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n-depth critical analysis of the forces shaping the Asia-Pacific...and the world.

Strong in the Rain, a new book co-authored by Japan Focus coordinator David McNeill and Lucy Birmingham, Time magazine's Tokyo reporter, tells the story of Japan's 2001 triple disaster through the eyes of six ordinary Japanese people. The books follows the six – a housewife, a fisherman, the mayor of the coastal city of Minamisoma, a student, a foreign teacher and a maintenance worker at the Fukushima Daiichi nuclear plant as they deal first with the shock of the initial earthquake and tsunami, then the horrific consequences of the nuclear disaster. In this except from Chapter Four, plant worker Watanabe Kai (a pseudonym) and Mayor Sakurai Katsunobu begin to realize the full scale of the triple meltdown at the Daiichi plant and what it will mean for their lives.

Listen to an interview with David McNeill on RTE Radio, Ireland.

Meltdown: On the Front Lines of Japan's 3.11 Disaster

Lucy Birmingham and David McNeill

Even as Watanabe Kai sprinted for home, the workplace he left behind was skidding toward the planet's worst nuclear crisis in 25 years. The quake's shock waves ripped pipes from the walls, toppled lockers and buckled roads at the 864-acre plant. The ten technicians and single shift supervisor in the main control room near reactor one would later describe shaking so hard that some fell to their hands and knees.[1] "Stay Calm!," shouted unit one superintendent Masatoshi Fukura. The tsunami was 49 minutes away.

Watanabe Kai

Initially, Fukura and his boss, plant manager Masao Yoshida, believed the Daiichi's defensive engineering had worked. The instant the tremors struck, control rods were automatically inserted into the plant's three working reactors to shut down nuclear fission, a process known as "scram." Nuclear power complexes basically operate on the same principle as coal- or oil-burning plants: water is heated into pressurized steam, which is used to turn turbines and generate electricity. The difference is in how the water is heated, by a process called nuclear fission. It begins by splitting an atom into two by, for example, bombarding the isotope Uranium 235 with a free neutron. The splitting or uranium fuel, formed into long rods, releases intense heat and, without water to cool it, would overheat and melt, releasing potentially deadly radiation. Water then is vital to nuclear power plants. Quakes and accidents can shut down electricity grids feeding power to water pumps and other instruments, which is why all plants must have backup power.

Reactors four, five and six were offline for maintenance. The engineers quickly learned that the quake had cut the plant off from the main electricity grid, leaving no power to pump water to the nuclear core and carry off the heat, but 13 back-up diesel generators would keep emergency water pumps running till power was restored. The generators were considered more than enough to keep the plant's juices flowing.

Nine months previously, there had been an unintentional dry run for this scenario. On June 17, 2010, power to water pumps for reactor 2 failed. Fukushima Prefecture's former governor, Sato Eisaku, was one of several observers who repeatedly asked what would happen if the backup generators also stopped working. It was essentially a rhetorical question. Even after nuclear fission ends, fuel rods give off intense heat. Fuel that is not cooled can heat up to 5000 degrees F. This heat boils off all the water surrounding the fuel rods, exposing them to air. In a worst-case scenario, without water the fuel can melt through steel, concrete and anything else in its way.

TEPCO did not allow for the possibility that those 13 generators could stop working. They should have learned from another rehearsal four years prior. In July 2007, a 6.8 earthquake struck 12 miles from the Kashiwazaki Kariwa, by some measure the world's largest nuclear power plant. In the seconds after tremors began, pipes burst, drums of nuclear waste toppled and monitors stopped working. A fire in an electrical transformer burned unattended for over two hours and 1,200 liters of contaminated water sloshed into the sea. Tepco subsequently admitted that the damage to the seven-reactor, 8200-megawatt complex "extended to the interior of a reactor building" and that a small amount of radioactive water had also escaped from the No.1 reactor. Many fundamental weaknesses and failures in safety procedures came to light afterwards. "The inadequate response by TEPCO to the unfolding events at Fukushima Daiichi should not have been a surprise to anyone," concluded a damning March 2012 report by the American Nuclear Society.[2]

Between 2002 and 2006, 21 separate problems at the Fukushima plant were reported. The whistleblowers, including employees at the plant, bypassed both Tepco and Japan's Nuclear and Industrial Safety Agency (NISA), the main regulatory body, because they feared being fired.[3] The information was ignored. Sato would later describe how whistleblowers were treated like "state enemies."[4]

Sato was but one of a large cast of extras in the nuclear drama who had predicted catastrophe. Seismologists cited Japan's most powerful modern seismic event, the 1707 Hoei quake, which triggered a huge tsunami that washed through much of Shizuoka Prefecture, south of Tokyo and would surely overwhelm the defenses of most nuclear plants if repeated. In 1933, 28-meter waves demolished the northeast coastlines of Aomori, Iwate and Miyagi prefectures, close to the Daiichi plant. A 38-meter wave had crashed ashore in 1896. There was evidence of at least seven magnitude-9 quakes along the north and northeast pacific coast in the past 3,500 years.[5]

A week before March 11, TEPCO and two other utilities persuaded the government to soften the wording of a report warning that a massive tsunami could hit the northeast region.[6] The government's Earthquake Research Committee subsequently altered the draft report to say that "further study" was needed because data was "insufficient." Three days before the disaster, TEPCO itself had released a three-page briefing paper indicating the need to assess the 40-year-old plant's tsunami disaster risk. The paper cited in-house computer simulations and other studies suggesting that a tsunami as high as 33 feet (10 meters) could hit the nuclear complex.[7] Given its five-decade track record of ignoring seismic data, it is unlikely TEPCO would have acted on it, says Kawai Hiroyuki, a corporate lawyer who would a year later lead one of the biggest lawsuits in history against the company.

Kawai was one of many voices outside the mainstream questioning the logic of building 54 commercial reactors in a country that experiences 20 percent of

the world's magnitude 6 earthquakes. And the logic of building them so close together: the Fukushima Daiichi and Daini complexes are about seven miles apart. Like all precision machinery, nuclear power plants are highly susceptible to water and shock."[8] Major seismic events deliver both.

Many of Japan's reactors were planned or online before modern seismology uncovered hitherto undetected fault-lines in coastal areas. Scientists uncovered several particularly vulnerable power plants, notably the five-reactor Hamaoka plant in Shizuoka Prefecture, 113 miles from Tokyo, which sits almost on the boundary of two restless tectonic plates: the Eurasian and the Philippine Sea. Kashiwazaki too sits on a major fault.

The studies forced the authorities to accept that an 8-magnitude quake could strike the region at any time - government forecasts have predicted an 87-percent chance of a powerful quake near Hamaoka in the next 30 years. The possible consequences for Tokyo are chilling: A Fukushima-scale accident would "signal the collapse of Japan as we now know it," warned seismologist Ishibashi Katsuhiko.[9]

Inside the earthquake-proof bunker at the Daiichi plant on March 11, manager Yoshida and his deputies began to take stock of what had happened. It was just after 3:00 pm. Kai and thousands of workers had been allowed to leave to check on their families. Convinced the crisis had been contained, the remaining men inside the bunker paid little attention to the sea. The tsunami struck the plant with waves of 43-49 feet after washing over a mile-long breakwater and the 19-foot (5.7 seawall. The waves were twice as tall as the highest wave predicted. Water flooded the basements of the turbine buildings about 450 feet from the sea, on the ocean side of the reactors and lower, shorting out electric switching units and disabling 12 of the 13 emergency generators and then backup batteries, the last line of defense.[10] The control room was pitched into darkness.

Flashlights winked on one by one. Dread filled the half-light. There was no power to operate or even monitor what was happening to the reactors, or to measure radiation. Henceforth, estimating water levels inside the reactors would simply be guesswork. Four-and-a-half-hours later, the water in reactor one had dropped below the bottom fuel, exposing the fuel core. Fuel melt had begun. Even before the tsunami arrived, many experts suspect that the quake may have fatally damaged the cooling system of reactor one.[11] Just over 15 hours after the power loss, the fuel melted through the reactor's pressure vessel. Reactors two and three were not far behind. Worse, there was no plan for what to do next because nobody in TEPCO had ever predicted total loss of power at a nuclear plant.

In Tokyo, the government's top government spokesman Edano Yukio quickly appeared on TV. "At this moment, no problem with the reactor itself has been reported," he told the nation in his first press conference after the quake. Nuclear disaster had been declared at 3:42pm and at 4:45pm TEPCO told the government it had lost control of the plant, meaning that it suffered a complete loss of power.

A few hours later, Prime Minister Kan Naoto chaired the first crisis meeting on the unfolding nuclear drama, pulling together officials from TEPCO, the Nuclear and Industrial Safety Agency, the Nuclear Safety Commission, and economy minister Kaieda Banri. Remarkably, no minutes were taken of that meeting but they were later reconstructed from interviews. "Meltdown is a possibility, right?," asked one of the men in the room, the first mention of a word that would be blacked out for weeks by Edano and TEPCO. When NISA spokesman Nakamura Koichiro let slip the following day that meltdown was a "possibility' – meaning core fuel melt inside at least one of the reactors -- he was removed from his post.[12]

The government immediately sent emergency generators loaded onto trucks to the Daiichi plant but when they arrived they found the electrical panel board they needed to reroute power flooded. The key aim was clear: somehow get water back into the reactors to cool the overheating fuel. Workers were sent out to scavenge car batteries to keep monitoring instruments working. At 7:00pm, Kan publicly declared a nuclear emergency, ordering the precautionary evacuation of everyone within three km (1.9 miles) of the plant and telling thousands of others within a 10 km (6.2 miles) zone, to stay indoors. The following day, the evacuation zone was widened to 10km, then 20km (12 miles).

In the small restaurant they had run for decades in Okuma, Kai's parents grabbed what they could on the morning of March 12 and fled inland to the small town of Tamura, then Iwaki city, about 21 miles south of the plant. They were never to return. As they drove away on a bus, a half-remembered word began reverberating, unwanted, in Kai's mind: "Pripyat." It was the name of the Ukrainian town evacuated in the aftermath of the Chernobyl disaster and still, 25 years later, a nuclear ghost town. Kai had a premonition that they might never come back home.

Okuma emptied within hours, along with Tomioka, Futaba and Namie, small, tidy little towns surrounded by picturesque fields, hills and harbors where people had farmed and fished for generations. Pets and farm animals were left behind to become feral or die. The off-site nuclear emergency center in Futaba, built to handle such evacuations, was useless, with no electricity or phones, or even filtering systems to keep out the radiation. Officials in Namie heard about the evacuation on public radio. Watching the disaster unfold on NHK, Kai could believe his eyes.

At Futaba Hospital, a few miles from his home, chaos reigned in the hours and days after the ground began shaking. The tremor had been met with screams and whimpers; now came rumors that a tsunami was on its way. Rumor swirled about what was happening inside the power plant next door. Phone networks were overwhelmed by incoming calls. Remarkably, in a country with a plan for everything, there were no contingency plans for an emergency of this kind. In the following 48 hours, the hospital staff would get about 200 of the 435 patients out before transportation workers began refusing to drive near the Daiichi plant. It was days before everyone could be evacuated. Of the patients at the hospital, 21 died in the immediate aftermath of the disaster, some strapped into wheelchairs on buses en route to evacuation centers.[13] There would be nearly 600 similar deaths in the coming days and weeks.[14] Futaba's mayor, Idokawa Katsutaka, would later call the disaster a meltdown of Japan itself.

Back at the plant, engineers began to realize that they could die from either a blast, or subsequent exposure to the deadly toxins inside the reactors. Radioactive steam and hydrogen was accumulating in reactor one 1, and seeping into the control room. Late on March 11, they faced a classic nuclear dilemma: vent the steam into the atmosphere or watch the reactor's containment vessel explode, releasing much worse radiation. Without electricity, however, the vents had to be opened by hand, a possibly fatal task.

After hours of confusing and incomplete information from NISA and TEPCO, and wondering why the vents remained closed, Prime Minister Kan flew the 155 miles from Tokyo by helicopter to the plant. Kan believed that TEPCO was dragging its feet because it wanted to save the plant and was refusing to flood the reactors with seawater, which would have ruined them permanently. The prime minister ordered Tepco engineers into the reactor building. It was, most believed, a suicide mission: the temperature inside the building was over 100 degrees F, radioactivity levels near the vents were at near lethal levels and the men would have to work in pitch darkness amid a string of aftershocks. Working from old blueprints in 17-minute bursts – the maximum time they could endure without absorbing fatal radiation -- the masked and suited men cranked open rusting valves. It was not enough. In the afternoon of March 12, the first hydrogen explosion ripped the reactor building. The managers inside their windowless bunker felt the blast first, then watched in horror the images on commercial TV. Radioactivity began seeping into the bunker and all around the plant, the toxic plumes spreading widely due to the brisk spring winds.

The heaviest contamination was blown north and northwest over Minamisoma and pristine farming land in Fukushima, one of Japan's key food baskets. In the following three days as more explosions struck the plant a plume hit the mountains that ring Minamisoma and rained down on the town of Namie and the mountain village of Iitate, about 25 miles northwest of the stricken plant.

Fearing panic, NISA bureaucrats withheld data from a hugely expensive radiation tracking system called Speedi (System for Prediction of Environment Emergency Dose Information) that showed the direction of the plume, though they released it to the US military in Japan.[15] Thousands of evacuees from the towns and villages around the plant fled into what would prove to be the most contaminated areas. The mayor of Namie would later call the decision to withhold the data "akin to murder."[16] "It was a crime," agrees Mayor Sakurai. "The government didn't protect its own citizens." Kan claimed that the data was sent to the Prime Minister's building but intercepted by NISA bureaucrats before it reached him.[17]

Immediately after the March 12 hydrogen explosion, Sakurai, whose town stood a mere 12 miles away, watched Edano try to reassure the public at a televised press conference. "Even though the No. 1 reactor building is damaged, the containment vessel is undamaged," the Chief Cabinet Secretary told reporters. "In fact, the outside monitors show that the [radiation] dose rate is declining, so the cooling of the reactor is proceeding."[18] Any suggestion that the accident would reach Chernobyl level was, he said, "out of the question."[19] The world's worst nuclear disaster, which had left behind a 1,100-mile wasteland that still remains almost devoid of people a quarter of a century later, would be invoked frequently as the crisis wore on. Soon, experts in Japan's media would also predict high radiation in Fukushima for decades to come.

Mayor Sakurai Katsunobu

The playing down of the crisis was not unique to Japan. After Chernobyl, the Soviet authorities famously hid the severity of the meltdown and radioactive release, then harassed or even imprisoned those who questioned the official version of what happened. The Pennsylvania government also withheld information during the 1979 Three Mile Island partial meltdown. President George W. Bush was accused of manipulating Environmental Protection Data on airborne toxicity from the 9.11 attacks in New York City.

The citizens of Minamisoma, on the border of the exclusion zone, did not believe Edano. Once they saw the explosion on TV, they immediately began to leave. The exodus started on March 12 and turned into a flood by March 15, creating a traffic jam outside the city government building. Cars inched by the mayor's office, the faces of children pressed up against steamed-up windows. Day after day, hundreds of people crowded the reception area below Sakurai's office, demanding information and help. Men cornered the mayor when they saw him walking through the first floor. "What the hell are you doing!" some shouted. "Tell us what's going on, you asshole." He knew little more than his accusers. There was no communication from the government or TEPCO. Calls went unanswered. It was a week before anyone from the central government arrived; 22 days before TEPCO finally told Minamisoma about the drama unfolding at the power plant a dozen or so miles away.

Gasoline was the most common demand as people started to flee but it had to be rationed because after the first reactor explosion delivery trucks started to stay away. City officials were sent to man pumps at the local gasoline stand. The day after the first explosion, a tanker driver called from Koriyama, about 32 miles away, and said he was not going any further because he was terrified of the radiation. Sakurai's staff had to go themselves and get the truck full of vital fuel. It was among the first ominous signs that deliveries to the city would stop coming. Food trucks and other utilities also ceased.

An exodus of city and medical workers from the city's biggest hospital began. How were they to cope with the sick and old? Who would retrieve the bodies still scattered around the city's coastal communities? On March 14, journalists from Japan's big daily newspapers and TV companies covering Minamisoma, suddenly disappeared, meaning that on-the-ground news from the most vulnerable large city in the nuclear crisis would vanish for weeks. They would not return for over a month. Some of the city workers had started to peel off too. "My city was melting down," he says.

In the middle of the chaos came the worst task of all: The exhausted mayor had to visit the makeshift morgue in the local agricultural college. The bloated bodies of men he had farmed with, friends of his family for years, were laid out on the ground. "There were just no words for what I felt," he recalls. But there could be no question of deserting his post or even going to look for his parents. Duty to the citizens who had elected him came first. Only later would he find out their fate. At night, he curled up for a few hours in a room behind his office, wrapped in a blanket. Before dawn, his eyes would open and he would wonder what horrors the new day would bring.

As the sun rose in the sky on a crisp Monday morning, March 14, another blast tore apart the concrete building around reactor three, which contained large amounts of plutonium among its cocktail of lethal poisons. The explosion stopped the water that was cooling reactor two, worsening its already critical state. Daiichi was now a mess of tangled metal and rubble. Radiation in some parts of the complex was 1000 millisieverts an hour, enough to quickly induce radiation sickness. Even with filtering systems laboring to keep out the contamination, levels of radioactivity inside the control room leapt 12-fold. The engineers stayed, rooted by loyalty to their company, duty…and fear. "Even if they ran, where could they go?" asked Kai**.** Some workers offsite, from Minamisoma and Iwaki even tried to navigate buckled, flooded roads back to the plant, their huge fear tramped down by the weight of solidarity and empathy.

That night, NISA cancelled its usual hourly press briefings, an ominous indicator of the chaos behind the bureaucratic wall erected to manage the crisis. In the bunker at the Daiichi plant, engineers were openly contemplating a once unthinkable scenario: three reactors completely out of control and spewing a vast toxic cloud toward Tokyo, the world's most populated metropolis. Many were digesting the most terrifying news of all: 1500 fuel rods in the reactor four building, normally covered 16 feet below water, had boiled dry, raising the specter of a nuclear fission chain reaction and contamination far worse than a reactor meltdown.

As Tokyo slept, plant manager Yoshida, wearing his blue boiler suit, pulled together his staff. A tough man with a reputation for independent thought and plain speaking, Yoshida was characteristically blunt. "Go home," he said. "We've done what we can here."[20] Afterward, debate would rage about whether he and TEPCO had ordered a full or partial retreat, leaving some workers behind to stop the plant from sliding completely out of control. Some of the engineers had tears in their eyes. They thought that Yoshida was opting to die. Like the captain of an atomic-age Titanic, he would go down with his ship.

Trying to put together what happened at the refugee center in Iwaki, Kai feared the worst. The center was crowded with people from his town who sat fearful and transfixed in front of the TV, but few were as qualified as he was to imagine how bad this could get. A professor from the elite University of Tokyo was saying that there was no cause for alarm but it was obvious that there was no water in the reactors and that the fuel was melting. *Why were they saying it isn't melting down?,* he wondered. *We're looking at a Chernobyl-type situation, maybe worse.* Eventually, he thought, the evacuation area could stretch to 100km or perhaps 200 km.

And where was the company's management, he wondered. TEPCO president Shimizu Masataka had disappeared from public view, amid rumors that he was in hospital, overwhelmed with stress, or that he had attempted to commit suicide. It would be a month before Shimizu even came to Fukushima to apologize to furious locals, by which time his reputation was in tatters and his career ruined. Kai was not that surprised. In the Daiichi plant hierarchy, he and his friends considered the TEPCO management desk-bound plodders, graduates of Japan's elite universities; men with too much head and no heart, unlike blue-collar grunts like Kai who kept the plant running. They had no experience of crisis.

Still, as soon as he saw the explosion on March 12, he began waiting for a call from his company, asking him to save the plant and clean up the mess. And when it came, he would not hesitate to say yes. Instinctively right-leaning, Kai often thought in military terms, recalling wartime stories he had read in *manga* comics and seen on TV. "I thought of myself in the mode of *kamikaze*," he recalls, referring to the young men who strapped themselves to flying bombs in a doomed attempt to defend Japan from US invasion at the end of World War 11. "They risked their lives for their families, for their villagers and people they didn't know. That's what I thought of: protecting people. It wasn't defending my country; it was people's faces I saw in my mind. Even if we have to give up our lives, we would allow people from our home towns to some day return home."

The call came later, about a week after the crisis began. "We have to go back," said Kai's manager. He used a military term; "final battle orders." Some people would refuse the request, saying they had children or they feared that the worry would drive their wives crazy. Kai was single and his family never spoke about the possibility of his returning, tacit approval in his mind. There was no disguising the danger. There could be more explosions, even worse radioactivity. There was just no way of telling.

Lucy Birmingham and David McNeill, *Strong in the Rain: Surviving Japan's Earthquake, Tsunami and Nuclear Disaster*, Palgrave Macmillan.

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Notes

[1] NHK Special, メルトダウン – 福島第一原発あの時何が, ("Meltdown - The Fukushima Daiichi Nuclear Plant: Behind the Scenes." Broadcast repeatedly in January 2012.

[2] Ibid, p.28.

[3] See David McNeill, "Sato Eisaku's Warning," *Japan Focus*, April 23, 2011. (March 22, 2012)

[4] Ibid. Sato wrote a book claiming that he had been toppled as governor, then framed on corruption charges, because of his growing opposition to nuclear power. See 知事抹殺 つくられた福島県汚職事件 ("Annihilating a Governor") (2009, Heibonsha). He and local people helped thwart Tepco plans that experts say could have made the March 11 disaster much worse. A decade earlier, the company proposed to load hundreds of tons of Mixed Oxide fuel containing tons of plutonium. If it had succeeded, the fuel would have presented an even greater challenge "in terms of the threat of widespread and large-scale plutonium dispersal and devastating human health impacts," says Shaun Burnie, an independent nuclear analyst.[4

[5] "Past 3,500 years saw seven M9s," *Kyodo News*, Jan. 27, 2012

[6] Kyodo News, "Tsunami Alert Softened days before 3/11," *The Japan Times,* February 27, 2012.

[7] "Rethink of tsunami risk was way too late," *Associated Press,* February 22, 2012. A definitive warning had already been made in 2009. At a panel meeting on nuclear regulatory policy in June that year, tsunami expert Yukinobu Okamura, with the government's National Institute of Advanced Industrial Science and Technology (ASIT), insisted that new evidence of the massive Joban earthquake and tsunami that hit the Tohoku coast in 869 AD be considered more closely. "I would like to ask why you have not touched on this at all," he demanded. "I find it unacceptable."

[8] Personal interview, March 27, 2012. He added: "If (nuclear plants) have to be built in Japan, there must be meticulous care in running them. This wasn't the case here. Tepco didn't raise its tsunami wall an inch. That's criminal negligence

[9] See David McNeill & Nanako Otani, "Waiting for Doomsday: Living Next to 'The World's Most Dangerous Nuclear Power Plant,' *The Asia-Pacific Journal Vol 9, Issue 19 No 2, May 9, 2011.*

[10] The single generator that survived saved the idling reactors 5 and 6 from meltdown, it later emerged. The generator was 13 meters above sea level.

[11] See David McNeill & Jake Adelstein, "Tepco's Darkest Secret," Counterpunch August 12-14, 2011. (April 13, 2012)

[12] "Panel: Wide Communication Gaps Hindered Response in Fukushima," *The Asahi Shimbun*, December 27, 2011. (March 25, 2012)

[13] Mari Yamaguchi, "Nuke Evacuation Fatal For Old, Sick," *Associated P*ress, March 10, 2012.

[14] 575 deaths 'related to nuclear crisis,' *The Yomiuri*, February 5, 2012. (March 22, 2012)

[15] See Norimitsu Onishi and Martin Fackler, "Japan Held Nuclear Data, Leaving Evacuees in Peril," *The New York Times*, August 8, 2011. (March 7, 2012). The Speedi system can now be found online at http://www.bousai.ne.jp/eng/.

[16] Mark Willacy, "Japan 'Betrayed Citizens' Over Radiation Danger," ABC News, January 20, 2012. (March 7, 2012)

[17] Personal interview, April 6, 2012. Also, see "Inside Japan's Nuclear Meltdown," Frontline PBS, February 28, 2012. (April 17, 2012)

[18] Quoted in Takashi Hirose, *Fukushima Meltdown: The World's First Earthquake-Tsunami-Nuclear Disaster, Fukushima Meltdown, (*Kindle edition, 2011). "Most of the media believed this and the university professors encouraged optimism. It makes no logical sense to say, as Edano did, that the safety of the containment vessel could be determined by monitoring the radiation dose rate. All he did was repeat the lecture given him by TEPCO." As media critic Takeda Toru later wrote, the overwhelming strategy throughout the crisis, by both the authorities and big media, seemed to be reassuring people, not alerting them to possible dangers.

[19] Japan's government later officially raised Fukushima to INES Level 7 – the same as the 1986 Ukraine disaster.

[20] Dan Edge (Director), "Inside the Meltdown," *BBC*, Feb. 23, 2012. David McNeill was a consultant on this documentary.