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Uncomfortable Questions in the Wake of Nuclear Accidents at Fukushima and Chernobyl チェルノブイリと福島原発事故が突き付けるいやな問い

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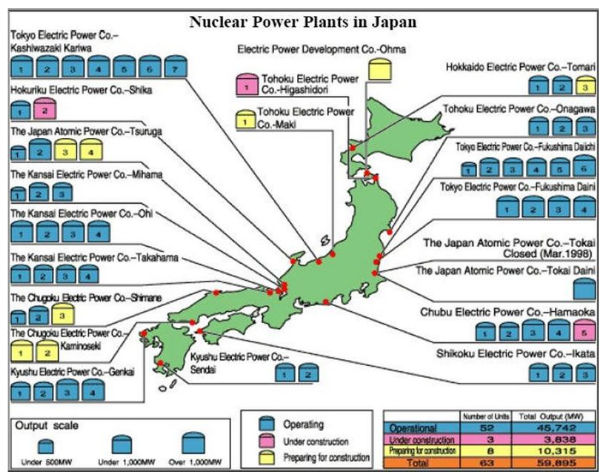
Twenty nuclear accidents at the official International Nuclear Event Scale of 4 to 7 have occurred between 1952 and 2011 (Lelieveld et al. 2012). The risk of another major accident during the next 50 years is high and it has been estimated that some 30 million people could be directly affected by such an accident (Lelieveld et al. 2012). The highest risks occur around major metropolises such as New York, Washington, Atlanta, Toronto, Western Europe, Shanghai, Hong Kong, and Tokyo and Osaka. The lessons that have emerged from Chernobyl and Fukushima reveal a range of serious questions that must be answered appropriately, above all for the sake of citizens, but also for the credibility of the nuclear industry, and for framing the ongoing debate over energy alternatives. Because recent models suggest that more than half of released radioactive material from a nuclear disaster would be transported more than 1000 km from the site of release (Lelieveld et al. 2012), these questions are important even for citizens in distant countries. It is in this spirit that we have produced a list of unpleasant questions that have been a cause of concern since we first started conducting research at Chernobyl in 1992, and have grown in urgency since conducting research at Fukushima beginning in 2011.

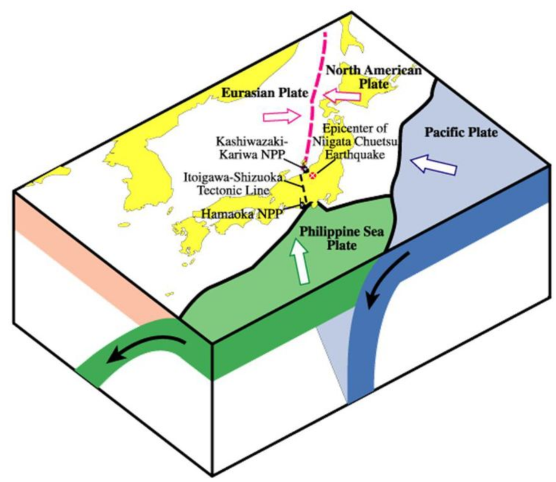
Question 1: Why are nuclear reactors frequently clustered making problems much greater in case of emergencies? How to get to the other reactors if one melts down completely? Nuclear reactors are clustered with pairs, quadruplets or even planned clusters with six reactors located at a single site.



Map shows clustering of Japanese Nuclear Power Plants

The reason is often logistical because of benefits of scale, optimal cooling water facilities, regulatory constraints, costs, and other practical reasons. However, the accident at Fukushima clearly showed the potentially disastrous consequences of such siting when a reactor melts down, because the proximity of another reactor may compromise access for emergency and maintenance crews and risk multiple melt downs. Previous assessments by both manufacturers and governments have estimated the risk of melt down in an individual reactor to be negligible and hence the probability of two or more of such events being virtually zero. Clearly that is not the case as shown by events at Fukushima. These observations suggest that nuclear facilities are in need of a re-assessment of risk of melt down given such non-negligible effects of neighboring nuclear reactors.

Question 2: Why are many reactors built on tectonic fault lines, making them highly susceptible to effects of earthquakes?



Earthquake fault lines in Japan

The accident at Fukushima has shown that assumptions about the risk of earthquakes and their consequences are seriously underestimated. This is now widely understood—yet continues to be debated—in the case of Japan. But the issue is also relevant in the United States (Indian Point, for example) and elsewhere. Clearly in the case of nuclear reactors it is insufficient to base assumptions on 'ordinary' risk scenarios derived from 'common' earthquakes. Recent assessments of risk related to future major volcanic eruptions in the Canary Islands or the Hawaiian Archipelago suggest these could produce tsunami waves in excess of 20 m height, traveling across the Atlantic or the Pacific in less than a day (e.g. Pararas-Carayannis 2002). The same may apply to risks of major earthquakes on the Pacific coast of the US (Dengler and Smits 2011. Link). Such an event would dwarf the exceptionally strong tsunamis at Fukushima. How resistant are existing nuclear reactors in North America or Japan to such threats?

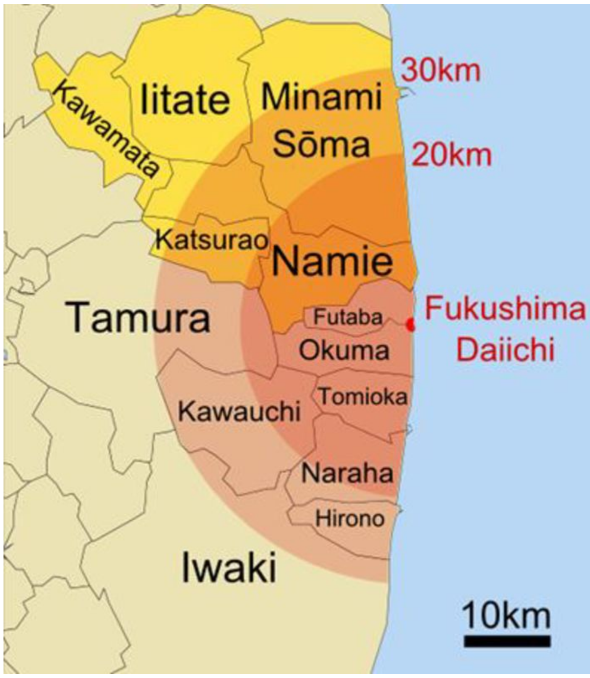
Question 3: Why were the back-up generators at the Fukushima Daiichi NPP located below ground level so they could be reached directly by seawater, causing malfunction and thereby preventing cooling of the reactors? Both Chernobyl and Fukushima have revealed a number of human errors (e.g. design flaws) that augmented the consequences of the nuclear accidents. Clearly these effects can occur equally likely in the context of an authoritarian Russia or China and a democratic Japan. Hence we can only assume that something similar could happen during a future accident in Western Europe or the US. The list of such human flaws is unlikely to be exhaustive and suggests that managers of nuclear power plants readily forget that humans invariably make errors with short- or long-term consequences. Given the enormous risks, there is an urgent need to generate a catalogue of past and present errors made in building and maintenance of nuclear reactors to prevent future disasters. Although both the US Nuclear regulatory Commission and the European Nuclear Safety Regulators Group have conducted “stress tests” to assess potential shortcomings at power plants in the US and Europe, it is not evident that power plant owners have taken appropriate actions in response to these evaluations. Amending shortcomings is costly, and if regulators and industry consist of the same group of scientists, the incentive for making amendments may be weak at best.

Question 4: Why are used fuel rods from the nuclear reactors stored at the reactor site, preventing cooling in a case of emergency, thereby compromising security? Spent nuclear fuel rods are commonly located next to working nuclear reactors in cooling ponds, ostensibly because they are considered to be 'safe' in these locations, although the real reason appears to be the absence of suitable alternative storage sites in most countries. But it is clear from events at Fukushima that there is a non-negligible risk associated with having spent fuel onsite as this increases the risk of additional problems in case of a nuclear accident especially if, as in the case of the GE-designed Fukushima reactors, the spent fuel pools are located high above the ground, making delivery of cooling water extremely difficult in the case of a station black-out.

Question 5: Why did the International Atomic Energy Association (IAEA) approve nuclear reactors with such poor locations and poorly designed emergency generators? The nuclear industry is monitored and ultimately controlled by the IAEA, under the assumption that it will act in the interest of all citizens of the world. The responsibility of oversight organizations such as national ministerial committees and international organizations is to ensure that citizens are protected from poor management by private or state companies that build and run nuclear power plants. However, citizens cannot be sure that oversight is performed in the interest of citizens because staff of oversight organizations typically move freely between the nuclear industry and oversight organizations, as most clearly shown by the revolving door between the Japanese ministry responsible for nuclear power and the nuclear industry creating what appears to be institutionalized conflicts of interest. It seems likely that similar conflicts exist in other countries as well.

Question 6: Why were pregnant women and children not evacuated earlier and for longer distances to avoid the well-known problems of effects of radiation on early development? The evacuation events in Chernobyl and Fukushima revealed a number of inadequacies with surprisingly great problems in Japan compared to the surroundings of Chernobyl. In Japan some evacuees were transported to locations that proved to be more radioactive than those from which the evacuees originally came from, thereby actually increasing exposure. Most Japanese are unaware of the fact that in 2013, almost 27 years after the accident in Chernobyl, people are still permanently evacuated from areas with levels of radiation that Japanese officials consider to be safe and requiring no evacuation. In Chernobyl no people are living permanently in areas with more than 1 microSv/h, while numerous people live in such areas around Fukushima. The reason for such discrepancies and their health consequences remain poorly understood, and they have certainly not been debated in Japan or elsewhere. The evacuation of people from their homes in poor Ukraine from contaminated areas suggests that this decision is not a direct function of money, but perhaps rather is a question of the large population living in contaminated areas around Fukushima and the magnitude of economic compensation requested by evacuees. The Soviet Union eliminated such problems of claims for compensation to individuals or states by decree.

Question 7: Why were Japanese people evacuated from an area with a radius of 30 km, when French and US citizens were advised to stay 50 km away, and airplanes owned by Air France, Alitalia and Lufthansa were re-directed from Tokyo to Osaka?



Japanes towns, villages, and cities in and around the Daiichi nuclear plant exclusion zone. The 20 km and 30 km areas had evacuation and sheltering orders, and additional administrative districts that had an evacuation order are highlighted.

Similar questions can be raised concerning the radioactive contamination of nearly 70,000 Americans from the army and the navy during the Fukushima event (Witherspoon 2013a, b here and here). The reason why specific actions were taken was to protect people from any potential hazard. In the case of Fukushima the Japanese government was clearly troubled by the scenario of having to evacuate Tokyo in case of a change in prevailing weather patterns that could have readily re-directed the radioactive cloud from the Pacific towards the south. Clearly in this case precautionary decisions were made depending on proximity to the accident site with decision makers further away from the disaster site making more precautionary decisions. Obviously, we should expect the opposite relationship because local people on site should make more informed and hence more precautionary decisions. However, such discussions were likely shrouded in secrecy. Another impediment to transparency may relate to the subjugation of the WHO to the IAEA. Specifically, the IAEA signed an agreement with the World Health Organization on 28 May 1959 that WHO cannot make any statements about nuclear consequences for human health across the globe without first having the approved by IAEA (Tickell 2009). This certainly gives the impression that the concern for human health is secondary to the concern for the peaceful use of nuclear energy and the corporations that provide it.

Question 8: Why was the level of radioactivity in Fukushima said by the Japanese prime minister to be low, when in fact it was, and continues to be, higher than the most contaminated areas around Chernobyl, from where people are still evacuated 27 years after that accident? The key to proper management of nuclear reactors in a safe and responsible way was suggested a long time ago by the Nobel laureate Niels Bohr, a founding father of nuclear physics and perhaps the first anti-nuclear activist. During the development of the nuclear bomb he insisted on openness as a means of building trust and reliability among nations. Unfortunately, his words went unheeded and the arms build-up and cold war between the east and the west followed.

The experience in Japan suggests that managers of nuclear power plants will maintain secrecy to protect their own livelihoods or the interests of their company. The “nuclear village” of this alliance of the nuclear company (TEPCO), the state, and the scientists and media who work to protect the industry is an affront that excludes ordinary citizens. Unfortunately, despite hundreds of minor accidents at nuclear power plants managers routinely ignore national or international requirements and attempt to hide such events. This is the case in authoritarian states like Russia, in Asian democracies like Japan and even in extremely open and non-corrupt Sweden, which despite this presumed openness still had a secret nuclear program to develop nuclear bombs during the 1950's. This raises serious questions about oversight of the nuclear industry and the extent to which citizens can have confidence in corporate, government, scientific or even international regulatory agency recommendations. The main reasons for such lack of confidence arise from the lack of impartial assessment, secrecy in the case of accidents, and a complete lack of consequences for managers and government regulators even in the event of serious accidents. This lack of accountability can only be restored by involving citizens in regulatory functions of the nuclear industry. If and when ordinary citizens are given the opportunity to play a significant role in such oversight, it might be possible not only for citizens, but also governments and the industry, to trust the statements and recommendations of oversight agencies.

Question 9: Why did the chairman of the IAEA (a Japanese) first travel to Japan four days after the first accident happened in Fukushima? The narrative following Chernobyl was that Soviet incompetence prepared the ground for this terrible disaster (Hopkins 1993), and once the Soviet Union was gone, there would be no further accidents. The Fukushima accident changed all that by revealing that even one of the technologically most advanced societies in the world was able to make a large number of mistakes that exacerbated the severity of the accident. Thus perhaps it was no surprise that neither the IAEA nor anybody else involved in the nuclear industry was willing to act responsibly in the face of this event.

Question 10: Why is Tokyo Electric (Tepco) unwilling to provide information about the identity of the rescue workers and their radiation exposure? Is it ethically defensible to allow rescue workers who are working under stressful conditions to breach accepted levels of radiation exposure? (Tabuchi 2011; interview with Paul Jobin). The reason for such limits is exactly to prevent people from being pressured to make decisions that they should or could not make based on their own knowledge. It is a moral imperative for individuals in some societies to sacrifice themselves for the common good, as shown by events in Chernobyl and Fukushima. Such rescue workers are glorified in writing and statues, but their moral dilemmas and their subsequent medical fate are rarely mentioned. The fact is that such sacrifice is not distributed equally, but is allotted to low paid short-term contract workers who generally are individuals with poor education and lack of resources (Tabuchi 2011), making it easy to impose sacrifice even to the extent that such events are no longer voluntary. Decisions about participation in clean-up should be based on sound ethics rather than forcing poorly educated part-time workers into activities with consequences that they may not even be able to judge themselves.

Chernobyl and Fukushima loom large when assessing the impacts of human technology on our planet. It is also obvious that the decisions made by humans and, therefore, an understanding of human behavior, is important if we are to learn any lessons concerning major environmental disasters. As evolutionary biologist Robert L. Trivers (2009) has stated in his recent book on self-deception, humans have evolved an entire battery of behavior to deceive themselves so to better deceive others. These behavioral mechanisms have evolved as a means to allow humans to cope with and survive small and major disasters, and our presence despite famine and major wars including nuclear war bears testimony to the efficacy of such behavior. We can only hope that thorough psychological and risk analyses of both Fukushima and Chernobyl will help us reduce the risk of future nuclear disasters by revealing the underlying mechanisms that led to these horrible outcomes.

About the Authors:

Anders Pape Møller is a Director of Research at the CNRS in Paris, France. Timothy A. Mousseau is a Professor of Biological Sciences at the University of South Carolina in Columbia, USA. They have worked together since 2000 studying the impacts of radioactive fallout around Chernobyl, and since July 2011 they have conducted field studies to determine whether fallout from Fukushima is likely to have comparable impacts to those documented in Chernobyl. Working primarily with birds, but also with insects, spiders, microbes, mammals, and plants, their work has demonstrated a large array of biological consequences for the flora and fauna inhabiting contaminated regions of Ukraine and Belarus, including elevated mutations rates and levels of genetic damage, increased frequencies of developmental abnormalities including tumors and cataracts, shortened lifespans, and decreased fertility. These individual-level effects have translated into smaller populations sizes for many species and even local extinction of particularly sensitive groups. Of particular note are their findings of no clear threshold below which effects are not observed and no evidence of radiation hormesis (i.e. positive effects of low dose radiation). Cumulatively, these studies indicate that even very low levels of radioactive contaminants can significantly impact natural populations and that such effects can increase over time.

The results from their first year of research in Fukushima have recently been published (Møller et al. 2012, 2013) and strongly suggest that many bird species and some groups of insects have been significantly impacted. Preliminary findings from July 2012 indicate that the impacts of Fukushima fallout are increasing over time. Most of their 40+ publications on this topic can be found here.

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