefson, 2017). After the error was discovered the review of the past data and related adjustments of the data suggests that sea levels are indeed rising at faster rates each year. This current analysis was presented this year and indicates the sea level increase in 1993 was 1.8 millimeters per year and increased to 3.9 millimeters in 2016 (2017 Steven Nerem, in press). If the sea level rise continues to accelerate at the current rate, Nerem predicts a rise of 75 centimeters (2.5 feet) over the next century. However, this ignores any unusual variation in land ice melt, volcanic activities, and earthquake activity.

If the Earth's warming continues beyond 2 degrees Celsius, sea levels will rise faster than any time throughout human history (Waldman, 2016). The Atlantic coast of North America will be the worst-hit area. New York and other cities could see seas rise by more than three feet by the end of century. If warming exceeds 2 degrees by 2100, as some climate scientist worry it might, about 80 percent of the global coastline will experience a rise in sea levels of six feet. While researchers typically focus on the loss of glaciers in Antarctica and Greenland, the loss of land ice in other spots across the globe is now contributing to sea-level rise at almost the same rate as the Arctic's melting ice.

There are five different forms of flooding that can occur as a result of hurricanes. Part of the problem is that 93% of the extra heat being trapped in the atmosphere by increased greenhouse gases is being stored in the ocean. Higher heat levels can even alter ocean currents like the Gulf Stream and atmospheric currents like the Jet Stream (Englander, October 11, 2017). These are:

- Rainfall: More water evaporates due to warmer oceans, increasing precipitation.
- Runoff: Extreme rainfall can trigger the problem of runoff.
- Storm surge: The cyclone force of a hurricane "sucks" a huge amount of water with its low pressure and pushes a giant wall of water as it moves.
- Sea Level: The primary driver is ice melt on land (i.e., glaciers). It is rising slowly and steadely due to climate warming.
- "King Tides:" The pull of the moon and other planets, the oceans change height on a regular tidal cycle. The extreme high tides are called "King Tides" and when they occur together with a storm surge, there are massive flooding effects.

Preparing for Future Disasters

The lessons of the recent set of hurricanes are that major changes are needed in Puerto Rico, Houston, in much of Florida and other low-lying coastal areas. The physical changes needed in the areas involved are in zoning, building codes, improved water management, and more survivable electric networks. For example: large tracts of land cannot be paved over with waterproof toppings to prevent the absorption of water; and forests cannot be removed from areas where excess water can produce major mud slides.

It is clear the heat wave in mid-California in 2017 is another result of climate change. There have been historical droughts in that area in the past but not some of the temperatures that have occurred recently. This year there was a temperature of 106F degrees in San Francisco and 109F in the Santa Rosa area. These are temperatures that are a real record in recorded history for those areas. Moreover, the south of California has expanding desert areas. In addition, in the U. S., the water systems are the oldest of all the infrastructures and will be a growing major problem in the near future (Turoff, 2015). They have passed an average age of 100 years and are getting older at about ½ a year per year. All the major infrastructures suffer from a lack of raising local, state, or federal tax funding that has all the major infrastructures aging and increasing vulnerabilities

(Turoff 2015, Turoff et al 2016, Turoff et al 213, Turner 1976).

Given our demonstrated vulnerabilities, is the Hurricane season for the year 2018 going to be like the year 2016 or 2017? As yet, we cannot answer this. The Atlantic Ocean is a "very big complex system" and there are some general principles about complex systems that have been observed in some natural systems such as biological systems over long periods of time, involving weather changes as well as the included living things. A complex system (Complex System, Wikipedia) over time undergoes a repeatable cycle, on say a yearly time period, and usually exhibits a series of stable conditions with smooth transitions between the outputs of the system which tend to be repeatable over time. These outputs are based upon inputs which may vary but be repeatable over time as well. When the input or control variables begin to change their expected input to the system, the stability of the system starts to disappear and extreme changes begin to occur outside the stability region of the output as the system seems to seek a new stability condition. As the input changes continue to exceed prior ranges, at some point the system may find a new area of stability and the output will find a new stability as well. It has been widely reported, recently, that the cost of natural disasters in the U.S. for the year 2017 is the largest ever recorded and largely due to the conditions generated by climate change. Given our lack of true preparedness, we can expect as well higher costs in the future.

We have to ask, dose the hurricane season for 2017 in the Atlantic Ocean represent a new stability for the occurrence of hurricanes? We cannot tell yet, for instance, if it will repeat in 2018 or if it is a two year cycle (or longer because of factors like El Niño) where 2018 will be like 2016 (mild) and the large hurricanes in series will repeat in 2019. Given the very clear occurrence of climate change and the warming of the oceans as well as the reduction of salt density taking place, we should believe a very significant change is taking place. Besides the record heat and many more severe wildfires as a result in the Western U.S., we have water shortages developing as well. In Oklahoma, a history of injecting waste water into the ground as well as considerable fracking for oil has now generated frequent earthquakes in a state that did not have more than one or two a year previously.

Given that it is possible that we are facing a future increase in the magnitude of natural disasters, is it correct to just try and replace what was destroyed with the same facilities that existed before? Or do we need to make major investments in a new preparedness level that will be able to cope with what we faced in 2017? A recent article that appeared online in Scientific American pointed out how Florida, using its current growth practices over the past decade, actually set the stage for a much larger case of destruction by the hurricane that struck Florida (Sneed, 2017). The article pointed out that in the last decade the amount of cement and asphalt not allowing water to seep into the ground was more than doubled. Pavements that allowed water to pass through were more expensive and not used even though advice was given to use that. This was one of many items reviewed. A similar spread of concrete and asphalt occurred in Houston before its devastating hurricane-related flooding.

Even if this sequence of large scale hurricanes does not reoccur for the next few years it is clear that within the next decade the warming of the planet and the increase in the sea level and temperature of ocean areas are going to produce quite a few level 4 and 5 hurricanes. If the professionals in Emergency Management are going to be effective in the future, they are going to have to convince the leadership in local areas to be prepared to deal with this new future. Even more importantly, the professionals and the leadership have to convince the public of why they should support this new emphasis and how the total community can become a critical part of preparedness for future disasters. The public can become the most critical part of the preparedness process for dealing with future disasters (Turoff, 2015). In some countries emergency plans for natural disasters are open to the citizens in a given location. This has to be a new approach in the U.S. and elsewhere (Canos et al, 2013).

In a classic paper by Turner (1976) it was pointed out that the lack of public understanding of how to prepare for future disasters increases with the length of the period since an occurrence of a similar disaster, and thus the next occurrence was often worse than the prior one. The best way we can undertake to prevent this is the development of a total community information system which integrates all the necessary infrastructures (Turoff, 2016) and the public into a community based geographical information system. Social media systems will not have what is needed to build an integrated community system to develop the plans and preparedness for a major disaster that is likely to occur at some point in the future. This information system should have the following characteristics.

1. Every citizen member of the community has their own identity on the system.
2. Every organization that a citizen has any need for at any time to contact is represented. This includes all the utilities, all government services, all government groups, all community organizations, all medical facilities, and community organizations, as well as commercial organizations.
3. Natural disaster plans will be open to the public and organizations so they can be reviewed and the involvement of organizations and individuals as well as resources will be clear to all.

If a citizen has any problem he or she can choose, the appropriate party or organization and fill out a form indicating the problem and/or need. If necessary the user can request a human interaction if the standard form for that organization does not cover it. If a party has resources or talents that might be useful in an emergency or disaster, those items may be added to his or her record for future use. All verbal reports going into the system, including telephone calls, will be translated automatically to text so the computer can monitor and use any useful information that is reported. This system will, of course, be the system that is used to respond to any emergency or disaster that occurs. For example, citizens who have bulldozers, boats, or any other useful items should always update a change of location of those items. Any citizen can put in a record of their necessary medications and any other information that might be relevant in a specific emergency. In an emergency, a person could enter any problems they are having or are observing.

The system could also be tied into sensors like ones that would indicate water levels at places in roads that are likely to flood. Clearly if, for example, there was a small earthquake, reports of natural gas problems by citizens might well cluster in an area and be an immediate indicator of what could be a dangerous gas leak. It would be possible to place any sensors into the system that might be of significant use in any major emergency or natural disaster. Citizens in given areas would have contacts with sick or disabled individuals that would need to be checked for their condition. The detection of road blockages from any cause would be straightforward. The community information system becomes the emergency response system when it needs to serve that function.

Electrical Systems and the Puerto Rico Example

The explosion of a hydrogen bomb over the Pacific or the U.S. mainland could have considerable negative consequences. The March 1954 Castle Bravo H-bomb test has been studied extensively over the past six decades (Greenemeir, 2017). The Castle Bravo bomb—code-named "Shrimp"—remains the most powerful nuclear weapon ever tested in the atmosphere by the U.S., about 1,000 times stronger than the atomic bombs dropped on Hiroshima and Nagasaki during World War II. Shrimp's detonation unleashed a 15-megaton blast that was two-and-a-half times greater than expected. (A megaton has the explosive force of one million tons of TNT.) It also resulted in the largest nuclear contamination accident in U.S. history, as shifting winds carried radioactive fallout across the inhabited atolls of Rongelap, Ailinginae and Utirik as well as Rongerik—where U.S. servicemen were stationed—in the central Pacific's Marshall Islands.

The Economist (2017), pointed out that a surge of energy on March 13th 1989 due to coronal mass ejection from the sun took down Quebec's electrical grid for nine hours. A transformer-wrecking pulse (EMP) is produced by a nuclear bomb, if donated high up, like 40 miles. A midrange missile tested by North Korea on April 29th 2017 exploded 44 miles up. A nuclear blast, say occurring above eastern Nebraska, would radiate out EMP over most of the continental United States. It could permanently damage the grid's multimillion-dollar high-voltage transformers. Many are old (their average age is about 40). Some would burst into flames. There has been some thought that some of the California fire starts were due to exploding transformers. America runs on roughly 2,500 large transformers, most with unique designs. Only about 500 of them can be built in the U.S. per year. The U.S. federal government has suggested specific improvements to correct this very vulnerable situation; however, due to prior congressional action it has no jurisdiction to enforce new standards for the electrical network. The problem can also occur from a solar storm headed in the right direction. NERC (the North American Electric Reliability Consortium) has repeatedly and successfully lobbied the US Congress to prevent legislation that would require EMP-proofing. This is something that could one day be seriously regretted.

Hurricane IRMA skirted the north side of Puerto Rico beginning on September 7, 2017 at 11:00PM and when it cleared the island, it left around one million people without electricity. Hurricane Maria hit the south east corner of the island on September 20, 2017 at 6:15AM and continued to travel most of the length of the island, leaving from the north east corner of the island. The electrical system was almost complete destroyed. While the Jones Act was lifted in Texas and Florida almost immediately after they were hit, it was not until September 28th that the Jones Act was lifted for Puerto Rico (Vicens, Sep. 27, 2017). The Jones Act, which requires that all things delivered by a ship from a U.S. destination to a U.S. destination must use U.S. crews, was not immediately removed after two hurricanes that hit Puerto Rico. Apparently, the department of Homeland Security was not "formally" aware of the complete lack of electricity and phone capability to most settlements outside of San Juan and in many parts of San Juan. Those FEMA personnel first brought to the island seemed to be completely unaware of the lack of electricity, communications, and roads, were telling **all citizens** to sign in online to fill out forms to get things and to come into the city of San Juan to pick up things.

The widespread lack of electricity had already occurred right after the first hurricane hit Puerto Rico and after the second hurricane hit the whole network was almost totally destroyed so that 95 percent of the territory was without power (Vincens, Sep. 30, 2017). In addition, most of the communication and electrical poles were destroyed. The concentration of the Homeland Security personnel in one "air conditioned" building in San Juan

did not seem to be aware of this situation for some time. Also, no FEMA personnel showed up in any of the remote areas until after a big boost in military personal and helicopters were finally brought to the island after the president's first visit. The FEMA personnel began to focus on the **local mayors** and were telling them to gather the requirements and bring those to them. They also said the mayors should arrange to have the needed supplies picked up. The mayors still had no communications, electricity, or clear roads for vehicles.

The only area outside of San Juan that the President visited on his second trip was an upscale area where most of the single family housing was made from cement, which was able to survive much better than the typical construction on the island. Given the possibility that the future will have much more frequent hurricanes at the 4 and 5 level, for these islands to survive with housing intact, the rebuilt houses and other buildings have to use cement for all housing. But even those cement houses in that one small area lost their electricity after the second hurricane.

On October 9, 2017, reporters from MSNBC visited a town in Puerto Rico that had not yet had any delivery of food, water, or medical services. It had one received visit from FEMA people but only to get the needs of the town to be written down by the mayor. Their claim was still that they do not deliver food, water, or medicines. They will gather what is needed but the Mayor had to arrange for the material to be picked up. The mayor had to get on the web to find out when the materials were ready for pick up. Without any electricity, phone service, or roads, this approach by FEMA was completely unworkable. In some cases, locals hiked out and in to bring in food but often locals had to rely on uncertain local water sources.

The lack of electricity situation has caused many deaths and continued generating increases in medical problems. Three weeks after the second hurricane the lack of medical facilities and care resulted in more deaths. One person who needed added Oxygen died at age 58 after a week without added oxygen; another died from a reduction in his allocated time on a dialysis machine due to a lack of fuel for the generator. The lack of electricity for most of the island is a clear cause of generating added deaths due to existing medical problems. People who became ill found it difficult to get to available facilities and Puerto Rico did not have any added capacity to treat the size of the population with medical problems (Robles, October, 10, 2017). A number of people got sick from contaminated floodwaters. Less than half of Puerto Rico's medical employees had reported to work in the weeks after the storm. It was still impossible in October for the local government to track the employees that had left the island for the mainland or were stuck in cut off areas of the island.

As of October 10, the number of deaths due to the disaster had risen to 43. There was a growing supply of facilities like the Navy medical ship but the key problems for those scattered throughout the island was the lack of electricity, the lack of any phone or online communications, and roads that were still impassible for vehicles. It is suspected that a number of people had died from leptospirosis, a bacterial disease likely in some of the floodwaters people had to walk through and increasingly in the only water access in the cutoff isolated areas. There were not adequate facilities to evaluate this. People were being warned to drink only bottled water and to wear protective shoes near bodies of water that can be contaminated with animal urine. These are not items that were in the usual preparation instructions from less strong storms and there was no ability to convey information of this sort to many localities on the island. Clearly water purifiers, solar radios, and water boots, are not typical items conveyed by local governments to the public for emergency preparation. Confirming the infection for leptospirosis is currently taking about a week. Usually Puerto Rico sees a few dozen cases a year and perhaps one death.

On the 26th of October over MSNBC, it was announced that FEMA had a specific plan for handling a major storm attack on Puerto Rico. It was also announced that FEMA would not make that plan public or available to the government of Puerto Rico.

As of the middle of October, forty percent of the island still lacked running water because of the lack of electricity which affected still 85 percent of the island (Acosta, 2017). As a result, many people were bathing in streams and non-potable water from huge tanks. One likely victim cut his hand a few days before the storm and it had not completely healed. A few days later he had pain in his feet and knees and his temperature went to 106 degrees. He was taken to the hospital more than a dozen times. Many of the medical facilities on the island were short of necessary supplies. Oxygen was another item in short supply. Infected insect bites were a common cause of swollen limbs. Puerto Rico had over 6,000 dialysis patients which clearly forced reduced time on such equipment and difficulties reaching the equipment. Dialysis treatment of 12 hours a week had been reduced to only 9 hours as the power emergency persisted. There was a local group arranging the ability of some dialysis patients to get a trip and location on the mainland where they can get better dialysis treatment.

Before these hurricane events, Puerto Rico was a supplier of water to other islands and had a number of factories producing bottled water for export. With the lack of an island wide electricity system, those facilities have not gone back into operation. The lack of electricity also created a demand for generators of any possible size available. It got so bad in some settled areas that there were now complaints of noise in many housing

areas (Fausset et al, Oct 7, 2017). Generators vary in size from lawn mower size to a moving truck size. With a 45% poverty rate, it is only half the population that can afford those machines and the cost of fuel. Currently, near the end of October, 85% of the island was still without island wide electrical power and it may be many months before a new island wide system is in place. At the end of October, there are still many localities where the military had to fly in food and water and there is no real data on the actual count of causalities in some areas. With respect to generators, the sales rate has been 250-300 units a day and they have used up U.S. sources recently and were now (i.e. November) importing them from Canada. Without a real island wide electrical system, it is doubtful that the water bottle industry or a number of factories for specialized medical items will reopen anytime soon.

Given the likelihood of future major hurricanes, the new electrical system has to be much more survivable than the prior one and needs, as well, to make major use of solar, and wind sources as well as significant battery backup for homes. The Governor of Puerto Rico estimated on Oct. 17th that it would be December before they would have a new electrical system (Fausset, 2017). Also, thousands have fled Puerto Rico, without knowing if they will ever return. Puerto Rico should go to buried water-proof electric cables everywhere and very sturdy metal supports buried in concrete for above ground use such as Wi-Fi/cellphone systems. They also should install an island wide broadcast Wi-Fi system not dependent upon cables.

The initial objective was to restore energy to one hospital in each region of the island. There are at least two regions where the electrical network was completely destroyed. Some patients were being encouraged to travel to the mainland to get the medical service they needed. A lot of the facilities were supported by generators running on diesel fuel and not a working electrical network. As of October 25th , a 300 million dollar contract for restoring the original network was given to a company in Montana with two initial employees and one of the owners was related to the head of the U.S. Interior department. This was done by the present company owning the network which was in bankruptcy. This has caused some concerns and by various parties even though the governor of Puerto Rico agreed with this action. As now planned, it is unlikely to be an improved system that might resist future hurricanes of similar size. As of January 12th 2018 in THE WEEK (page 14) included is a summary of news items appearing in many papers that only 50% of the power system in Puerto Rico was working and it would be May sometime before the total system will be restored. Deaths resulting from the disaster are expected to be more than 1000 persons which makes the results more like Katrina. There is no indication in local news that road repair equipment is in place. The funds made available by FEMA for bringing in crews and equipment from other state utilities were much less than that for Houston or Florida even though Puerto Rico had far more damage.

The 28,000 acre forest (El Yunque National Forest) in the South-Eastern part of the main Puerto Rican Island was largely destroyed. It was the only tropical rain forest in the United States and was a significant tourist destination. The billions of gallons of water that rain every year on the eight rivers that originate at this site supply 20 percent of the drinkable water in Puerto Rico (Ferre-Sadurni, October 12, 2017). The foliage and moss that made this a capture area for rain are now totally defoliated and this means this major source of drinking water may no longer be available for a very long time. The resulting climate will be dry and hot. There is also a likely loss of a unique breed of parrot that lived in this area and it could take a century for this forest to rejuvenate.

Some areas had not had power for 45 days due to the earlier hurricane Irma (Acosta, Oct 20, 2017). In Texas and Florida, thousands of professionals in the electrical network area were brought in almost immediately to repair a much smaller outage of the local electrical networks. In Puerto Rico there were only around 500 brought in to handle a much greater sized outage of the electrical network. The power loss in Texas was only about 10% the size of the Puerto Rico outage. The Puerto Rico situation was further complicated by possibly around 1000 mudslides blocking roads in the settled hilly areas. Getting to those areas required hiking and in some cases only motorcycles, rather than cars or trucks, could get by. The lack of any air conditioning and the lack of light at night made life in a very hot climate quite difficult. None of the bridges that were destroyed were being rebuilt by November. Shortly after President Trump's visit, a mudslide hit the neighborhood that Trump visited and destroyed a local bridge in Guaynabo, stranding families who then had to hike through mountainous, overgrown terrain to get food and water (Weir, B. and R. Clark, CNN, 20/16/2017).

The death rate has been increasing and on Oct 21, 2017 there was a outage reducing electrical power from 20% to around 10%. They had initially had 230 brigades (electrical repair teams) and as of Oct seventh they were beginning to bring many hundreds more. Associated problems include bringing in enough replacement equipment (e.g. poles, transformers, generators, etc.) and many of the plants date back to the 1950's. At least three repaired grids have subsequently collapsed. There was not yet any mention of attempting to build an electrical system that will survive future hurricanes of similar strength to the two that destroyed the original system.

In Puerto Rico, we seem to have developed an "after the disaster evacuation." All the available flights and boats that can carry passengers were packed every day in October. Those with relatives and friends already in states like Florida and New York were receiving large numbers of fleeing Puerto Rican residents. This is something that should have been part of the plans for islands subject to strong hurricane attacks. In fact, we do not do a good job of planning evacuations in urban areas because all the public and organizations in the area need to be involved by knowing the plans and agreeing to participate in the process. Many urban plans do not have agreements and participation by local private organizations and business as well as community organizations. There is also no prior involvements of the citizens and the community groups to hash out many details. Examples are the lack of services like stopping for gas and eating during the evacuation as well as assurance that those without cars can also evacuate. For example, in Katrina, the plan called for the bus drivers of the city's buses to not bring their families and the participants not to bring their pets. As a result, many bus drivers chose to drive their own cars and families out rather than report for driving the city buses. While the federal government normally supplies aid to move people out of danger areas, it does not include evacuating those they rescue farther than a temporary shelter area. This is a limitation that should be eliminated.

Summary and Conclusions

We need to start assuming that a new level 5 hurricane, or a set of them, can occur every year and hit any Caribbean island or any major urban area on or off the Gulf or Atlantic coast of eastern Mexico or North America. We need to evolve a set of national standards in the U.S. for our electrical system and connections of neighboring systems as well as with Canada and Mexico. In addition, we have to design the electrical nets to handle better destructive EMP forces from the future use of nuclear weapons. The earth could have a solar storm that would also create EMP interference and destruction of our current electrical network as it is currently designed. Strongly encouraging local solar and wind generation of electricity is also very desirable. In 2017, the costs of solar production of electricity have fallen to be less than a kilowatt hour more than the use of the typical utility networks. As we have discovered from the Puerto Rico network failure, the production network of transformers is not sufficient for the replacement of the Puerto Rican system, let alone a major U.S. continental failure. According to various news items and photos, Puerto Rico is replacing the system as it was instead of deciding to bury local cables and greatly reinforce the long distance line supports and, perhaps, better protect transformers with concrete structures. This applies to all of the U.S. as well as Puerto Rico. In the recent fires in California, it is believed some were started by transformers creating fires remote from the main blaze. However, in January 2018, the federal government has put a tariff on importing solar electrical generation panels.

We need to allow the maximum ability of pavement and road areas to pass water into the earth. This was also a significant problem in both Florida and Houston. For urban and rural areas, we should move to wide scale Wi-Fi networks for local communications. This would allow distributing sensors on a large scale and being able to determine the conditions of roads, water ways, traffic, buildings, fires, etc. We need to construct all types of buildings, including homes, based upon cement. All windows should have metal shutters that can be closed and help to prevent pressures on roofs and doors. At the very least, this should be required for whatever distance hurricane water surges augmented with king tides can reach.

A recent irony for those in Texas and Florida is that five weeks later a great many people had not yet been assigned home inspectors (Fermandez et.el, October 23, 2017). Homeowners must have this inspection before they can receive money to repair their home. To reach FEMA by phone, waits of 3-5 hours holding the phone were typical. FEMA was seeking additional contractors rather than authorizing local building inspectors to take up the slack based upon a simple payment scale, with the cooperation of local governments seeking additional help. The U.S. policies on insurance for water damage need great improvement not likely to occur. The original intent for that U.S. program was to encourage people to take the funds they received and move to an area not likely to flood in the future. Instead, the lack of proper zoning approaches has caused people to rebuild many times and spend government funds many times the value of the house over an extended period with reoccurrence of many natural disasters.

In looking at infrastructures it has been shown that without drinkable water all the other attempts to restore a disaster situation to normal will fail (Turoff et al, 2016). Clearly, by November 10, 2017, this was not yet solved for Puerto Rico and had led to bacterial infections that can be fatal if not treated. A recent satellite photograph shows what looks like around 500 dirt slides around the island but the photo is such that it does not show slides for all the possible areas and the actual number could well be over 1000 (Bessetter-Kirton et al, October 25, 2017). As of November 2017, there did not seem to be the manpower and heavy equipment to do major repairs of roads. Many remote areas had to be hiked into or at best allowed motorcycles in. There were also cases of destroyed bridges to be repaired. It is going to take a few years, at the least, to repair Puerto Rico, or longer if we have more severe hurricanes in the next few years. We would hope at some point there is more realization of what is needed for the probable future we all face with respect to natural disasters.

In local areas, we need the complete involvement of the population in understanding and evaluating our efforts and plans for handling any likely natural disasters. One suspects that the people of Puerto Rico are ready to realize future natural disasters are something they have to decide to prepare for with the total commitment of the population to secure their future. They have not received from the government the aid and financial assistance that a U.S. state would have received and there needs to be the corrections to allow that population of U.S. citizens to prepare for a decent future.

A recent article expresses very well the situation in Puerto Rico long after the storms:

"It is not just water and electricity that are in scarce supply, Cellphone service ranges from spotty to nonexistent. Cars are damaged and roads blocked. For many, work and school still have not resumed, so they wander the streets, play board games and sit around telling stories by candlelight." (Dickerson and Ferre Sadurni, October 25, 2017)

Perhaps, the most important message the Puerto Rico situation can stimulate is that we have to go back to a time when we had an office of Emergency Preparedness that could impose requirements on local situations that strongly influence the ability of local areas to invest in preparing for likely disasters and reducing the likely negative consequences. For just one example of many, insurance money for flooding should go to having people move to safer areas and the locations turned to other functions useful to the community (Turoff, et al, 2004). We have to have a federal level body that will establish national guidelines and standards to reduce the negative impacts of likely disasters and insure a reasonable level of preparedness. We need national safety standards for all our infrastructures and especially for electrical systems, communication systems, and water purification.

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