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RESILIENCE MANAGEMENT: FROM FUKUSHIMA DISASTER TO BOILING OCEANS AND NORTHWARD VIRAL SPREAD

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ABSTRACT

The present paper reviews the necessity of 'resilience based on disaster management' (Chroust, G., 2015). Firstly, it examines non-resilience, showing the current status of nuclear fuel debris, contaminated water and radioactive waste after the Fukushima Nuclear Disaster, since when radioactive contamination has damaged the local community and socio-economic systems. Secondly, it presents evidence of global spread of super-typhoons and unusual weather patterns, with the location of maximum typhoon intensity having moved northward by approximately 150-200 km compared to 1982, and at the same time expanded due to the 'boiling ocean' effect. Thirdly: it considers ir-resilience, 'global ocean warming' through the multiplier effects of hydrospheric and CO_2 atmospheric warming. Finally: it discusses un-resilience, arising from the spread of infectious tropical diseases to the northern hemisphere caused by global ocean warming, as part of the irreversible environmental change caused by our artificial systems, which will increase the risk and crisis of disasters for all human beings. Re-consideration of our living systems is therefore necessary to create awareness of the 'five functions of resilience management' for all-round sustainability.

Keywords: Disaster Management, Super Typhoon, Northward Viral Spread

I. NON-RESILIENCE: AFTER THE FUKUSHIMA NUCLEAR DISASTER

Regarding the definition of the word resilience, it was originally a term from the field of psychology that referred to the ability for self-healing and recovery or resistance, the opposite of vulnerability. This meaning is exemplified in well-known works such as (Gunderson, L.H. and Holling, C.S., 2009), (Zolli, A. and Healy, A.M., 2013) and (Unger, M., 2013). It denotes system design in the modern era for recovery and reconstruction in the wake of physical, biological, social, or psychological crises, including natural disasters, human-made disasters, accidents, and systems pathologies. Especially, Worldwatch Institute by L. Brown (2016) adapting to global warming, to organizational accidents (Reason, J., 2008).

(i) Molten nuclear fuel debris and nuclear decommissioning robotics: *Innovative Technology*

Six years after the meltdown of reactors nos. 1-3, decommissioning work is still ongoing at the Fukushima Daiichi Nuclear Power Station. According to the roadmap drawn up jointly by IAEA and TEPCO (Tokyo Electric Power Company), decommissioning will be completed in 30 to 40 years' time, but the final destination of the molten nuclear fuel debris that broke out of the containment shroud is not clear. Only at reactor no. 4 is the removal of the nuclear fuel complete, but as no definite arrangements have been made for the clearing of the highly concentrated radioactive waste material, including debris from inside the nuclear reactor building, the reactor cannot yet be dismantled. As of March 2017, the known state of each reactor is as shown below Table 1.

Table 1. Condition and radiation level of nuclear fuel debris in nuclear reactor

Reactor	No.1	No.2	No.3
Radioactive dose	11 Sv/h	650 Sv/h	1 Sv/h
Molten nuclear fuel debris	Unknown	Melted down remains located	Unknown

Source: TEPCO Decommissioning Project and press release

Inside the nuclear reactor building, a radiation level has been measured that exceeds the limit to which humans can operate, and the fact that the conditions inside are described as 'unknown' is problematic. In response, under the guidance of the International Research Institute for Nuclear Decommissioning (IRID), robots developed by Hitachi GE, Toshiba, and Mitsubishi Heavy Industries have been deployed. Robots of this kind are engaged in debris removal and surveying inside the nuclear reactor building, However, the wreckage within the nuclear reactor and the high radiation level have caused a series of accidents, and many of the robots have become unrecoverable. The final goal is the removal of the nuclear fuel debris and the demolition of the building, but as the condition of the debris is not known, the question of whether removal is possible remains uncertain.

(ii) Contaminated water crisis: *Timeline for Limitation*

Given the presence of nuclear fuel debris, measures are needed to cool the interior of the nuclear reactor and stabilize the temperature. As the coolant water comes into direct contact with the contamination source, it undergoes radioactive contamination at high concentration and becomes contaminated water, the volume of which amounts to 400m^3 a day. In addition, 300-400m^3 a day of groundwater seeps into the soil beneath the power station building and become contaminated, bringing the total to 800m^3 a day of contaminated water. This contaminated water is kept in storage tanks, which as of March 2017 hold over one million tons of contaminated water. However, weakening of the tanks has led on several occasions to leaking of the highly concentrated contaminated water. Although a new highly durable tank has now been installed as a replacement, unless the actual amount of contaminated water is reduced, the capacity limit will at some stage be exceeded. TEPCO reports that it has reduced by 100-200 m^3 the daily seepage of groundwater from the nuclear reactors and the building. However, the attempt to prevent contaminated groundwater from the whole of the nuclear reactor facility from reaching the sea by erecting a wall of frozen underground soil has failed, which is a cause for concern including among the local fishing community.

As for the purification of the contaminated water, since the multi-nuclide species removal equipment (ALPS) began to operate normally, plutonium and caesium have been removed. At present, contaminated water containing tritium, which is hard to remove, is held in a tank. The plan for this tritium water is to dilute it and release it into the natural environment, but it will be essential to establish a social consensus among residents and other 'stakeholders' regarding the associated risk.

(iii) Caesium-particle and radioactive waste: *Decision-making for policy*

The earthquake debris generated by the Great East Japan Earthquake was projected as being beyond the clearance capacity of the three prefectures affected. The approach taken was therefore to disperse disposal to other prefectures, which raised fears of the wider spreading of radioactive internal pollution by 'caesium particles' and provoked a debate. As a result, almost all the earthquake debris of Miyagi and Iwate prefectures was handled within the prefecture, but Fukushima Prefecture's debris still remains to be dealt with. To establish a criterion for distinction between radioactive waste and earthquake debris, the government has set a threshold value of 8000Bq/kg, but emissions of the radioactive waste continue. In response to the government's adoption of a dispersed disposal approach, the IAEA has recommended that the radioactive waste be dealt with under an appropriate management system.

Within Fukushima Prefecture, the surface soil, dead leaves, and other material removed for decontamination constitutes soil with highly concentrated contamination, and is kept in storage. The containers holding the material are not robust, and leakage of radioactive materials has been measured. Similarly, within the grounds of the Fukushima Daiichi Nuclear Power Station, there is a store of radioactive waste which has nowhere to go, which includes the dismantled contaminated water tanks. The clear-up after the nuclear accident is thus proceeding with no storage location decided for the range of waste materials associated with the decommissioning operations, which will continue for decades to come.

(iv) Radioactive contamination and evacuees who never return: *Spacing for Living Systems*

As shown in Figure 1, between 2011 and 2016, the districts of Fukushima Prefecture showing high radiation levels have shrunk, and in response the gradual lifting of evacuation orders has begun.

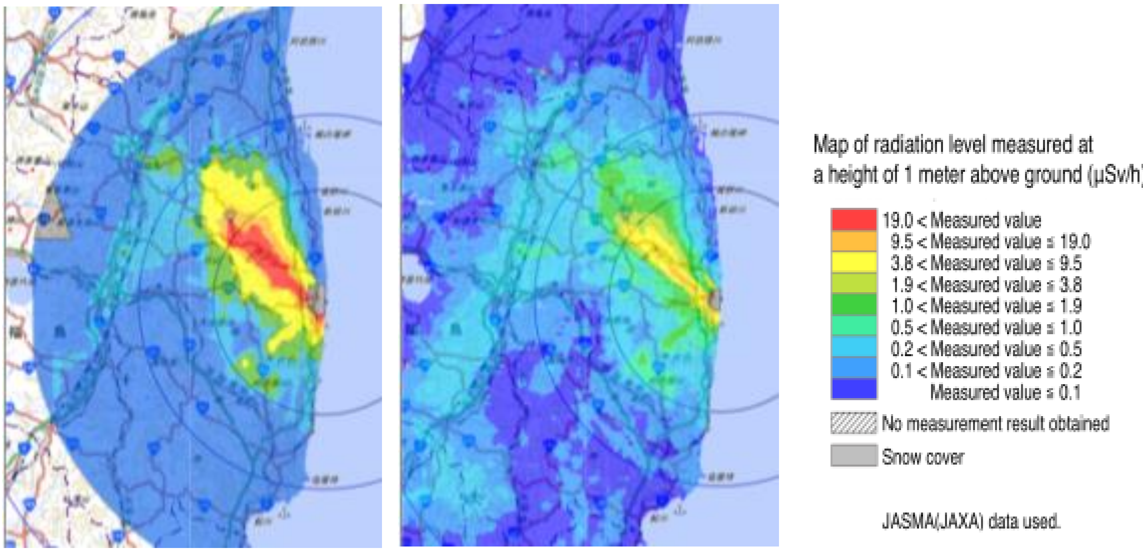

Figure 1. Comparison of Spatial Radiation Level in Fukushima Prefecture: April 2011 (left) and November 2016 (right)

Source: Extension site of Distribution Map of Radiation Dose (http://ramap.jmc.or.jp/map/)

At the time of the accident, the areas covered by evacuation order were classified according to radiation level into (1) districts to which residents cannot return; (2) districts with restricted residence; and (3) districts preparing for lifting of evacuation order. Successive lifting of orders began in 2014. As of April 2017, the evacuation order has been lifted at Iitate-mura, which had previously been a district with restricted residence, and at Namie-machi and Tomioka-machi, which are within 20 km of the Fukushima Daiichi Nuclear Power Station. The number of evacuees outside Fukushima Prefecture reached more than 60,000 people at one point, but in 2017 it was just over 36,000. Some residents return home after the lifting of the evacuation order, but there is an increased number of people who are reluctant to go home out of consideration for their children and the next generation. One of the likely reasons is that the condition for the lifting of the evacuation order is an annual cumulative dose of 20mSv. The evacuees are thus forced to choose between living with the risk of radiation and settling down at the location to which they have evacuated. The government is promoting the return of the residents under the banner of reconstruction, but is it really a reasonable choice?

The aftermath of the nuclear reactor accident is environmental contamination affecting foodstuffs and other elements of the ecosystem, health damage, and destruction of the local society and economy. These factors impair the resilience of the people and areas affected by the disaster. Regarding the recovery and reconstruction operations around the Fukushima Nuclear Power Station, the local community and the local economy continue to suffer the effects of the radiation-contaminated water from the nuclear power facilities and the decontamination operations within the nuclear reactor. For instance: (1) approximately 70 companies in the affected area have gone bankrupt and there have been more than 1,400 chain bankruptcies of associate companies nationwide (Abe, H. and NHK, 2014); (2) the exposure to irradiation of agricultural land and fishing grounds has led to a consumer boycott of crops and dairy and fish products, one form of 'damage by association' to neighboring areas not in fact affected by contamination; (3) children evacuated to other prefectures meet with hostility from their peers at school. These are some examples of the incalculable physical, biological, social, and psychological damage which has left the area in a continuing state of non-resilience.

II. EVIDENCE: SUPER-TYPHOON AND UNUSUAL WEATHER PATTERNS CAUSED BY THE 'BOILING OCEAN' EFFECT

'Boiling Ocean', outlined the fact of thermal energy accumulation not in the atmosphere, but in the oceans and the rest of the hydrosphere due to the discharge into the sea of thermal effluent from the world's 441 nuclear reactors over a period of 40 years (Atsuji, S. et al., 2015). In the case of atmospheric warming through CO_2, methane gas, and similar agents, part of the thermal energy in the global atmosphere is released from the earth, for instance through radiation into space, but in the seas it is likely to remain stored in the ocean liquid. Geo-historically, typhoons, hurricanes, and cyclones acted as a heat cycle system, balancing out temperature differences at global level by redistributing thermal energy build-ups in the equatorial region from the tropical zone through the temperate zone to the cold polar-regions. The abnormal weather patterns and climate change of recent years, together with the great increase in the size of tropical depressions, raise the fear that global warming affects not only the atmosphere, but is also reflected in ocean warming.

Fresh in our memory are Hurricane Katrina (902hPa, 2005), a storm of the strongest category C5 in which yachts were cast up onto the street; Hurricane Andrew (922hPa, 1992), when St. Louis and Mississippi were flooded; and Hurricane Sandy (940hPa, 2012), when President Obama declared a state of emergency '36 hours of *Timeline* on the storm route', New York subway and Wall Street stock exchange were shut down as crisis management measures to reduce the impact of the disaster. Super-typhoon Haiyan (895hPa, 2013), which attacked the Philippines with heavy rainfall and wind speeds of 100 m/sec, flattened trees and buildings on the island of Leyte, Leaving devastation on the same scale as the tsunami that followed the Great East Japan Earthquake. Low-pressure systems of 900hPa or below, compared to atmospheric pressures of 1000hPa, result in a 10% greater incidence of sea surface swells and storm tides. Typhoon 14 (Meranti, 890hPa, 2016), which made direct landfall on Taiwan this year with damage extending as far as Fujian Province in China, was called a 'super-typhoon.' Ocean surface temperature rise in the North Pacific has magnified the scale of tropical depressions and caused them to take more complex pathways. This magnification of typhoons and hurricanes has been accompanied by increased frequency due to a rise in seawater temperature in the Pacific and Atlantic, and completely altered pathways (Atsuji, S. et al., 2015). Seawater temperature rise, driven by the cumulative effect of the nuclear thermal effluent of some 441 reactors over 40 years (7℃×3.5 trillion tons), has caused a 7℃×11 cm sea surface temperature rise in the northern hemisphere (1℃ rise in 77cm sub-surface layer), which has at least intensified ocean warming, and is undeniably one aspect of human-made global warming (Fig. 2).

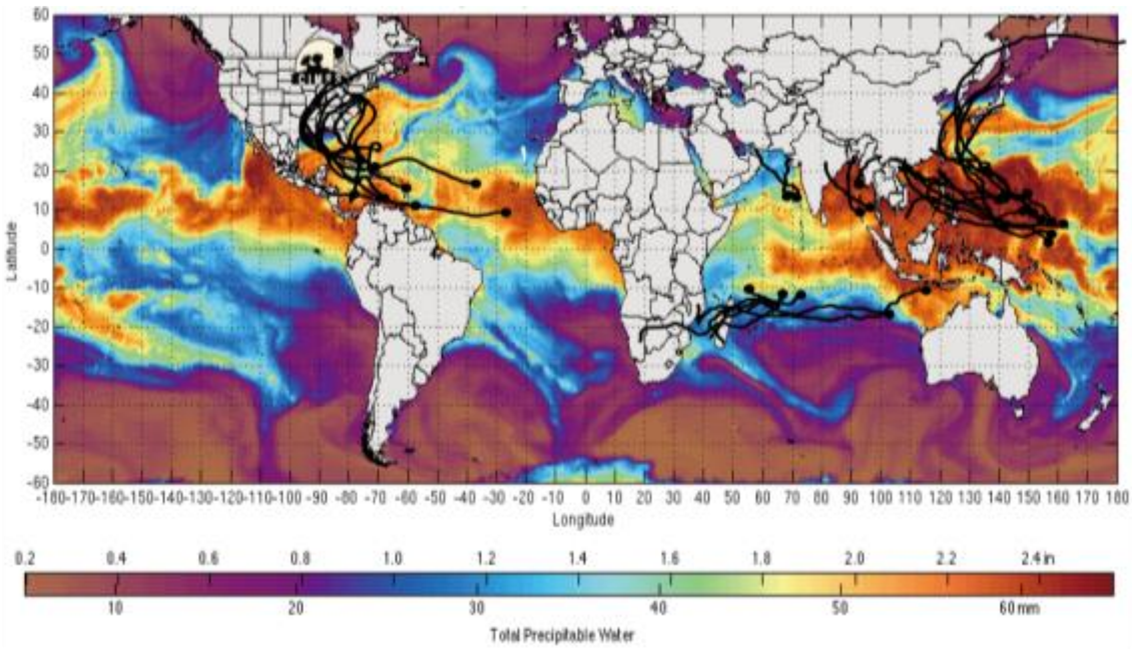

Figure 2. Tropical depression pathways

Table 2. Category C5 tropical depressions with air pressure of 950hPa or below

Formed	Dissipated	Name	Minimum Pressure (mb)	Region	Dead or missing	Category
1992/8/17	1992/8/28	Hurricane Andrew	922	Bahamas, US	65	C5
2003/9/6	2003/9/13	Typhoon Maemi	910	Japan, Korea	over 100	C5
2004/3/1	2004/3/18	Cyclone Gafilo	895	Madagascar	418	C5
2004/9/2	2004/9/24	Hurricane Ivan	910	Lesser Antilles, Venezuela, Greater Antilles, US, Canada	127	C5
2004/9/13	2004/9/28	Hurricane Jeanne	950	Leeward Islands, Greater Antilles, US, Canada	over 3,000	C3
2005/8/23	2005/8/30	Hurricane Katrina	902	Bahamas, Cuba, US	1,833	C5
2005/9/18	2005/9/26	Hurricane Rita	895	Hispaniola, Bahamas, Cuba, US	125	C5
2007/6/1	2007/6/7	Cyclone Gonu	920	Oman, UAE, Iran, Pakistan	115	C5
2007/8/31	2007/9/5	Hurricane Felix	929	Trinidad and Tobago, Windward Islands, Venezuela, Leeward Antilles, Colombia, Costa Rica, Nicaragua, Honduras, El Salvador, Belize, Guatemala, Mexico	133	C5
2007/11/11	2007/11/16	Cyclone Sidr	944	Bangladesh, India	about 15,000	C5
2012/11/26	2012/12/9	Typhoon Bopha	930	the Philippines	over 540	C5
2013/11/4	2013/11/11	Typhoon Haiyan	895	the Philippines, China, Vietnam	about 8,000	C5
2014/7/12	2014/7/19	Typhoon Rammasun	935	the Philippines, China, Vietnam	114	C5
2016/9/8	2016/9/17	Typhoon Meranti	890	the Philippines, Taiwan, China, Korean	45	C5

*Category by Saffir–Simpson hurricane wind scale   TD < TS < C1 < C2 < C3 < C4 < C5

As shown in Table 2 (Category C5 tropical depressions with air pressure of 950hPa or below), Super-typhoons and large-scale hurricanes and cyclones are becoming increasingly common, causing increasingly widespread damage worldwide. The energy source of these tropical depressions is water vapor from seawater heated at the equatorial regions. As shown in Figure 3 (Ocean temperature distribution and tropical depressions), the Pacific and Atlantic zones with seawater temperature of 28℃ or above, where typhoons and hurricanes arise, coincide uncannily with the sea areas into which the northern hemisphere's 436 nuclear reactors discharge thermal effluent. Figure 4 (Heat storage in deep-sea layers), issued by America's National Oceanic and Atmospheric Administration, warns that thermal energy accumulates in the deep ocean at a depth of 700 m, so that even when atmospheric temperature decreases in the fall and winter seasons, this body of warm water continues to warm the sea surface from the deep, inevitably causing this retained heat to spread globally from the northern hemisphere (NOAA, 2013).

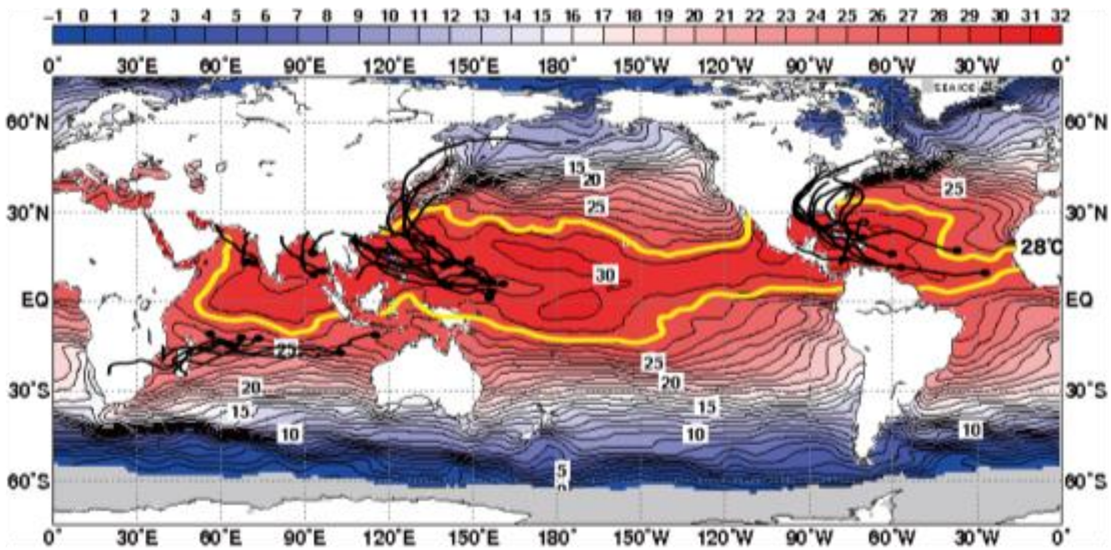

Figure 3. Ocean temperature distribution and tropical depressions

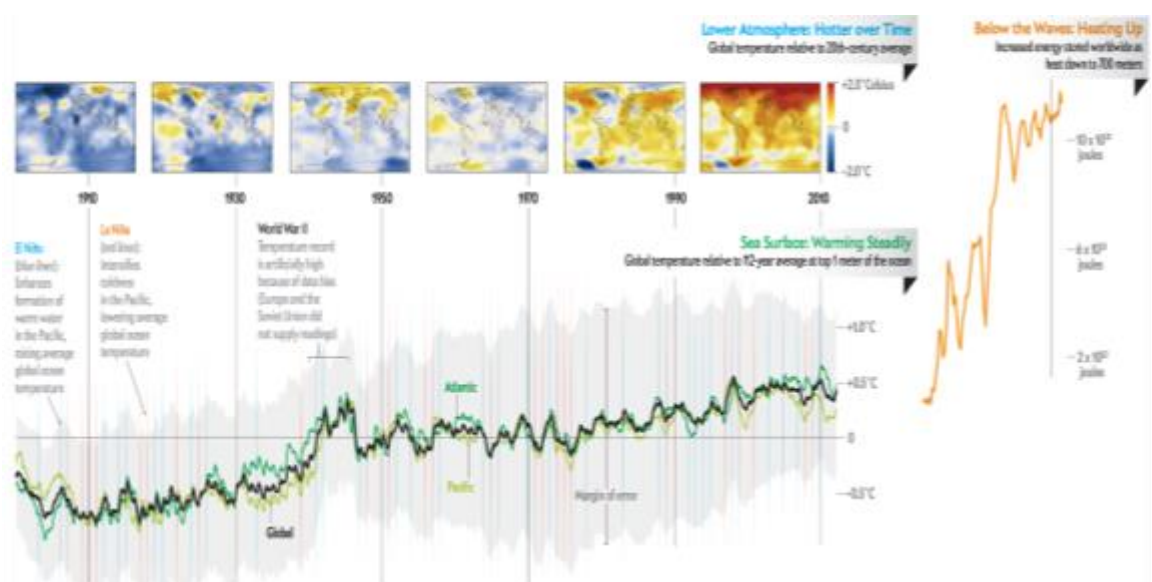

Figure 4. Heat storage in deep sea layers

Traditionally, the area where typhoons are generated is the sea area immediately east of the Philippines, but the zone with seawater temperature of 28℃ has now drifted north to the sea area off Okinawa. Likewise, the area where hurricanes are generated has moved north from the sea area around Cuba to the area off Florida. Dr. James P. Kossin has found that the location of maximum typhoon intensity moved northward by approximately 150 km in the 30 years from 1982 to 2012, and that the location of landfall and the area affected by damage have also moved northward, at the same time expanding in the east-west direction (Kossin, J.P. et al., 2014).

Global warming is not limited to the atmosphere; warming of the ocean surface and deep sea layers results in magnified tropical depressions. Even the NASA figure of a temperature rise of around 2℃ since the industrial revolution of the 19th century would have caused low pressure decreases of an average of 50hPa, velocity rise from 50m to 100 m/sec, and a rise in rainfall of 100mm or above, which in some regions exceeds the yearly rainfall amount. Together with the atmospheric temperature rise of 4.8℃ forecast by the IPCC, it is possible that the accumulation of thermal energy through sea discharge of effluent from nuclear reactors and other sources may lead to exponential and accelerating magnification of tropical depressions. Assuming for the sake of argument a rise of 2℃, the scale of typhoon and hurricanes will be doubled and damage from violent winds and torrential rain will be unprecedented in terms of historical meteorological data. Even if the earth is cooling down toward a new ice age, the extreme weather phenomenon of tropical depressions is a negative factor for humanity.

This climate change—seen in violent high-latitude low pressure systems extending inland into Europe from their chief target along the western coasts, abnormal weather patterns in inland areas of Europe (destructive winds in Britain, floods in France, extreme heat in Russia), and typhoon damage in China and South Korea—causes damage to the world economy and spreads the damage of global warming. The statistical frequency of tropical depressions such as hurricanes and typhoons has been high in recent years. At the same time, it has become difficult to forecast the whole process from storm generation to growth and dissipation, which has seen a northward shift in pathways and location of maximum intensity, so that tropical storms now affect areas previously outside their range. Together with ocean warming and movements in seawater temperature zones, this unpredictability is destroying sustainability for the near future.

III. IR-RESILIENCE: 'GLOBAL OCEAN WARMING' THROUGH THE MULTIPLIER EFFECTS OF HYDROSPHERIC AND CO_2 ATMOSPHERIC WARMING

The rise in sea temperature causes a problem of increased seawater volume leading to sea-level rise due to the big-melting not only of the land-based ice at the poles but also the glaciers of eastern Siberia and Greenland, the Arctic and Antarctic ice sheets, and the frozen seabed. The last of these causes methane gasification and further accelerates atmospheric warming. As for the buildup of nuclear coolant effluent over the years, those who have observed nuclear power generation and have seen the amounts of effluent involved at first hand will, like me, have been overwhelmed by its scale. As mentioned above, the year-on-year accumulation of nuclear thermal effluents, amounting to 17.9 trillion tons, cannot be ruled out as a factor in the abnormal weather patterns observed worldwide.

Figure 5 presents data on the deviation of 2013 sea-surface temperature from average values for the period 1981-2010 by the Meteorological Research Institute of the Japan Meteorological Agency and the Advanced Earth Science and Technology Organization, together with a map of the locations of nuclear power stations. As the figure shows, hydrospheric warming has occurred mainly in the northern hemisphere, with a particularly high rate of rise in the North Atlantic, where there is a concentration of nuclear power stations, which may be due to the effect of thermal effluents. In a current affairs program called *Close-up Gendai* made by the Japanese broadcaster NHK, it was suggested that the rise in 'hot spots' shown in this figure by the Japan Meteorological Agency (JMA, 2014) could have repercussions as far away as Asia in the form of abnormal weather patterns and natural disasters such as floods and typhoons (NHK, August 29, 2013). The program thus sounded the alarm over the potential threat of extreme weather in the form of a 'hiatus'.

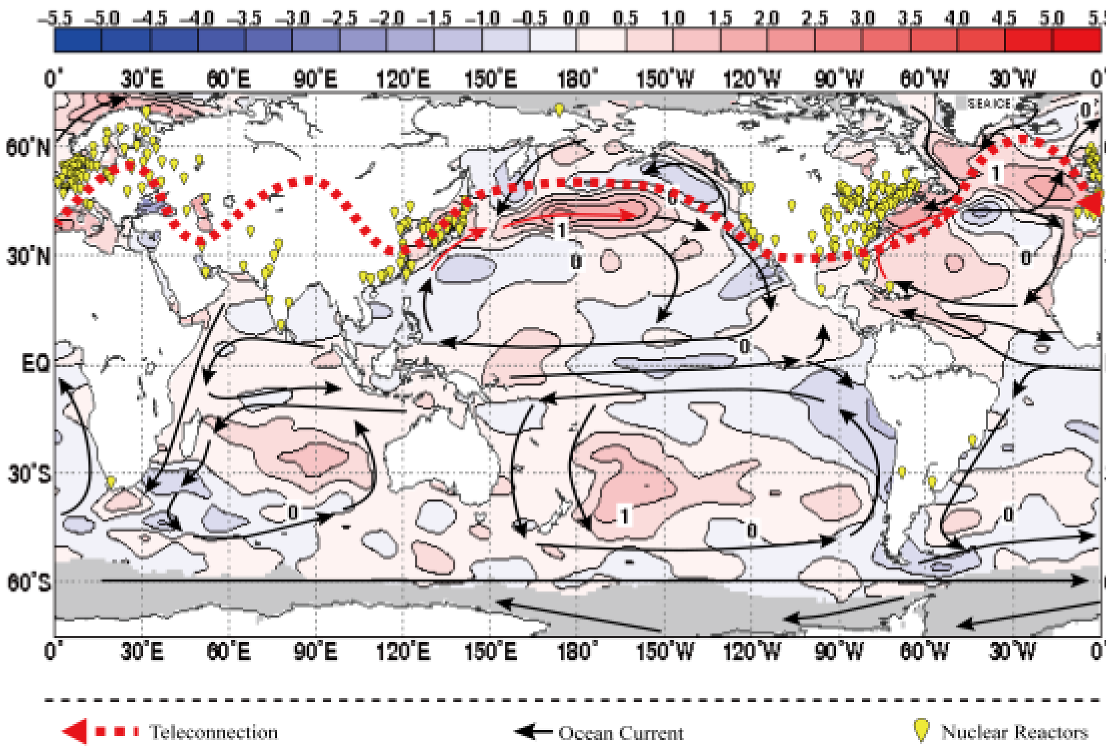

Figure 5. Climate Crisis by nuclear-heated oceans

Note: Redrawing of 'Teleconnection Curve' based on the map of Japan Meteorological Agency
Source: by *permission* of Japan Meteorological Agency (JMA URL: http://www.jma.go.jp/)

For instance, a largest typhoon ever recorded (Super-typhoon 30 named Haiyan), struck the Philippines on November 8, 2013, and is estimated to have claimed over 10,000 lives. The U.S. Navy's Joint Typhoon Warning Center reported it as the strongest ever recorded typhoon at landfall, with maximum wind speed of 315 km/h and gusts of up to 378 km/h. In the wake of the super-typhoon that hit the Philippines (with winds averaging 324 km/h, and atmospheric pressure of 895 hectopascals), every building on the island of Leyte was left flattened, an aftermath tragically similar to that of the Japanese earthquake and tsunami disaster of March 2011. The reach of the rainstorm's winds was limited by rising land, but the formidable winds destroyed all buildings, crops, and trees on Leyte. What caused this super-typhoon of a kind never before seen in human history?

It was known already in August 2013 that the surface temperature of the sea off the Philippines had risen by 2-3°C. Together with the atmospheric warming caused by CO_2 and methane emissions, sea-temperature rise is an insidious threat. Nuclear effluent directly heats the ocean, and, unlike CO_2 and methane which hold thermal energy, brings the possibility of 'Climate Crises'. Japan has also been hit by damage from unprecedented typhoons and torrential rain. In the season up to November 2013, 31 typhoons were recorded, the first time since 1994 that the typhoon count had exceeded 30. Typhoons have also become increasingly powerful year after year, and the connection between this expanding scale and global warming has been pointed out Figure 6 by Intergovernmental Panel on Climate Change reports (IPCC, 2013).

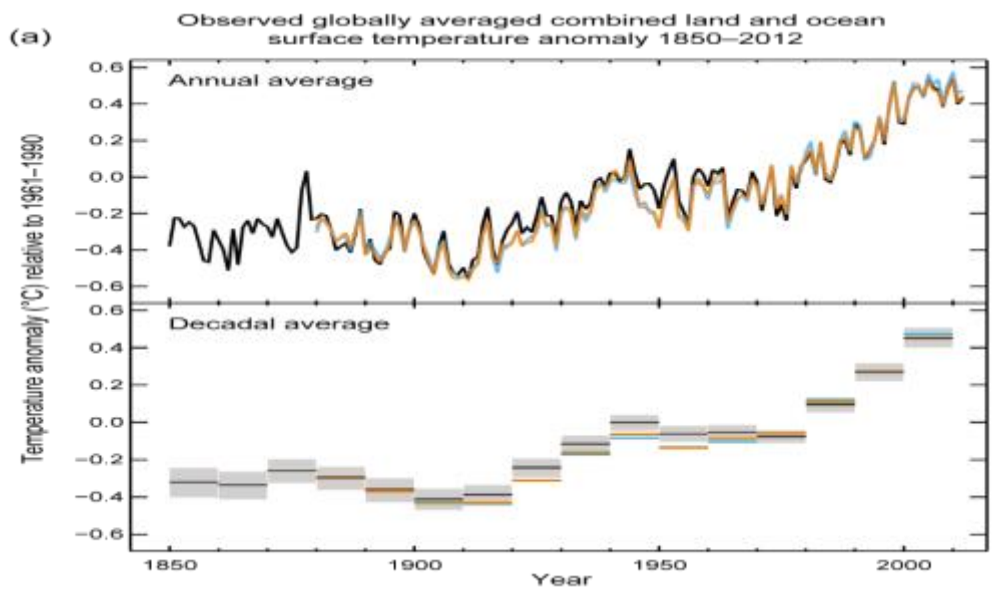

Figure 6. Global warming by IPCC Report

Source: IPCC 2014 (permitted IPCC website policy)

The IPCC also predicts a rise in atmospheric temperature of up to 4.8°C by 2100, which will be accompanied by an 82-cm rise in sea levels, while the 19^{th} session of the Conference of the Parties to the United Nations Framework Agreement on Climate Change (COP19) in Warsaw, Poland, saw conflict as developing countries insisted that developed nations should compensate them for floods and typhoons caused by warming and for loss of submerged territory and other damage. This clash between developed and developing nations led to an impasse at the 2013 conference, which had to be extended. The extreme phenomena 2016 already being reported worldwide include unprecedented super-typhoons with air pressure under 900 hPa, great floods, summer snowfall in France, floods in Germany and Austria, landslides in Vietnam and Japan's Izu Islands, and massive tornados in America. Posited as a remote cause of this is a possibility of 'global ocean warming' caused by effluent from the nuclear power plants? If true, this demonstrates that 'a chain of human-made disasters adds up to the natural disaster' and that ultimately the two types of disaster are intertwined via 'teleconnection' (Fig. 7).

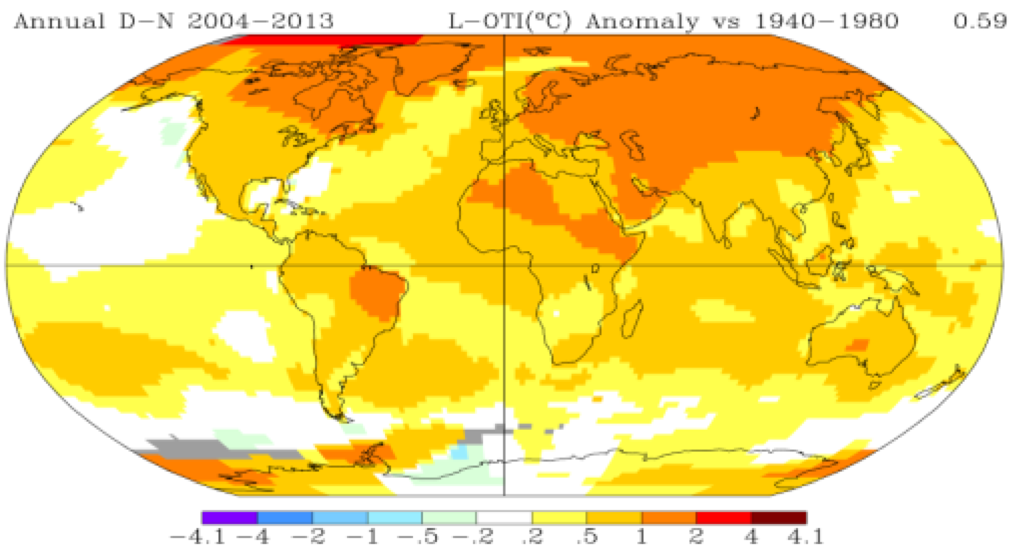

Figure 7. Global warming by NASA Report

Source: NASA 2014 (permitted NASA website policy)

In a project to predict the situation with global warming around the end of the 21st century, conducted by research groups including the Meteorological Research Institute of the Japan Meteorological Agency and the Advanced Earth Science and Technology Organization (JMA, 2014), it is stated that the number of very strong tropical low-pressure systems with maximum wind speeds over sea or land of more than 162 km/h is on a rising trend due to the increasing scale worldwide of typhoons, hurricanes, and cyclones, with a rise in sea level caused by extremely low air pressure like the 895 hPa of the Haiyan Super-typhoon of 2013, and other weather events accompanying global warming. If human activity, including such Pacific Ocean Warming, is promoting global warming, then there is, underlying natural disasters such as typhoons and torrential rain, floods and earthquakes, an accumulation of human-made disasters. As with the Fukushima nuclear disaster, which arose out of the Great East Japan Earthquake, there are cases where natural disasters develop into human-made disasters; but conversely, there are also cases where natural disasters develop out of unnatural disasters. The cumulative chain of human cooperation thus creates a situation where 'human-made disasters and natural disasters are interconnected', and contributes to the un-safety.

Even more so than the global warming caused by the protected thermal energy of the globe by CO_2 and methane, the 'boiling globe' effect of the total thermal energy of the globe by heated water has the potential to produce ‘unexpected consequences: un-safety’. For instance, the permanently frozen glaciers of Greenland and Antarctica could melt under the influence of global warming and form a moraine. The moraine would cause water to flow in and gather two to three kilometers below the ice sheet, which would lift the glacier so that the whole ice cap might plunge into the sea in one piece, setting off a huge wave. As the ice cap lifted with further melting, the rising sea-levels of the continents of Greenland, Siberia, the Arctic and Antarctica, which had until then been subject to subsidence of several kilometers, might suddenly be forced upward and release a tsunami. In such an event, there would be a threat of ir-resilience to the coastlines of countries around the North Sea, such as Norway, Iceland, and Great Britain.

IV. UN-RESILIENCE: RISK AND CRISIS FROM VIRAL NORTHWARD SPREAD OF OUTBREAKS OF SERIOUS TROPICAL DISEASE

Human-made disasters such as the phenomenon of iatrogenic AIDS infection outlined above have an inevitable ‘teleconnection’ with natural disasters. New viral strains and infectious diseases are one form of ‘unsafety threatening humankind’. Historically, tuberculosis, cholera, plague, influenza, AIDS, and other infectious diseases have claimed many victims. More recently, the worldwide spread of SARS and avian influenza in 2003 is fresh in our memory. There are fears of epidemics of the three major infectious diseases (AIDS, malaria, and tuberculosis) arising from the ‘biological hazard’ caused by the world population explosion to 7.2 billion. The particular danger of biological hazard is its exponential pattern of spread. Explosive damage arises through bacterial and viral infection via living organisms, person-to-person infection, or cross-species infection, for example from cattle to humans through bovine spongiform encephalopathy (BSE), variant Creutzfeld-Jakob disease (vCJD), and foot-and-mouth disease. Moreover, rubella infection in pregnant women may cause cataracts and glaucoma, congenital heart disease, hearing impairment, and other conditions in the fetus, while congenital rubella syndrome (CRS) poses the risk of damage to the next generation. Whether this is regarded as a case of human-made or natural selection, the result is the same: the disaster leads to an indivisible resonance phenomenon, the negative interaction of which causes the accelerated spread of ‘unsafety’.

The WHO has published Figure 8 worldwide to signal the risk from biological hazards. The northward spread of infectious tropical diseases caused by recent global warming is proceeding at an ever-accelerating pace. Among the hazards facing the world, the proportion represented by these biological hazards is second in number only to natural disasters such as earthquakes, tsunamis, volcanoes, typhoons and hurricanes, and accounts for one-third of all hazards.

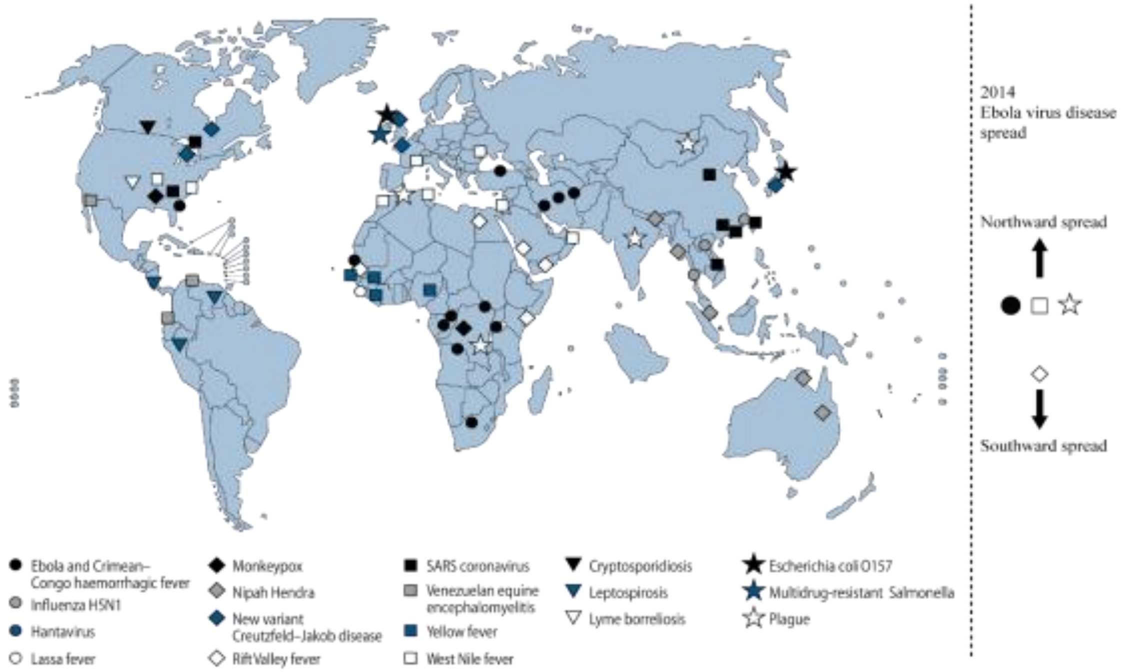

Figure 8. Selected emerging and re-emerging infectious diseases: 1996–2004
Source: WHO, *World Health Report 2007: A Safer Future: Global Public Health Security in the 21st Century*, p. 12 (WHO Publicity).

Meanwhile, there is concern that global warming's disruption of the energy balance may allow the spread of infectious tropical diseases to the northern hemisphere. The serious prevalence of West Nile fever in the United States resulted from its being spread to the temperate zone of North America by travelers. In Japan, similarly, the example of the redback spider (*Latrodectus hasseltii*), which was discovered in Osaka Prefecture and has extended its habitat to the whole country, demonstrates that this is not an insubstantial problem. In particular the recent prevalence of Dengue fever, whose incidence has increased thirty-fold in the last fifty years, means that over 100 countries are threatened by the growth of the domain of infection (WHO, 2012). Figure 9 shows areas with high risk of Dengue-fever infection as of 2011.

The lines to the north and south of the figure indicate the minimum temperature of 10°C delineating the habitat limit of the mosquito that transmits the Dengue-fever virus. Advancing northward like an army, global warming is extending the habitat of the mosquitoes that transmit tropical viruses and is pushing the infection toward the northern hemisphere, which has a large land mass and is home to a large proportion of the human race. This poses a threat to the populations of these areas, who have no experience of or resistance to tropical viruses, the global distribution of countries or areas at risk of Dengue transmission.

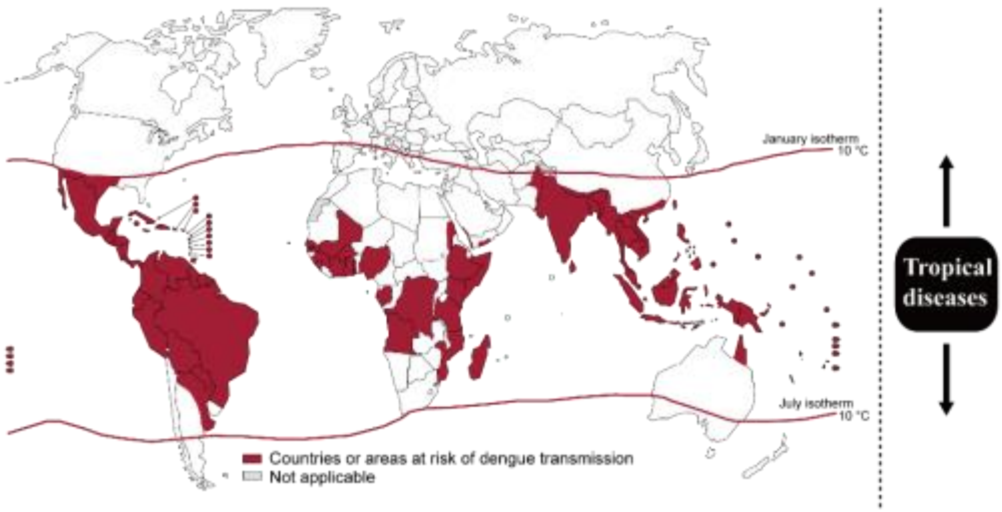

Figure 9. Global distribution of countries or areas at risk of Dengue transmission, 2011

Note: Mapping based on the discussions at 'Climate Change and Global Warming' by WWF Japan 2011. Adapted from 'Sustaining the drive to overcome the global impact of neglected tropical diseases', WHO, 2012, p. 25

If human activity, is promoting global warming including Pacific Ocean warming, then there is, underlying natural disasters such as typhoons and torrential rain, floods and earthquakes, an accumulation of human-made disasters. As with the Fukushima nuclear disaster, which arose out of the Great East Japan Earthquake, there are cases where natural disasters develop into human-made disasters; but conversely, there are also cases where natural disasters develop out of unnatural disasters. The cumulative chain of human cooperation thus creates a situation where 'human-made disasters and natural disasters are interconnected', and contributes to un-safety.

Not only the abovementioned infectious tropical diseases transmitted by bacteria and viruses, but also the risk of infection spread through global warming and the resulting crisis, will be of increasing concern going forward. For instance, since cholera bacteria live in symbiosis with plankton in seawater, the rise in sea temperatures, causing plankton to breed more prolifically, also leads to an increase in cholera bacteria, which has extended its infection zone northward. Already, it is reported that the 1991 El Niño phenomenon in South America has led to sharp year-on-year increases in cholera cases. The IPCC report from the end of September 2013 states that the world's average atmospheric temperature rose by 0.85 degrees from 1880 to 2012 and predicts that the temperature rise by the year 2100 will rise by up to 4.8°C, leading to fears of a 'Global Big Melt', which will precipitate a worldwide struggle over water and food resources.

V. CONCLUSIONS: FIVE FUNCTIONS OF RESILIENCE MANAGEMENT

Even more than the global warming caused by the thermal energy from CO_2 and methane, the 'boiling globe' effect of the total thermal energy from heated water has the potential to produce 'unexpected consequences'. For instance, the permanently frozen glaciers of Greenland and Antarctica could melt under the influence of global warming and form a moraine. The moraine would cause water to flow in and gather two to three kilometers below the ice sheet, which would lift the glacier so that the whole ice cap might plunge into the sea in one piece, setting off a huge wave. As the ice cap lifted with further melting, the rising sea-levels of the continents of Greenland, Siberia, the Arctic and Antarctica, which had until then been subject to subsidence of several kilometers, might suddenly be forced upward and release a tsunami. These phenomena would be a threat of un-safety to the coastlines of countries around the North Sea, such as Norway, Iceland, and Great Britain. An extremely phenomenon occurring somewhere in the world is an inevitable event that also occurs on the other side of the world through teleconnection.

The hypothesis of global warming from the 'boiling globe' phenomenon, which is caused by the accumulation over 40 years of thermal effluent from the cooling processes of the world's 441 nuclear reactors, points precisely to the interconnection of human-related and natural disasters. This highlights further aspects of the multiple impacts of nuclear power on the environment, including accident-related atmospheric and marine pollution and nuclear effluents. The impact on the environment means direct impact on the ecosystem and people living in the environment. Going forward, in response to the danger which has passed the limits of manageability by business enterprises and central governments, there is a need for a preventive social system to oppose the collusive relationship between business management and government policy over nuclear power. Essential here is a global eco-civilization in which individual citizenship has preventive functions.

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The freshwater available on the planet for human consumption as drinking water is said to represent 0.008 percent of all the earth's H_2O, so a Global Big Melt would mean the depletion of the water resources for the human population of 7.2 billion now. Especially in the northern hemisphere, which contains a high proportion of the planet's land mass, the melting of glaciers and permafrost soil to which the Big Melt refers is predicted to lead to the spread of viral infection to previously unaffected areas. Combined with 'trans-global' movement of travelers and migrants, and biological weapons, terrorism, and other disasters arising from human-made unsafety, these outbreaks could spread worldwide.

Governments and the responsible departments of regulatory authorities are loath to recognize ‘socio-biological hazard’. The leak and spread of radioactivity following the meltdown of the Fukushima nuclear power plant, although a question of life and death for local residents, the wider community, and the Japanese population as a whole, were hidden by the government and the company involved. Socio-biological hazard thus cannot be controlled by central government policy or corporate management, which instead frequently respond with concealment or falsification of information. Nor is it susceptible to control by social or other systems. Outbreaks or pandemics of social or biological problems are accompanied by the breakdown of social functions, indicating the limitations of policy and management at the level of national government and business organization.

Unlike war, coups d’état, and conflict, the influx of people into an area of hazard results in new infections as contamination with the pathogen spreads along the chain among the members of families, communities, and organizations. National governments and the WHO have, albeit discreetly, sounded the alarm over the worldwide spread of locally endemic diseases not only through mosquitoes, ticks, and migratory birds, but also through human movement (travelers on business or otherwise). A crucial role in the infection zones has been played by the organization Médecins Sans Frontières, known for its role in the discovery of SARS. In such a spread of infection, as in the model predicted by Reason, J. (1977), accidents and disasters leak through security holes, author which suggests a resonance between human-made and natural disasters.

To summarize, the increased risks and crises brought about by global warming can emanate through leaks in physical, social, and biological defensive barriers. The resulting human-made disasters have already brought about systemic breakdown on various fronts. The ‘survivability’ which is a defensive barrier programmed into human DNA does not operate in C.I. Barnard’s so-called ‘zone of indifference’, where hazard is neither made known nor perceived. Consequently one could suggest, in many cases, hazard is only registered when a crisis emerges from the damage due to the spread of infection instigated in the breakdown of health and sanitation and other social systems and functions.

Un-resilience by viral outbreaks on a global scale, such as the worldwide pandemic of iatrogenic AIDS, reveals a similar structure. First of all, insufficient information disclosure allows an influx of people into the infection area; secondly, government measures to suppress infection and efforts at an organizational level by corporations or other bodies remain weak; and thirdly, there is a ‘zone of indifference’ outside the infection area. These three factors create disregard for hazard information (de-civilization). Accurate publicity of ‘socio-biological hazard’ is therefore essential at the levels of international society, government, corporate organizations, and the individual, while also urgent are preventing unnecessary or unauthorized business visits or travel to the hazard area and other issues of ‘organizational compliance and governance’ (Atsuji, S., 2016), together with Human Resource Management (HRM). The northward spread of tropical infectious diseases through global warming has created a need for social systems at various levels, including those of government, corporate organizations, and the individual. This means that the concept of an ‘eco-civilization’—promoting coexistence at the level of the social ecosphere, and associated disclosure of information—is the only viable approach to suppressing the combination of human-made and natural disasters that constitute socio-biological outbreaks and pandemics.

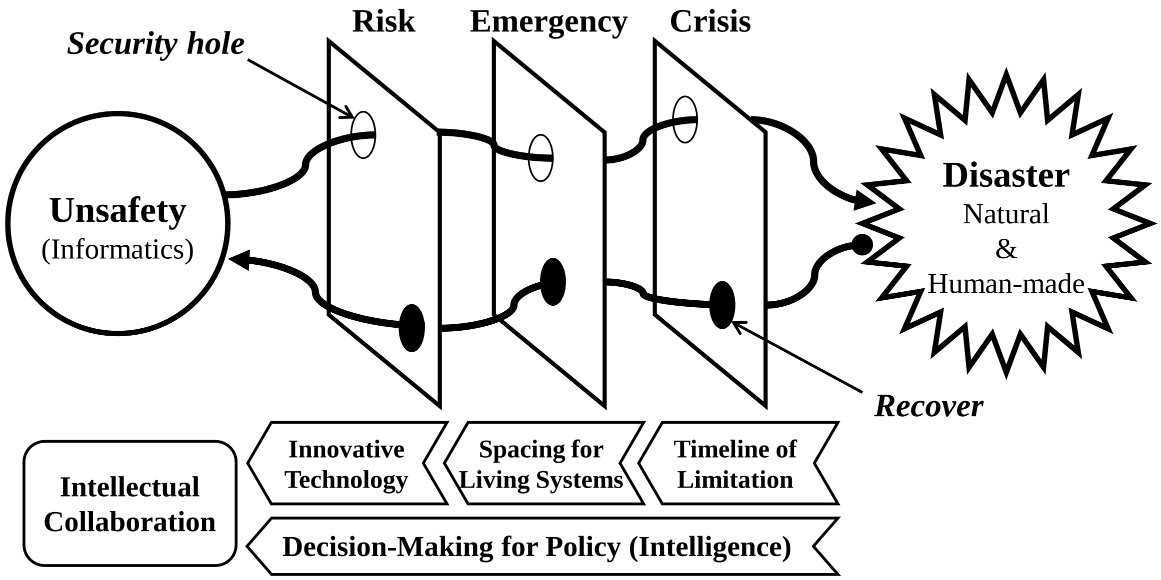

Figure 10. A concept of resilience management

Note: Charting based on 'Security Holes' and 'Swiss-cheese Model' in Organizational Accidents by J. Reason.

What are the requirements for resilience management in the modern era for recovery and reconstruction in the wake of physical, biological, social, or psychological crises, including natural disasters, human-made disasters, accidents and systems pathologies. In Sections Ⅰ to Ⅴ above, we have argued that resilience management including risk/emergency/crisis, as shown in Figure 10, requires at least five functions; (i) ***Timeline of Limitation***; (ii) ***Spacing for living systems***; (iii) ***Decision-making by policy***; (iv) ***Innovative technology***; (v) ***Intellectual collaboration*** for our future.

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