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Author(s)	Yoshida, Fumikazu
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Chapter 2
The Fukushima Nuclear Disaster: One of the World's Worst Cases of Pollution

Fumikazu Yoshida

Professor, Graduate School of Economics, Hokkaido University

1. Introduction

Until recently, Japanese tended to think that such pollution disasters as **Minamata disease** (caused by organic mercury poisoning from a chemical factory in Kyushu in the 1950s and 1960s), **Itai-itai disease** (resulting from cadmium pollution in Toyama emitted by the Kamioka mine in the 1950s), **Yokkaichi air pollution** (linked to emissions from power and petro-chemical plants in Yokkaichi in the 1960s) — and similar industrial pollution problems — were things of the past, that their causes were largely understood, and their consequences basically overcome. The Fukushima nuclear disaster, however, is responsible for the worst case of pollution to have occurred during the postwar era. It is much more than just a reiteration of the kinds of pollution problems of the past. It represents a neglect of the lessons they were supposed to have taught us. The Fukushima nuclear disaster's complexity and scale are greater than anything that has gone before.

Box 1: Minamata disease

Minamata disease is a neurological syndrome brought on by severe mercury poisoning. Symptoms include ataxia, numbness in the hands and feet, general muscle weakness, narrowing of the field of vision and damage to hearing and speech. Although it was first noted in 1932, it was not until 1956 that the disease was finally identified in Minamata city in Kumamoto prefecture, western Japan, and hence its name. The cause was finally traced to the release of methyl-mercury in industrial wastewater from a chemical factory owned by the Chisso Corporation. This highly toxic chemical

bio-accumulated in shellfish and fish in Minamata Bay and the Shiranui Sea, which when eaten by the local populace resulted in mercury poisoning. A second outbreak of Minamata disease occurred in Niigata Prefecture in 1965. The original Minamata disease and Niigata Minamata disease are considered two of Japan's Four Major Pollution Diseases.

Box 2: Itai-itai disease

The first documented case of what came to be known as Itai-itai disease was some time around 1910; in the 1950s, there was a severe outbreak of the disease as the result of mass cadmium poisoning in Toyama Prefecture in central Japan. Known to medical science as **osteomalacia** (a softening of the bones), the name *itai-itai* disease (from Japanese 痛い *itai*, 'it hurts') was coined by locals in response to the severe pains experienced in the joints and spine. Cadmium released into the Jinzu river by the Kamioka mining division of the Mitsui company in the neighboring prefecture of Gifu caused softening of the bones and kidney failure. The victims, mostly older women who had given birth to children, sued the mining companies for damage compensation. Itai-itai disease is also known as one of Japan's Four Major Pollution Diseases.

Box 3: Yokkaichi air pollution

Yokkaichi air pollution, the fourth of Japan's Four Major Pollution Diseases, occurred in the city of Yokkaichi in Mie Prefecture in central Japan between 1960 and 1972. The burning of petroleum and crude oil released large quantities of sulfur oxide that caused suffocating smog and resulted in severe cases of chronic obstructive pulmonary disease, chronic bronchitis, pulmonary emphysema and bronchial asthma among local inhabitants. The generally accepted sources of the sulfur oxide pollution were petrochemical processing facilities and refineries that were built in the area between 1957 and 1973.

Environmental economists (of whom I am one) have worked out a method to deal with the problems caused by pollution through the analysis and resolution of the various cases of pollution that have formerly occurred in Japan. Our work has been based on a variety of what for want of a better word we may call theories: concepts and principles that deal with the causes of pollution, the nature of the damage caused by pollution, an assessment of the responsibility for the pollution, styles of countermeasure to deal with the consequences of pollution, the social costs of pollution, types of relief, alternative policies and so on.[1] Among these, the causes of pollution and the damage caused by pollution are foundational principles, for upon them we build theories of responsibility, the social costs of pollution, countermeasures, relief and finally alternative policies. If we analyze the nuclear power plant disaster

from the standpoint of the theory of pollution and related concepts, we will learn more about the nature and full extent of what happened, which will then in its turn help us to clarify the issues that still need to be resolved, set a course of action and a timeline for their resolution and find in all this some prospects of hope for an ultimate solution.

At the end of the lawsuits in the early 1970s addressing Minamata disease, Yokkaichi air pollution and Itai-itai disease, the courts delivered historic rulings. As a student who aspired to conduct research on the problems of pollution, I read these judgments published in special numbers of *Houritu Jiho* (Journal of Law) and *Jurist* and remember their contents even now. These rulings had a major impact on Japanese society and on major Japanese corporations, not only by systematically denoting the causes of pollution, the nature and extent of the damage, and the issue of responsibility, but also by clarifying the course of relief afforded to the victims and the responsibility of the polluters.

The experience of the four major tribunals led Japan to establish the **polluter pays principle** while at the same time inaugurating a relief system for victims. Japan also came to recognize the importance of the joint efforts made by the responsible corporations and victims and the administration, scientist and lawyers, to clean up the mess caused by the severe pollution and to restore the environment to its former state of relative health. Yet, even though the pollution problems were relatively localized, these reclamation and restoration efforts have required over 40 years. And, in the Minamata disease case and other similar cases the issue of victims' relief has still not been satisfactorily resolved. Japan has also learned that in addition to such essential countermeasures as cutting off the source of pollution, decontamination and the provision of compensation for damages to health, conscious efforts must be made to resolve the social conflict and overcome the social discrimination unleashed by the pollution. This is necessary in order to rebuild local communities that have been divided by the problems of pollution. Many issues remain concerning who should bear the cost burden generated by compensation payments for victims, the cleanup of pollution and appropriate countermeasures to contain the source of the pollution.

Box 4: Polluter pays principle

The basic concept behind the Organization for Economic Cooperation and Development (OECD)'s Polluter Pays Principle (PPP) is that pollution prevention and control should be installed in certain tax classes. PPP is a well-known principle of payment, but

since it includes no duty for provision of additional liability, it is not the equivalent of victim compensation. It consequently does not entail the expectation that all costs will be borne entirely by the polluter (OECD, 1975). The OECD's PPP was originally devised to correct distortions in the rational allocation between resources and international trade, and cannot be applied as additional compensation to relieve and rehabilitate the environment in order to achieve an optimal pollution level of whatever pollution still persists (Miyamoto, 2007: 236).

Although, at the time of writing, two years have passed since March 11, 2011, the day of the Great East Japan Earthquake and the TEPCO Fukushima Dai-ichi Nuclear Power Plant disaster, it is still difficult to obtain a complete, or even a relatively accurate, picture of the event, or work out a direction in which to go to cope with the myriad of problems that it has caused. So severe are the problems that we can characterize this disaster as equivalent in scale to a "second war defeat." The disaster's impacts on the nation force us to question the whole basis upon which Japan's postwar society has been built. Quite apart from the immense dangers that the "accident" still poses, the dimension of the "emergency" caused by these circumstances requires us first to reexamine and where necessary revise the old polluter pays principle and the victims' relief principle that have been established as a result of the experiences tied to Japan's postwar pollution problems. Japan's **Nuclear Damage Liability Facilitation Fund** provides a legislative basis for the relief of the victimizer (rather than the victim). As the principle of "res nullius" responsibility instead of "polluter pays principle" already has been raised by the polluters (the victimizers), it is very important to analyze the Fukushima nuclear disaster from the standpoint of the principles already established to deal with Japan's past pollution problems. Society demands and deserves a systematic and thorough explanation of the theories and principles that underlie: the causes of the nuclear disaster, the nature and effects of the damage it has caused, the social costs of the explosions and radiation release, the responsibility for the disaster, the countermeasures that can be taken, and finally, proposals for alternative energy.

Only in this way will Japan be able to grasp the whole picture of the worst nuclear disaster of the postwar years and map out future prospects for reform.

Box 5: Nuclear damage liability facilitation fund

The rationale of the Nuclear Damage Liability Facilitation Fund Law (2012) is to provide public support for TEPCO's liability for the nuclear damage caused by the

explosions and core meltdowns at its plants. Its fundamental purpose is to avoid TEPCO's bankruptcy and in effect pays compensation for the nuclear disaster out of public funds. It will take several trillion Japanese yen to meet the compensation needs of the victims of the disaster.

On the basis of research and considering the facts about the disaster that have so far been revealed, the remainder of this article looks more deeply at the nuclear disaster relating the disaster to the general concept of pollution and its problems. The first half of this article (this Chapter) is based on contributions published in 2011 in the "Asahi Shimbun" *webronza* (web site), and for the second half (Chapter 5) on contributions published in the evening edition of the "Hokkaido Shimbun" from November to December of the same year. These have been reorganized, with some new information added and the appropriate adjustments made.

2. The perspective afforded by the theory of the problems of pollution

As a scholar who for many years has devoted himself to the study of Japan's pollution and environmental problems from the standpoint of environmental economics, I want first to discuss core concepts that are relevant to understanding the nuclear disaster based on lessons learned from earlier pollution problems.

(1) The purpose of analyzing pollution and the environmental problems that follow in its train is to determine the situation confronting people and the environment and the actual scope of damage. Only then is it possible to suggest how and to the greatest extent possible, we may counteract the effect of the damage. Yet since research into and countermeasures against the Fukushima nuclear disaster have been delayed, knowledge concerning the scope and degree of the radioactive damage caused by Fukushima's damaged reactor is still seriously insufficient. Indeed, tardy disclosure of information and improper instructions for evacuation are everywhere manifest. Data collected by the System for the Prediction of Environmental Emergency Dose Information (SPEEDI) have been forwarded to the U.S., but have not been used for the evacuation of the local population. **SPEEDI** is "computer-based decision support system" used by researchers, and its function is for a real-time Dose assessment in radiological emergencies.

Box 6: SPEEDI

The Nuclear Safety Division of the Ministry of Education, Culture, Sports, Science and Technology streams information about levels (or doses) of radioactivity from a national network of detectors called the System for Prediction of Environment Emergency Dose Information (SPEEDI). It is a computer-based decision support system and its function is to provide real-time dose assessments in radiological emergencies. It was introduced in 1993 to monitor domestic local range accidents and is being developed into a national scale emergency response program linked to local governments. A worldwide version (WSPEEDI) is also under development. The government recommendation that people voluntarily evacuate from places within a 20-30 km radius of the Fukushima Dai-ichi plant came after the Nuclear Safety Commission watchdog released forecasts based on SPEEDI measurements. It was found that geography and wind direction significantly affected radiation levels, and led to the suggestion that, because of this, the way evacuation areas were being designated should be revised and should offer more detailed information. In the first hours and days after the onset of the nuclear emergency, local residents received little information about what to do or where the highest levels of radiation were due to the spreading radioactive plume.

(2) The investigations to date have identified the electric company's "saving on safety measures" and the "site location mistake" as overlapping causes of this nuclear disaster and the pollution that it has caused. These are decisions that ought to have been avoided. The Investigation Committee on the Accident at the Fukushima Nuclear Power Stations is carrying out the current investigation and needs to shed light not only on the evacuation support that has been provided to affected communities since the accident, but also on problems existing before the accident, such as the lack of adequate preventive measures. It also must focus attention on future steps and measures needed to correct flaws in the national safety regulations and standards. The committee's conclusions should be used during the overhaul of all nuclear power plants across the country.

(3) While the provision of relief to the victims has been delayed, a system to protect and relieve the victimizer (in this case, TEPCO) has been set up. When the Nuclear Damage Liability Facilitation Fund Law designed to bail out TEPCO was passed, the reason given was to avoid bankrupting the victimizer so as to ensure that indemnities would be paid out. The logic of this reasoning is clearly similar to that which led to the split-up of the Chisso Corporation after the outbreak of Minamata disease: despite the enormous number of victims, the political and economic domination of the victimizer entails an asymmetric relationship between "the victimizer and victims." The Chisso

Corporation's compensation contract (which took the form of a simple "solatium" or apology) forced victims to abandon their right to institute a lawsuit to claim for indemnifications. Similarly, in the face of a lawsuit to request the decontamination of a golf course, TEPCO has argued that "radioactive material not being the property of TEPCO, TEPCO has no responsibility for decontamination." This use of the "res nullius" responsibility concept to evade the polluter pays principle cannot be ignored. It can be regarded as an example of neo-liberal "disaster capitalism"[2] trying to ride out the catastrophe it has caused. If this is allowed to continue, a vast quantity of public funds will be used for decontamination and TEPCO's responsibility will be shelved. To argue that "profit is a private monopoly, but risk is taken over by the state" is unacceptable.

(4) The issue of insufficient compensation to residents for "voluntary evacuation" is a question for the administrative authorities. During the Minamata disease, the authorities advocated "self-regulation" of seafood consumption as a method to lessen their liability for indemnities and therefore reduce the total amount. The Nuclear Safety Commission has initially tolerated the dumping of radioactive contaminated water in the sea since they claim that it will be diluted. But even if diluted in seawater, contaminants can be concentrated thousands of times throughout the food chain. Such elementary knowledge concerning the environmental consequences of pollution, one of the main lessons of Minamata disease, is now apparently being forgotten.

(5) We must also recognize that another consequence of contamination is the problem of discrimination and what has been called "reputational damage." The outbreak of Minamata disease meant that people would no longer buy products labeled as from Minamata, and locals could not reveal their identities for fear of facing discrimination. That Fukushima Prefecture and neighboring areas are likely to face the same problems of discrimination is an issue of grave concern. Of course, the polluter is responsible, and sufficient compensation ought to be obligatory.

(6) We anticipate long-term pollution and the enormous costs of decontamination, while analysis concerning the social costs due to the nuclear disaster will be a major challenge for environmental economics, a matter that we shall discuss in detail later.

The problems experienced during earlier outbreaks of Japanese pollution and the course these problems followed are now being repeated. Indeed, it might be better to say that the phenomenon is a symptom of a regular and recurring characteristic of Japanese society.

Different from earlier industrial pollution problems, the nuclear disaster is

in addition characterized by radioactive contamination. This puts it on a scale that reaches far beyond the scope of traditional environmental issues. Rather than simply being a local problem, it has been from the beginning a nation-wide and potentially international issue (some say that it has the potential to affect the whole of the northern hemisphere).

If we consider the nature of the devastation and the number of victims (115,000 people subject to evacuation and about 1 million people located in relatively high level radiation zones) as well as the extent of the affected areas (the evacuation area alone is 800km^2, equivalent to Tokyo's 23 wards and the city of Hachioji combined, and the contaminated area extends up to a 200km radius, from the whole of the Kanto region to Iwate and Yamagata), then we understand that the Fukushima Dai-ichi Nuclear Power Plant accident has been the cause of injury to human society and the natural environment on a scale that is unprecedentedly wide-spread and life-threatening in its effects.[3)]

While the polluting company is one of Japan's major corporations and its political and economic powers are formidable, the state's involvement and the institutions dealing with nuclear power are specific to Japan. Moreover, as earthquake-prone Japan has 54 nuclear power plants nationwide, the risk of a similar situation occurring exists and makes this problem even more serious. This disaster is the result of the failure of Japan's energy policy. It is an environmental issue, but it is at the same time a management problem arising from Japan's energy crisis.

3. The theoretical concept of the causes of pollution as applied to the nuclear disaster

The events that followed the tsunami were so severe that Masao Yoshida, the director of the TEPCO Fukushima Dai-ichi Nuclear Power Plant, confessed at a press conference on November 12 that "During the week after March 11, I thought many times that I would die." At the height of the immediate crisis, the prime minister even examined the possibility of evacuating 30 million people from the metropolitan area. As for the causes of the accident, many questions have been asked, yet we wonder how many of them have been answered in the Investigation Committee on the Accident at the Fukushima Nuclear Power Stations' interim report published on December 26, 2011[4)]. We can thus understand that what we may call the theoretical concept of "the causes of pollution" is at the root of the concept of nuclear pollution.

There are several questions that the interim report does not really address:

- Why in an earthquake-prone region like Japan have 54 nuclear power

plants been built?

- Why when the Onagawa Nuclear Power Plant managed by the Tohoku Electric Power Company was closer to the epicenter and also hit by the tsunami was it able to prevent a total loss of power, while the Fukushima Power Plant was not?
- Why have measures against severe accidents been left to the voluntary initiatives of the operator?
- Why had no adequate measures been taken against a total loss of power?

The interim report of the Investigation Committee on the Accident at the Fukushima Nuclear Power Stations focuses on the official response after the earthquake and tsunami, and draws attention to certain failures that have, in various ways, been widely reported: poor communication between TEPCO and the government, a lack of cooperation within the cabinet over measures to cope with the crisis, and the fact that even TEPCO itself did not really grasp the full implications of the developing situation nor notice the dysfunction of the emergency condenser in Unit 1.

The investigators have also pointed out failures of foresight and planning: when considering preventive measures against severe accidents, insufficient attention was paid to the risk of a tsunami that might exceed the design criteria, while the response to a total loss of power or an emergency situation was inadequate; and no one seems to have taken into consideration the effects of a combined earthquake and tsunami of such a magnitude. But the real problem is why these failures should have been allowed to continue unnoticed and remain uncorrected in the first place.

We may cite for comparison the tsunami countermeasures undertaken by Tohoku Electric Power Company, whose Onagawa Nuclear Power Plant was built 15 meters above sea level, and as an earthquake countermeasure, its earthquake-resistance strength was three times that required by the Building Standards Act. Consequently, although closer to the epicenter of the earthquake, it was somehow able to secure its power supply. TEPCO's Fukushima Nuclear Power Plant, on the other hand, had taken neither of these measures.

The Fukushima Nuclear Power Plant, built originally by the U.S. General Electric Company (GE), was not designed to withstand either large earthquakes or tsunamis, and though over the last 40 years, earthquake resistance standards have certainly become more stringent, no drastic measures to strengthen the plant's defenses were carried out. It is no exaggeration to say that at the time of the disaster, the Fukushima Nuclear Power Plant was a defective plant.

Mr. Toru Hasuike, the former secretary general of the Association of the

Families of Victims Kidnapped by North Korea who served as head of maintenance personnel in the Fukushima Dai-ichi Nuclear Power Plant, explains in his book, *Watashigaaishita Tokyo Denryoku* (I loved TEPCO)[5] that since thermal power generation by natural gas has been steadily becoming cheaper, spending more money on securing the safety of nuclear power plants was likely to make electricity derived from nuclear power the more expensive method of the two. Since the cheapness of operation of nuclear was its main selling point, the electricity companies decided to make stringent reductions to operating costs while "remodeling where necessary" "to secure old plants." At the same time, management took the decision to use nuclear power plants for as long as possible after the legal depreciation period of 20 years had passed, a decision that was the source of big profits for the power companies.

We can postulate the following as likely causes for TEPCO's total loss of power: (1) the immediate collapse of power transmission lines due to the earthquake, (2) the breakdown due to the tsunami in the operations of the emergency diesel power supplies placed beside the sea, (3) an inadequate supply of batteries in the control room so that the reactors became inoperable. At the same time, during the process leading to core meltdown, deficiencies in the vent and filter system (which are required in the European Union but were not required in Japan) became apparent. We can therefore point to TEPCO's efforts to cut costs by making "savings in safety measures" as a primary cause of the accidents.

According to the interim report, TEPCO ran a trial calculation in 2008 on the effects of a tsunami based on expert opinions and the views of the national Earthquake Headquarters. The result indicated the need for a seawall of at least 15.7m in height. Current estimates suggest that the installation of such a seawall would cost tens of billions of yen and that it would take about four years to build.[6] In fact and ironically, only on March 7, 2011, four days before the earthquake, did the Nuclear and Industrial Safety Agency (NISA) learn of the estimation of 15.7m, but did not specifically request that such countermeasures should (at once or at any time) be undertaken.[7] It goes without saying that TEPCO has responsibility because of unacceptable trade offs that were made. Out of its desire to contain cost increases that would be incurred by installation of a higher seawall, the issue was ignored. Yet, responsibility also lies with the state given its loose application of regulations that were themselves already too loose.

During their interviews, the TEPCO executives are all reported to have affirmed, "We never thought that a natural disaster would exceed the design criteria, nor that it would be necessary to deal with it." Nobody has clearly

explained why they believed this, but some testimonies hint at reasons: "There would be no end if we were to start making hypotheses about likely catastrophes" or "Since the Kashiwazaki—Kariwa Nuclear Power Plant was able to deal with the situation, we judged that the design was correct" (Yoshida, director at the time). These responses indicate the company lacked any proper awareness of possible dangers.[8] During the Hamaoka Nuclear Power Plant trial, the Chairman of the Nuclear Safety Commission, Haruki Madarame, speaking as a witness for the Chubu Electric Power Company, stated that: "To hypothesize a total loss of power would mean the impossibility of being able to operate a nuclear power plant at all" and that "A pragmatic and clear-cut attitude is needed." If this blinkered attitude was shared by government officials, then the problem is not simply confined to TEPCO: it is one that affects the whole Japanese nuclear power system.

Since TEPCO's safety philosophy was unable to envisage a severe accident nor seems to have foresee any need to think about a long-term total loss of power in the event of an accident, the government authorized the continued running of the Fukushima Nuclear Power Plant, until, finally, the inevitable accident occurred. Since all the nuclear power plants nationwide operate according to the same standards, one can assume they all have the same or similar problems.

The interim report fails to come to grips with the structural and organizational history that lies behind such a lack of awareness and so many misjudgments. In other words, it has been unable to analyze the structure and get to the core of what has been called Japan's "nuclear village," a kind of group dynamism. If we hope to take advantage of the lessons that are being revealed by the investigations of the accident, and consequently engage in fundamental reforms of regulations for the safety and running of the plants, we need first a full-fledged analysis and verification of the report's findings.

The Commission on the accident at Three Mile Island (Dauphin County, Pennsylvania, 1979) held 150 public hearings within six months and produced a report that included recommendations for improvement. In Germany, the Ethics Commission for a Safe Energy Supply, while not investigating any specific accident, has carried out some theoretical groundwork in support of denuclearization. Yet in Japan, we have now learned, no minutes were taken of government meetings over the nuclear accidents, a record that is essential for any investigation of actual accidents and planned countermeasures. Such an oversight is either an elementary mistake or an attempt to hide the decision process. In either case, the absence of such a record shows that Japan, unable as a consequence to withstand the judgment of history, possesses neither the

characteristics nor the appearance of a modern nation. It is more than doubtable that this country is fully qualified to operate such high technological resources as nuclear power hardware and software.

In its report "Fukushima Lessons Learned" (October 2011), the Swiss Nuclear Safety and Inspection Agency (ENSI) pinpointed 39 organizational and technical failings and inadequacies in the running and supervision of the Fukushima Nuclear Reactor. Some of the main points raised are:

(1) a deficient educational program (for staff), (2) a poor corporate culture, (3) limitations placed on safety precautions for economic reasons, (4) the safety inspector was a member of METI (and thus not an impartial observer), (5) structural defects in the overall supervision system, (6) inadequate supervision in depth, (7) the operator (TEPCO)'s lack of a safety culture, (8) a weakness in procedures for decision-making, (9) the inadequate preparation of emergency measures, (10) excessive demands of staff, (11) regulatory deficits, (12) a delay in emergency planning, (13) insufficient measures for protection against radiation, (14) insufficient information provided for the local population, (15) the dangers inherent in group dynamics (the concept of the "Nuclear Village"), and (16) stressful working conditions.

4. Japan's nuclear reactors should not be re-started until the findings of the official reports have been thoroughly considered and appropriate actions taken in the light of their proposals

The long awaited official reports by the national Diet and the Government Investigation Committee on the accident at the TEPCO Fukushima Nuclear power station were finally released in July 2012.

My own past analyses of pollution problems have focused on the causes of such accidents and the plight of the sufferers. Now, on the basis of detailed hearings and a great body of material evidence, these two official reports have adopted nearly the same point of view as mine; the reports are thus not only the most recent but also, in my view, the most thorough of the official reports on the Fukushima nuclear disaster to have appeared so far. We may note in particular that the key phrases in the reports are "man-made disaster," "a misreading of risk," and "regulatory connivance," which we can rephrase as "tacit consent (by the authorities) to the neglect (by the company) of the safety regulations."

Although seismologists have repeatedly warned of the likelihood of earthquakes and tsunamis, TEPCO and its regulators have consistently postponed the taking of appropriate countermeasures. This is because TEPCO has looked

only at the risk to its own operations and whether taking such actions would result in the suspension of existing reactors or would weaken the company's position in potential lawsuits. The company ignored the potential risk to public health and welfare.

The reports by the government investigation committee point out that the national government's lamentable failure to foresee the calamitous consequences of a nuclear accident serve to highlight the grave inadequacies of Japan's crisis management.

A man-made disaster:

The national Diet reports concluded that the TEPCO Fukushima Nuclear Power Plant accident was the result of collusion between the government, the regulators and TEPCO, and the lack of governance by the said parties. Since the root causes were the organizational and regulatory systems that actually encouraged (and indeed connived at) the production of faulty rationales for decision-making and the taking of action (rather than issues relating to the competency of any specific individual), the commission concluded that the accident was clearly "manmade." (The National Diet of Japan *The official report of Executive summary*, The Fukushima Nuclear Accident Independent Investigation Commission)

Although the direct causes of the accident were all foreseeable prior to March 11, 2011, the Fukushima Dai-ichi Nuclear Power Plant was incapable of withstanding the earthquake and tsunami that hit on that day. The operator (TEPCO), the regulatory bodies (NISA and NSC) and the government body that promotes the nuclear power industry (METI) all failed to set in place and seek to enforce the most basic safety requirements, such as assessing the probability of damage, making preparations to contain any collateral damage likely to follow from such a disaster, and developing evacuation plans for the public in the case of a serious release of radiation.

TEPCO and the Nuclear and Industrial Safety Agency (NISA) were aware of the need for structural reinforcements in order to conform to newly issued guidelines, but rather than demanding their implementation NISA stated that action should be taken by the operator at the operator's own discretion.

The Commission discovered that by the time of the accident the operator had implemented not a single one of the required reinforcements in Units 1, 2 and 3. This was the result of tacit consent by NISA for a significant delay in completing the reinforcements. In addition, although NISA and the operators were well aware of the risk of core damage from a tsunami, no mandatory regulations were issued, nor had TEPCO taken any protective steps to guard against such an occurrence.

Since 2006, the regulators and TEPCO had been aware of the risk of a total outage of electricity at the Fukushima Dai-ichi plant if a tsunami were to reach the level of the site. They were also aware of the risk of reactor core damage from the loss of seawater pumps should a tsunami be greater than those assumed in estimations produced by the Japan Society of Civil Engineers. NISA knew that TEPCO had not prepared any measures to lessen or eliminate the risk nor provided specific instructions to remedy the situation. The commission found evidence that while the regulatory agencies explicitly asked about the operators' intentions whenever a new regulation was due to be implemented, they did not expect that the regulations would necessarily be enforced. For example, NISA informed the operators that they did not need to consider a possible station black out (SBO) because the probability was small and other measures were in place. It then asked the operators to write a report that would give the appropriate rationale for why this consideration was unnecessary. After NISA failed to respond to several requests for information on this matter, the Commission was forced to exercise its legislative right to acquire evidence of collusion.

Furthermore, the regulators appeared indifferent to new advances in knowledge and technology from overseas, and failed to take advantage of these advances. If NISA had passed on to TEPCO details of the measures that were included in the B.5.b subsection of the U.S. security order that followed the 9/11 terrorist action, and if TEPCO had put such measures in place, the accident might have been prevented.

TEPCO had many opportunities for taking preventive measures prior to March 11, and the accident occurred because the company did not take these measures, while, at the same time, NISA and the Nuclear Safety Commission (NSC) turned a blind eye to TEPCO's negligence. TEPCO either intentionally postponed putting safety measures in place or made decisions based solely on their organization's self-interest, and not in the interest of public safety (The National Diet of Japan *The official report of Executive summary* The Fukushima Nuclear Accident Independent Investigation Commission,p.16).

In addition, the government investigation report pointed out that because of a failure to prepare multiple countermeasures against damage to the cooling reactors, the Fukushima Dai-ichi (No. 1) provisions were significantly weaker than those in place at the Fukushima Dai-ni (No. 2) power station.

Over the years, as the nuclear power business became less profitable, TEPCO's management began to put more emphasis on cost cutting while still increasing Japan's reliance on nuclear power. Although the company paid lip service to a policy of "safety first," in actuality, safety suffered at the expense

of other management priorities. An emblematic example of such culpable negligence is the fact that TEPCO did not possess proper diagrams of the piping and other instrumental parts at the Dai-ichi plant. The absence of the proper diagrams was one of the factors that led to a delay in venting at a crucial time during the aftermath of the accident (Ibid.,p.44).

As the government investigation committee pointed out, internal investigation by TEPCO alone is not sufficient since it is likely to be partial, while the company's stance on the prevention of accidents is entirely inadequate.

As for the sufferers, the national Diet report carried out surveys amongst the evacuees.

The survey drew 10,633 responses, a reply rate of approximately 50 percent. Of these, 8,073 respondents took advantage of the space allocated for the free expression of their own opinions. Furthermore, 431 respondents wrote on both the front and back of the survey sheet and/or provided further comments on separate papers, all of them expressing their strong will to be heard. Their comments indicated three general concerns:

(1) Delay by the government in communicating information about the accident led to confusion thereafter.

(2) Because instructions for evacuation were made on an ad hoc basis, many people were evacuated multiple times, evacuated to areas with high radiation, and evacuated with only the barest necessities.

(3) Many of the written messages spoke of the agony borne by the evacuees.

These issues have not yet been resolved. Proper measures to alleviate the sufferings of the evacuees should be considered as soon as possible (p.50).

The government investigation committee reports pay particular attention to the standpoint of the victims of the disaster:

An accident at a nuclear power station runs a high risk of bringing about damage over a vast area and of affecting the lives of thousands of people. When designing, constructing and operating such nuclear systems, nuclear operators on the one hand and nuclear regulators on the other need to establish systematic procedures that will identify all potential risk from the "disaster victims' standpoint", so as to ensure that credible nuclear safety precautions will include plans for the evacuation of the local society. And since radioactive materials may scatter over vast areas after an accident at a nuclear power station, the prefecture and local municipalities involved have an obligation to collaborate closely in building up an effective system to lessen its effects and minimize confusion through proper evacuation planning and appropriate drills (Ibid.,p.31).

It is consequently most disappointing that a new nuclear regulation system

about to be introduced pays no attention to the proposals made by the two investigating committees. If the Fukushima accident was in truth "manmade", then Japan's other 50 reactors, which have been regulated according to the same standards, are bound to entail similar problems and are likely to pose similar risks.

If this is indeed the case, Japan's other rectors should not be restarted until the regulators carry out a proper study of the official reports and until they have acted on the vital lessons that both reports seek to impart. We cannot afford to make the same mistakes again.

5. Background causes: a Questioning of Japanese society and science

The Great East Japan Earthquake and the subsequent nuclear disaster have brought to the surface a major issue that concerns Japanese society and the nature of science and technology as these are practiced in Japan. Although experts at once pointed out that the meltdown had reached level 7, it took from one to two months for the government and TEPCO to admit that this was so. They repeatedly used the expression "beyond expectations". But the term "beyond expectations" is dishonest since it refuses to admit that "the expectations" were based on calculations or models that were themselves inexact. This vague and self-exculpatory expression has been repeatedly used by all the experts, from seismologists to meteorologists, from civil engineers to nuclear engineers, and finally by the managers of TEPCO itself.

The "unexpected" tsunami has been made the cause of the damage that led to the "total loss of power" at the Fukushima Dai-ichi Nuclear Power Plant. In drawing up earlier models, the Japan Society of Civil Engineers had estimated a tsunami of no more than 5.7m, yet the nonpartisanship of this estimation is very questionable since parties interested in the electrical power industry played a key role in drawing it up. The expression "beyond expectations" became a "watchword" or mantra that has been used as a shield to protect people from the recognition of their own responsibility.

A number of critical essays have now been published that deal with the process of nuclear "accidents," starting with "Hiroshima" and leading to "Fukushima." A March 15, 2011 *New York Times* article by Jonathan Schell entitled, "From Hiroshima to Fukushima" states that "The problem is neither in emergency generators nor safety standards, but in the fact that it is human nature to make mistakes", and he concludes that a nuclear accident is an event that is endemic to the modern history of nuclear power use (and, presumably,

that operators will continue to make mistakes).[9]

My own view is that the problem is more nuanced than this. I think it is necessary to consider that "Hiroshima" and "Fukushima" are the result of problems that have to do specifically with the nature of Japanese society. Sixty years ago, driven by the ideology of the "Greater East Asia Co-Prosperity Sphere" and heedless of differences in national power, Japan started a war. At least some of those who led the nation into that war knew in their hearts that they would never be able to win. Still, until the very end, denying the disjunction between ideology and reality, Japan continued to ignore the worsening war situation and the air raid damage on metropolitan areas. Only after the atomic bombings of Hiroshima and Nagasaki did Japan finally admit defeat and accept the "end of the war."

Equally shortsighted ideologies and myths, such as that "nuclear power is safe" or "nuclear power is cheap" underlie the Fukushima Dai-ichi Nuclear Power Plant accident. Japan, unlike most other countries, is prone to earthquakes, so why have nuclear power plants been built in such a country? And, why are the plants concentration along the coast supposed to guarantee safety? Those who use the "defense-in-depth" principle of safety as their argument repeatedly dismiss such doubts and queries: there is always, they say, a back-up line of defense.

Although there have been a spate of accidents, cover-ups and falsification of data, the construction of new nuclear power plants and their expansion has continued without any effort being made to learn lessons from these disturbing events, generalize from them, and take actions to prevent their recurrence. Indeed, under the banner of "a resource poor Japan" and despite the country's inability to develop a fast-breeder reactor or a successful reprocessing plant, the government has continued to pursue the development of "nuclear fuel cycle" technology. It has failed to adequately consider the difficulties that this technology pose or the principles that lie behind it. As a result, the disposal of spent nuclear fuel has now become a pressing problem. We have also learned that cost estimates for the direct disposal of spent nuclear fuel have been concealed.[10] The theory of "a resource poor Japan" is a kind of delusion that was once used to rationalize the pre-war invasion of the Asian continent, and has now, since the war, been touted to support the development of nuclear energy and the reprocessing of nuclear fuel. With spending almost 19 trillion yen, only about a half of the spent nuclear fuel could be reprocessed into MOX fuel to the value of 900 billion yen. The nuclear deterrence theory has been used to paper over this failure in economic rationality.[11]

Another major problem is that the concepts of risk management, risk

training and logistics have not taken root in Japanese society. It is as if people thought that preparing for an unlikely event through the daily performance of risk management and training would somehow be calling into question the ideas of safe and cheap. Finally, worst-case situations such as a core meltdown and total loss of power were not seriously considered. They were simply perceived as being beyond imaginable and thus, were ignored and replaced with more imaginable (but unrealistic) predictions.

Once accidents or disasters have occurred, a downward spiral can begin, and further damage can accrue exponentially. In crisis situations where insufficient training has been undertaken, the logistics of important goods are often mishandled. Insufficient change of personnel and lack of rest often lead to further exhaustion of workers. Responsibility for evacuation training has been left to the municipalities where nuclear power plants are located, and training has been elementary and limited to following simple crisis scenarios. As a result, when an emergency situation actually occured as it did in Fukushima, no concrete evacuation order was issued to the surrounding towns and villages. The affected inhabitants were left to evacuate at their own discretion. On this occasion, information transmitted directly through mobile phones by employees who actually worked in the nuclear power plant played a critical role in advising people to evacuate (according to interviews).

A further cause of confusion lies in the fact that while a "roadmap" has been drawn up to deal with the crisis, the actual situation and full details of the reactor's condition since the accident remain unknown and implementation of the road-map is delayed. At the same time, the problem of Japan's vertically integrated science and engineering has come to light. Power supply problems are considered to fall within the competence of electric power engineering. Nuclear reactor experts only focused on problems linked to the reaction within the reactor; they did not take into account any problems of electricity supply to the reactor or the possibility of power outage, including the kind of fateful "total loss of power" that occurred at the Fukushima Dai-ichi Nuclear Power Plant.

We have now learned from the power companies themselves that though they are expected to be in control of the whole process, only the plant manufacturer actually knows everything about the plant and its workings. The Fukushima Dai-ichi Nuclear Power Plant was the first "Full Turn-Key" nuclear power plant, which is to say, the plant manufacturer built and delivered it, yet there is no way of verifying whether the plant was built strictly according to the GE design. Such ignorance uncovers the superficiality of much Japanese science and technology. Here is how the former nuclear power

plant site supervisor, Mr. Norio Hirai, testified: "For example, TEPCO's Fukushima Nuclear Power Plant was operated while a steel wire had been left inside one reactor. This could have led to a major accident that might have affected the whole world. The worker actually noticed that he had dropped the steel wire, but he wasn't aware that his careless action could have caused a severe accident. In that sense, new nuclear power plants built by unskilled workers are as dangerous as old ones."[12)]

Despite their having to face the daily likelihood of earthquakes and tsunami and the ever-present threat of nuclear disaster, the Japanese people have retained their human dignity. While this shows the courage of which Japanese society is capable, certain issues that affect Japanese society adversely have also been exposed. "People can see human dignity in tragedy, but it is with the same pair of eyes that they can see deprivation in prosperity. Nuclear power experts were disdainful of amateurs' opinions. But, finally, the amateurs' apprehensions were 100 percent right."[13)] This quote says it all.

Technology is just a means to an end, a means to a social purpose. Society must not concentrate only on the means and lose sight of the goals. If the means do not fit the purpose, then it is up to society to choose a different means. Although I believe in the power and resilience of Japanese society, I do not think that it will be possible to give Japan a fresh start without admitting to the problems that the disaster at the Fukushima Nuclear Power Plant have caused. A rethinking of the whole basis of Japanese technology, science and society is warranted.

6. The theoretical concept of "background causes" as applied to nuclear power plants: An analysis of nuclear power from the perspective of environmental safety governance

To begin we must analyze the historical causes of this nuclear disaster from the perspective of environmental safety governance. The concept of environmental governance is a combined political and economic analysis of environmental issues. It is also a methodology that determines the location of problems and offers solutions by means of an analysis of the interactions of "institutions, laws, and customs" with "each actor's strategy and their conditions."[14)]. It observes the way the legal system regulates each actor's actions, while also observing the manner by which interactions between the actors create the legal system.

The Japanese legal system and the regulations concerning nuclear power have been placed under a dual administration: the Nuclear Reactor Regulation

Law under the former Science and Technology Agency, and the Electricity Business Act under the Agency for Natural Resources and Energy of the former Ministry of International Trade and Industry. No laws exist, however, to deal with radioactive contamination as an environmental issue. This topic is excluded from the Environmental Basic Act, and although we may have believed that it is laid down in the Atomic Energy Basic Act, no law actually establishes it concretely and unequivocally. It is partially handled in Article 64 of the Nuclear Reactor Regulation Law and Article 26 of the Act on Special Measures Concerning Nuclear Emergency Preparedness, but in neither case do the articles address large-scale and extensive radioactive contamination. Moreover, since no concrete legal regulations concerning countermeasures have been instituted to deal with severe accidents such as tsunamis, earthquakes and total loss of power, these countermeasures have been left to the voluntary efforts of companies.

So it has come about that on the narrow, crescent-shaped Japanese archipelago, the authorities, for more than 40 years, have allowed, have indeed encouraged, the construction and running of 54 plants without any concrete legal system designed to deal with the radioactive contamination likely to be generated by a large-scale nuclear power plant accident. So when the Fukushima accident actually, and perhaps inevitably, happened, both the tardy response to the nuclear accident itself and the inadequate response to the subsequent radioactive contamination was the logical outcome of this legal ambiguity. Yet while, crucially, there has been no radical reform of the legal regulations nor any concern over the intensification of seismic activity around the Japanese archipelago, the movement to restart nuclear power plants has been gradually gathering momentum.

Also important to the problem are the nuclear power generation actors (the participants). The largest group of actors is the power companies themselves. In addition to these 9 power companies who conduct nuclear power generation within regional monopolies and using a **fully distributed cost method**, the Japan Atomic Power Company acts as a business operator. Heavy electric machinery manufacturers are also important participants, since companies like Toshiba, Hitachi and Mitsubishi participate in the construction and maintenance of nuclear power plants through the multilayered structure of the subcontracting system.

Box 7: "fully distributed cost" method

Japanese electric power companies are permitted to use a rate calculation system

known as the fully distributed cost method. This method calculates rates on the basis of power generation costs and includes the utility's profit. The costs include fuel costs, operational costs and labor costs, as well as subsidy for the siting of the power stations. This is the basic reason for the regional monopoly of electricity and is responsible for the high price of Japanese electricity.

Japanese technology for commercial nuclear power generation was originally imported from the United States, and General Electric built the Fukushima Dai-ichi Nuclear Power Plant. At the time, it was even called "the GE village." Since the technology was imported from abroad, the safety of nuclear power use was guaranteed by the foreign country's safety standards. Consequently, because problems specific to Japan such as tsunamis and earthquakes were not taken into account and many of the standards were merely translated without necessarily being fully understood, a failure of clear thinking with regard to adequate safety regulations appropriate to Japanese conditions naturally persisted.

An analysis of the governmental actors responsible for overseeing these issues is a more complex task. On the one hand, the former Science and Technology Agency (the current Ministry of Education, Culture, Sports, Science and Technology) was responsible both for implementing the Nuclear Reactor Regulation Law and for the development of homegrown nuclear power technology. The Agency for Natural Resources and Energy of former Ministry of International Trade and Industry (now, the Ministry of Economy, Trade and Industry) was in charge of the Electricity Business Act that defined the "national policy, private management" method for the generation of nuclear power. Thus a dual system was established. Throughout the 1980s and the 1990s, further impediments to ensuring safety lay not only in a conflict between the Science and Technology Agency and the Agency for Natural Resources and Energy over competence, but also because of the compartmentalization of public administration. The government has not been able to mobilize actors in order to push for regulation improvement. This is also the underlying cause that explains why SPEEDI data, which are under the jurisdiction of the Ministry of Education, Culture, Sports, Science and Technology, could not be used for an evacuation plan.

Following the Central Government Reform of 2001, application of the Nuclear Reactor Regulation Law has fallen to the agency of the Ministry of Education, Culture, Sports, Science and Technology; but the actual inspection is performed by the Nuclear and Industrial Safety Agency (330 people) under the authority of the Ministry of Economy, Trade and Industry, and then only

Table 1 Regulation related to Nuclear in Japan

	Safety Regulation	Safety Regulation	Security	Nuclear Security
Nuclear Commission	Peaceful use	planning	Policy check	Policy check
Nuclear Safety Commission	Guideline Double check	Guideline Double check		
Ministry of Education, Science	Research Reactor Act on Compensation for Nuclear Damages	Regulation on Radiation	Security supports	Research Reactor RI Facility
Ministry of Economy, Trade	Commercial Reactor Radioactive Waste Management			Commercial Reactor Radioactive Waste Management
Ministry of Foreign Affairs			International Negotiation	International Negotiation
Ministry of Welfare, Work	Labor Safety	Health Effects		
Ministry of Transportation	Transportation Shipping of Radioactivity			

after approval by the Nuclear Safety Commission under the authority of the Cabinet Office. So, while the result is double-checked, the reform has also made the regulation system a good deal more complex; it has also created a conflict of interest by putting maintenance of the safety regulations under the authority of the pro-nuclear energy Ministry of Economy, Trade and Industry.

In fact, access to information and the human resources at play are overwhelmingly weighted on the side of the power companies (information asymmetry). Although the Nuclear and Industrial Safety Agency is supposed to regulate operations, its human resources are insufficient and collusion with the power companies is well established (see Table 1). There are also problems concerning the Nuclear and Industrial Safety Agency executives themselves. First, senior executives specialize in nuclear matters too late in their careers. Second, most executive promotions result from the rotation of internal person-

nel within the Ministry of Economy, Internal Trade and Industry. For example, when the Fukushima accident occurred, the director was Mr. Nobuaki Terasaka, a graduate in economics, while the officer in charge of public relations was changed to Mr. Hidehiko Nishiyama, a graduate in law. As an unfortunate consequence of such arrangements, true professionals are unable to "rise through the ranks" to positions of management and only the "nuclear village" remains. Even if related institutions publish research results — as the Japan Nuclear Energy Safety Organization (JNES, 480 people) in fact did when they reported the possibility of core meltdown damage due to a tsunami[15] — the Nuclear and Industrial Safety Agency is not able to exploit them.

After the Chernobyl accident, Japan, too, should have decided what measures to take to counteract severe accidents at its nuclear plants. Yet, at the time, any consideration of countermeasures to cope with severe accidents was thought equivalent to admitting that nuclear power is not safe. This explains why the government, considering the possibility of lawsuits across the country, and the power companies, worrying about the effect on the neighborhoods near nuclear power plants, both opted for no regulations and allowed countermeasures to simply rely on voluntary efforts.[16] And this is why, when the governmental Investigation Committee on the Accident at the Fukushima Nuclear Power Stations conducted interviews with some of the persons concerned, the manager of the Nuclear Emergency Preparedness Section of Nuclear and Industrial Safety Agency told the Committee that: "As AM (Accident Management) belonged to the field of 'voluntary security' and was not a regulation, we focused on near-term regulatory tasks and were swayed by them."[17] As this statement shows, the biggest problem since the "trouble cover-ups" that TEPCO and other companies concocted in 2002 is that attention has been given to detailed regulations and reports, and no longer to essential countermeasures against severe accidents, which were postponed and left to voluntary initiatives. As the old idiom reminds us, we "have failed to see the wood for the trees." At the same time, a sharing of roles among the administrative actors responsible for enforcing regulations and cooperation with local governments was delayed. The Fukushima accident has shown that, even now, the measures taken are totally inadequate since most of the emergency evacuation plans are intended for towns and villages that host nuclear power plants and do not include areas further afield that may suffer contamination. Katsutake Idogawa, the mayor of Futaba Town, which hosts a nuclear power plant, has said: "Of course, if these data had been available, I would have organized (the evacuation) differently. Our guilt is beyond measure." And he has severely criticized the government for not providing the residents with

forecast data concerning the diffusion of radioactive materials. For, as he pointed out, "The evacuation order was given by the government, but since that day there has been no guidance or instructions about the actions to take afterward. I deeply regret this." (Testimony before the National Diet of Japan Fukushima Nuclear Accident Independent Investigation Commission, January 30, 2012)

On any reckoning, the Fukushima accident ought to lead to fundamental reforms of the legal system concerning nuclear power and to a radical re-examination of each actor's role within their cooperative relationships. The existing Nuclear Reactor Regulation Law should have prevented this accident, but there was a flaw in the law. We need legal regulations on the evaluation of tsunamis, countermeasures to cope with a total loss of power, and means to prevent severe accidents. Possible terrorist and unlikely, but still conceivable enemy attacks need to be taken seriously as well. The Electricity Business Act and the Nuclear Reactor Regulation Law should be unified. Safeguards, radiation regulations and an Act on Compensation for Nuclear Damages should be integrated within the Nuclear Regulation Committee as an independent agency. The monitoring of radiation should be conducted at a prefectural level as a legally delegated affair. Disaster prevention measures must be drastically strengthened.[18] Without such fundamental reforms of safety regulations as these, any restarting of the nuclear power plants is unthinkable.

7. The theoretical concept of "relief" as applied to nuclear disaster

One hardly needs to say that the cost of a serious accident at a nuclear power plant is bound to be tremendous. For many years I have studied the social costs of environmental damage and the health hazards engendered by environmental problems from the perspective of environmental economics. This nuclear accident has points in common with past cases of pollution, but also significant points of difference. The long-term consequences of this accident are of a different scale. This is true in relation to the rise in every kind of incurred cost and the still unknown consequences of the invisible radioactive contamination that has affected wide areas around the nuclear power facility.

The chairman of Fukushima Prefectural Medical Association (Mr. Yuzo Takaya) said during his interview that at the time of the earthquake disaster no members of the Medical Association were represented on the Disaster Response Headquarters of the prefectural government. He also reported that hospitals along the coast (2,713 beds) were no longer functional, and that the psychiatric hospital functions (905 beds) had been completely wiped out. In

Fukushima Prefecture, the Obstetric and Pediatric departments had no more patients, and 125 doctors or 12 percent of doctors formerly working in the prefecture have now left. The treatment of chronic diseases, such as those requiring dialysis, has become a serious problem. No emergency cases can be accepted locally and it takes more than two hours to transfer patients to Fukushima or Sendai.

After the triple disaster people's lives and the living environment were completely changed. Among the irreversible or long-term consequences affecting the region are:

- destroyed houses, tsunami damage, fire, the nuclear accident
- death or disappearance of family members, the abandoning of pets and livestock
- loss of income due to the nuclear accident or evacuation
- anxiety due to life in an evacuation center or acute-phase and chronic-phase treatments
- shortage of food, water, hygiene products and lack of toilets, bathing facilities and heating
- family breakup, life in temporary housing, community disruption, loneliness, loss of livelihood and economic instability
- anxiety over likely health damage due to radiation exposure, especially among children, infants, and pregnant women and their fetuses.

Although a clinic has been installed within the Big Palette evacuation center of Kohriyama City, the temporary housing remains unheated, and a feeling of distrust towards administrative agencies is growing stronger. The evacuees have to accept that 30-40 years must pass before they will be able to return to their homes. And while anxiety over the evacuees' general health is a matter of concern, it is, in particular, most important to carry on with thyroid gland examinations to monitor any signs of radiation sickness. An international center is being planned for this purpose.

We may learn numerous lessons from this accident. "No More Fukushimas" would be one. Others would have to do with the importance of ensuring electrical power supply, efficient means of communication, clearly defined evacuation routes and adequate supplies of gasoline. We must also recognize the need to secure and provide iodine tablets and to maintain up-to-date knowledge of levels of radioactivity. Most importantly, perhaps, is to prepare for the earthquake that is predicted to strike the Kanto-Tokyo region in the foreseeable future.

While the "psychological care team" from Kyoto Prefecture and Kyoto University continues to support evacuees now living in Aizu, the problems of

drug shortages and the management difficulties of providing personal information are getting worse and the risk of depression amongst the evacuees is growing greater. All of this, when combined with the feeling of so many survivors that there is "no end in sight," adds greatly to their heavy burden of stress.

Since the laws relating to the siting of power plants award subsidies to those living in the shadow of such plants, it is critical to ask how these subsidies are to be distributed among Fukushima Prefecture's separate localities. It is also important to ask if these localities still dependent upon nuclear power plants? Fukushiima University Professor Shuji Shimizu, who for many years has studied the relationship between the power source siting laws and municipalities where nuclear power plants are located, speaks for the residents living next to nuclear power plants when he says: "Nuclear power plants do have chimneys but the smoke they emit cannot be seen. I wish that the smoke were colored." Since it would be easy to perceive the direction of the wind by watching the drift of the smoke, it would be possible to evacuate windward should an accident occur. The issue here is of hazards to health. Damage due to radioactive contamination is not only an immediate problem for employees working at the nuclear power plant but also for residents in the neighborhood of the plants.

Other significant forms of damage to health are the highly damaging emotional, psychological and social stresses that the survivors underwent and continue to undergo. Fukushima City, the site of Fukushima University, is 60km from the nuclear power plant. At the time of the accident, many young children living there were evacuated to places far from their homes. But some children could not evacuate due to individual household constraints. Moreover, sometimes, in the course of evacuation, parents and children or couples were separated or were forced to move to places that they had never visited before. Those who chose to stay in their own homes sealed up the windows and watched the TV news flashes and reports night and day. Significant numbers of these people were close to nervous breakdowns. The provision of social care for them was, and still is not sufficient.

In towns closer to the nuclear power plant, all residents were eventually required to evacuate and city offices and their administrative functions were moved to other prefectures. This is the first time that such a thing has happened in the history of Japanese local government. Income loss due to the suspension of business in offices, agriculture and fishery trades can be calculated in monetary terms, and, to some extent, we can even estimate the expenditures and opportunities lost as a consequence of evacuation, soil pollution and the

cessation of planting because of radioactivity, and even the pollution of the sea. Such calculations have certainly been made in previous cases of serious and deadly pollution. In the case of the Itai-itai disease, the source of the pollution was heavy metal contamination. The polluter, a mining company, had to pay compensation to farmers (about 12 billion yen). The amount of compensation paid to farmers for loss of their crops was actually at levels that were far greater than the amount that was paid out in medical care compensation (about 8 billion yen). The company that was the source of pollution also had to pay for about one-third of the colossal cost for soil decontamination (about 13 billion yen).[19]

The Fukushima nuclear disaster has caused a far greater range and variety of damage. Because of harmful rumors, farmers and fishermen can no longer sell their goods. The value of the land assets is also decreasing, and the number of visitors is falling. The halting of operations at the power plant, the closing down of factories and the evacuation of residents have led to a reduction of tax revenues, while the number of students who enroll in educational institutions in the reion is dropping.

The report "Calculation of damage caused by pollution"[20] defines "the nature of the damage caused by pollution" as (1) the irreversibility of the victim's position, (2) the difficulty of avoiding damage, (3) the extent of the damage, (4) the loss of profitability occasioned by the damaging act, (5) the continuity of the damage. These criteria can all be applied to the Fukushima nuclear disaster. As Nobuo Kojima, a lawyer of the Japan Federation of Bar Associations, has pointed out,[21] this damage can, in particular, be characterized by (1) the unprecedented magnitude of the large-scale damage, (2) the long-term continuity of the damage, and (3) the complete destruction of the bases of people's livelihood. No legal system exists to take the necessary countermeasures to cope with this situation. Japanese nuclear power plants have operated for more than 40 years without any specific legislation designed to deal with radioactive contamination in cases of a large-scale nuclear accident. The reality of radioactive contamination spreading and dangerous radioactive wastes accumulating are deeply serious concerns. Preventive measures to protect the local residents from the hazards of radiation require a comprehensive health study that rejects easy and bland presuppositions and necessitates a program of long-term health monitoring. Pollution abatement and the evacuation of residents in danger of harm to their health will be necessary.

It is often said that history repeats itself, but when the scale of the Fukushima nuclear disaster is compared to earlier cases of pollution, it is seen to be

incalculably larger and more serious. Even considered on a short-term basis, the Fukushima nuclear disaster has raised certain issues that are quite new in their extensiveness. (1) the problem of criteria for compensation and midterm guidelines for damages, (2) a survey and monitoring of the residents' health, (3) standard measures of safe radioactivity, (4) the disposal standards of radioactive material, (5) the extent of the evacuation zone, and (6) the problems of decontamination. In order to relieve the victims and ensure their safety, national and local governments, residents, scientists and lawyers must continue to consult and negotiate over issues of compensation and its standards. The Japan Federation of Bar Associations has issued a written opinion and a chairman's statement in which proposals are made and problems relating to the government's policies and standards are strenuously pointed out.[22)]

8. The theoretical principle of "social cost" as applied to the nuclear disaster

Since, as the consequence of the accident at the Fukushima Dai-ichi Nuclear Power Plant, the operation of all but 2 of the 50 nuclear power plants nationwide has now been brought to a halt (note that the 4 damaged reactors have been permanently shut down), I shall consider the problem of the power supply system and its cost.

The Japanese Institute of Energy Economics originally estimated that if all the 54 nuclear power plants across the country stopped working, the cost of supplying alternative fuels, such as oil and natural gas (LNG), would increase in 2012 by about 3500 billion yen. This would mean that the price of electricity for an average household would rise by 18 percent. This represents an increase in the burden for each family of about 1,000 yen per month.[23)]

Yet these estimates calculate the cost of thermal power generation as an alternative to nuclear power plants in a simplistic way. Behind them is an assumption that it will be necessary to restart the nuclear power plants because the costs of not doing so will be too large. But if we go back to the beginning of the problem, we have to recognize that the Fukushima nuclear disaster is the result of the promotion of nuclear power generation within an earthquake-prone zone, so that even if no further nuclear accident happens, we shall need to renew the facilities for both thermal and nuclear power generation. These costs need to be integrated and compared in the original estimates.

It is therefore necessary to reconsider what the real cost of nuclear power is based on the situation in Japan since March 11, 2011.

8.1 Costs range of nuclear power

Until now the main reasons given for the promotion of nuclear power have been that nuclear power is cheap, safe and the trump card in the battle against global warming. Now, the nuclear power is safe myth is no longer viable. Nor, when we consider the many trillion yens' worth of damage that the accident has caused, does the nuclear power is cheap argument hold anymore. Even if the costs occasioned by the accident are not taken into account, some studies, such as Takeshi Murota's "Economics of Nuclear Power"[24] or Ken-ichi Oshima's "Political Economy of Renewable Energy," have shown that nuclear power was not cheap even in the first place.[25].

According to Oshima, nuclear power involves 4 types of costs: (1) the direct cost of power generation, (2) the backend cost (fuel reprocessing, reactor decommissioning and disposal of radioactive wastes), (3) the public investments (development and location costs), and (4) the cost generated by an accident and its compensation. On the basis of data listed in the annual securities report of the nine power companies, the sum of costs (1), (2) and (3) from 1970 to 2007, are as follows: The cost for 1kWh has risen to 10.68 yen for nuclear power, 9.90 yen for thermal power, 7.26 yen for hydraulic power, 3.98 yen for general hydraulic power, 53.14 yen for pumped-storage hydraulic power, and 12.23 yen for the combination of nuclear and pumped-storage hydraulic power. It is clear that nuclear power is not cheap. Moreover, the backend cost (2) has not adequately been calculated or accounted.

8.2 The social cost of nuclear power

The nuclear disaster at the Fukushima Dai-ichi Nuclear Power Plant is a "multiple disaster" of a kind never before experienced in human history, composed of one part that can be evaluated in monetary terms and of one part that cannot. While, as we see below, there are common points and differences with traditional pollution cases, the present disaster is also characterized by a high degree of uncertainty; and though huge future costs are expected as inevitable, their actual extent is quite beyond our power to foresee. This is linked to the problem of trying to given an economic measurement to the social costs of a nuclear disaster. The social cost of nuclear power include but are not limited to:

- "Invisible pollution" with "no direct fatalities"
- Health hazards (radioactive contamination of residents and workers, social stress)
- Income loss due to suspension of business in offices, agriculture and fishery

- Soil pollution with a halt to all planting and marine pollution caused by radioactivity
- Expenditures and opportunity loss caused by evacuation
- "Reputational damage" (farm and marine products, land assets, tourism)
- Reduction of tax revenues (halt of power plant operations, the closedown of factories, evacuation of residents)
- Reduction in numbers of students enrolled in educational institutions, and consequent loss of educational opportunities[26)]

A number of important empirical and theoretical studies clarify the characteristics of the nuclear seismic disaster that has generated the wide-ranging multitude of issues listed above. They support policy proposals that will contribute to the relief of victims, as well as providing tools to study the social cost of nuclear power more deeply, and more objectively.

Estimating an economic loss of 50 trillion yen and evaluating the total amount of electricity generated by nuclear power over 40 years of exploitation to 75,000 billion kWh, Hitoshi Yoshioka has calculated that the cost per kWh of electricity will rise by about 6.7 yen. This is more than double the figure provided by the Ministry of International Trade and Industry in 1999 (5.9 yen per kWh).[27)]

After the accident, the government carried out a review of the cost of nuclear power. According to the estimates (December 2011) of the Cost Verification Committee,[28)] which included accident costs and social costs such as CO_2 emissions, the generation cost of nuclear power is at least 8.9 yen per kWh. This is about 1.5 times the price previously published by the power companies and the government. If we add the cost of the removal of radioactive material, the decommissioning of the reactors and consequent compensations, the cost will rise further. And since coal-fired and liquid natural gas (LNG)-fired thermal power generation cost around 10 yen per kWh, the cost advantage of nuclear power generation basically disappears. Under favorable conditions, wind and geothermal power can compete with nuclear power. In 20 years' time, solar power is likely to be cheaper than nuclear energy.

We do not therefore need to include the accident cost in our calculations to conclude that nuclear power is not (and never has been) cheap. If we add the cost of the accident to the calculation, it is even more evident that nuclear power is actually the most expensive form of power generation. Yet, despite its not being viable economically, Japanese electricity policy uses nuclear power as the base-load source of electricity production.

Given that nuclear fuel itself is cheaper than the fuel used for thermal power, restarting the already-built nuclear power plants will, in fact be a way for

power companies to save on (1) the direct cost of power generation, although this does not take into account (2) the backend cost, (3) the public investments and (4) the cost generated by the accident. So that if on the stopping of nuclear power plants, we calculate the loss at several hundred million yen per day, management will make use of this argument to support a decision for their restart; and, indeed, by doing so, even if each power company has to pay tens of billions of yen for earthquake and tsunami countermeasures, nuclear power generation would still be a profitable business for them. However, hurrying up the restart of nuclear power plants in a seismically active zone like the Japanese archipelago means taking the risk of a second nuclear disaster. This is an unacceptable risk because of the enormous (4) damage costs. There is no doubt that were such a worst case scenario to reoccur, Japan would not be able to recover and would suffer social and economic collapse.

9. The theoretical principle of "compensation" as applied to nuclear disaster

As a consequence of the Fukushima Dai-ichi Nuclear Power Plant nuclear disaster — itself the result of the Great East Japan Earthquake and the subsequent tsunami —TEPCO will now be obliged to pay a huge amount of money in compensation. The way things stand it is already clear that TEPCO's total debt will exceed its total assets and that if it were required to pay this itself, the company would suffer a capital deficit. This possibility brings into immediate focus the growing conflict between TEPCO and the state over the sharing of the burden of compensation.

In section 2, I wrote that we can already observe similarities with the case of Minamata disease in that the state has quickly expressed its intention to participate in the compensation process by adopting policies that give priority to the relief of the victimizer rather than to the relief of the victims. This has now actually become the point of political issue over the Fukushima Dai-ichi Nuclear Power Plant nuclear disaster.

In the terms of the Nuclear Damage Liability Facilitation Fund Law, TEPCO is nominated as the main actor in the compensation process. The state and the other power companies are expected to cover any shortage of funds, and this sum is to be repaid out of TEPCO's annual operating revenues. In other words, although TEPCO continues to operate, the newly created Nuclear Damage Liability Fund will be supported by the other 8 power companies and the government. It is this money that will be used to compensate the victims of the nuclear damage. But even if the compensation process is managed by the

government and regardless of the percentage of the burden carried by the state, the burden borne by citizens, through the injection of public funds for payment of compensation and the raising of electricity prices, will inevitably be huge. The financial institutions and power companies support this option so that the unified generation and transmission and regional monopoly of the Japanese electric power production system can be maintained as it is.

On the other hand, if TEPCO is allowed to go bankrupt, all claims and corporate bonds become null and void, while the power industry itself continues to function as before. Such a procedure was followed in the case of JAL. Questions of the separation of the generation, transmission, distribution and dismantling of nuclear power are all now open for discussion. Suggestions have been made for the selling of the transmission sector to the state in order to acquire funds for compensation; other suggestions have proposed the management of nuclear power by the state.[29] The Japan Federation of Bar Associations has also proposed the legal liquidation of TEPCO through the sale of its current assets in order to pay compensation, the cession of power transmission and distribution business to the state, and the use of the reserve fund for fuel reprocessing and the payment of debts.[30]

According to Liberal Democratic Party Diet member Taro Kono's blog[31]: "Every day people from the Ministry of Economy, Trade and Industry, TEPCO and the Federation of Electric Power Companies throng the Diet Building, and attempt to speak with every member of the Diet. It seems that they are all lobbying on behalf of their own particular interests. 'If TEPCO is partitioned the supply of electricity will be disrupted', 'Insisting that TEPCO pay compensation will lead to a financial crisis'. The main strategic objectives of the Ministry of Economy, Trade and Industry, TEPCO and the Federation of Electric Power Companies are to prevent the partitioning of TEPCO and to raise the burden carried by the state. The composition of the present government formed from the former Democratic Party of Japan confirms this orientation, since many of its members come from the former Democratic Socialist Party and in the past had connections with The Federation of Electric Power Related Industry Worker's Unions of Japan."

The argument that "If TEPCO is partitioned the electricity supply will be disrupted" is just a means to protect the monopoly of Japan's unified power generation and transmission system. As for the financial crisis argument, I here cite a relevant article by Hoshi-Kashyap-Schade[32] which points out that it all depends on the response of the regulatory agency. JAL, just like TEPCO, is an important company, but it is now undergoing a rehabilitation process in accordance with the Corporate Rehabilitation Law. With regard to damages,

Hoshi and his fellow writers say, "The Corporate Rehabilitation Law just determines the procedure for debt restructuring. It's not a strict allocation rule. In a reorganization plan, considering fairness, even claims with a statutory lien are often put together with other general claims into one class. What is important is to carefully draw up a fair reorganization plan under the supervision of the court. In this sense, rather than an inflexible rule, the Corporate Rehabilitation Law is a process to ensure fairness."[32]

Taro Kono's blog also reports that a young bureaucrat of the Agency for Natural Resources and Energy sent him a "Ghost Draft for the Energy Agency" which had been crushed by his superiors ("Current energy policies issues revealed by the disaster, Ministry of Economy, Trade and Industry, April 24, 2011").[33] The ghost draft lists nine Priority Problems:

(1) Settling the Fukushima nuclear power plant accident
(2) Providing a stable power supply during the summer (to avoid sudden and large-scale power outages)
(3) Avoiding a financial crisis brought on by TEPCO's uncertain finances
(4) Urgent implementation of compensation to the victims of the nuclear accident in Fukushima
(5) Minimizing the burden on citizens
(6) Realizing a fair burden-sharing among stakeholders so as to win the people's approval and confidence (essential to smooth processing)
(7) Radical revision of nuclear power regulations, including countermeasures to cope with remotely triggered earthquakes and the breaking-up of NISA
(8) Radical revision of power generation business regulations, including the separation of electric power generation and transmission
(9) Improving the decision-making and implementation of the rehabilitation process, including the breaking-up of TEPCO

Although this list of nine items, with which many people agree, clearly organizes the challenges posed by Japan's current energy problems, the alternative mechanism proposed by the government is what will determine the basis for the policies that will deal with these nine problems.

The mechanism proposed by the government sets the stable power supply and the avoidance of financial crisis as nominal goals, while trying to implement a compensation system as soon as possible to lighten the burden placed on the citizens. But the attempt to avoid any radical revision of the regulations affecting the power generation business and the split-up of TEPCO is obvious. It will therefore be extremely difficult to realize a fair burden-sharing among the stakeholders and so satisfy the wishes of the people.

Although the proposed mechanism clearly should have been given a fundamental (and thus lengthy) review before its adoption, it was decided upon almost immediately without sufficient discussion amongst members of the National Assembly, within the Cabinet, or with any form of public debate in order to settle TEPCO's accounts as quickly as possible. If we hope to reduce as much as possible the burden on public finance and citizens and pay proper compensation, while also looking ahead to the reduction of our dependency on nuclear power and the reorganization of the Japanese electric power supply system, then it will be necessary to consider the option of the separation of electric power generation and its transmission.

10. The theoretical principle of "compensation" as applied to the nuclear disaster Verification of the TEPCO Management and Finance Investigation Committee Report

After the accident in Fukushima and before the report of the Accident Investigation Committee was released, few local governments were ready to agree to the restart of nuclear power plants. Doing so based on a stress test that did not take into account new safety standards would be unnecessarily risky. It is a justifiable question to ask if nuclear power plants, scattered as they are all over the country, will be able to withstand earthquakes and tsunamis such as those experienced during the Great East Japan Earthquake or other unlikely, but not inconceivable impacts. As the chairman of the Nuclear Safety Commission admits, Japanese nuclear safety regulations have never assumed situations such as the total loss of power or core meltdown, and he agrees that a fundamental reform of the regulations is necessary. Yet although so many nuclear power plants have been built in such an earthquake-prone territory as Japan, no sufficient countermeasures against earthquakes were taken. Rushing the restart of nuclear power plants could lead to a second accident.

The TEPCO Management and Finance Investigation Committee published its report on October 3 2011.[34] The fact that it strongly urges the restart of the nuclear power plants and an increase in electricity bills constitutes very serious issues that cannot be overlooked by an environmental economist such as myself. Indeed, in contrast with media coverage of the report, which in general represents the report favorably as pressing for a severe restructuring of TEPCO, I consider, after a deep review, that it contains many problematic proposals. While it aims for the restructuring of TEPCO by streamlining the management, expects the state to shoulder the responsibility of providing the compensation due to nuclear accident victims, leaves unquestioned the respon-

sibility of financial institutions as lenders, makes an imaginary excess of liabilities over TEPCO's assets, presses for the restart of the Kashiwazaki Kariwa nuclear power plant and for a rise in the price of electricity, and finally avoids the issue of TEPCO's legal liquidation.

Furthermore, the impartiality of the report is itself questionable. Although it claims to be written by a third party committee that was originally established in August under the "Nuclear Damage Liability Facilitation Fund Law" in order to call for an objective assets evaluation and expenses revision (due diligence process), Therefore, the problems of this report are problems of the law as it stands. This important fact is signified in the report by considerations concerning the evaluation of TEPCO's assets. Despite the length, the report is excerpted below.[35)]

(1) After its establishment the facilitation fund of Article 41, Paragraph 1, No.1 of the Facilitation Fund Law will provide assistance to TEPCO through subsidies to the funds devoted to the payment of damage compensation that TEPCO will be obliged to perform, with the prerequisite that revenue of the equivalent amount will be recognized. In addition, the consolidated net assets after adjustment has been executed will carry the prerequisite that the nuclear damages costs that have already been incurred (397.7 billion yen for the first quarter) and the nuclear damages that should be appropriate in the future are not implemented in the allowance.

(2) On the basis of Article 52, Paragraph 1 of the Facilitation Fund Law, the amount of special contributions will be determined in accordance with standards specified by ordinance of the competent minister, in light of TEPCO's future balance of payments, and to the extent that it does not pose impediments to smooth business operations and stable electricity supply. Since accounting the cost will remain at TEPCO's charge in the future, the ascertainment of the above actual net assets is not taken into consideration.

(3) Since we expect a large deficit by the end of the fiscal year (March 2012), and as the duration and the amount of special contributions are uncertain, the occurrences of future taxable income cannot be comprehended. Therefore the adjustment of tax effect is not implemented.

(4) states that under the Facilitation Fund Law, TEPCO, in order to pay damages, will receive subsidies from the state that are recognized as profits of the same amount. Thus the damages cost is not implemented in the allowance. TEPCO is supposed to pay back these subsidies through special contributions. However, according to (2), as special contributions are decided by ordinance of the competent minister, their duration and amount are uncertain, and therefore are not incorporated in any trial calculations. In a normal case, there

is no bank to lend funds while the repayment amount and the repayment plan remain deliberately ambiguous.

As the Japan Federation of Bar Associations has pointed out, if damage compensation obligations were implanted in the allowance, TEPCO would become insolvent. For example, even if only the amount of transitory compensations (about 2,618.4 billion yen) and the amount of annual compensations for first year (about 1,024.6 billion yen) are subject to allowance obligations, TEPCO would not, as the report states, be in excess of 1,602.5 billion yen in assets, but in fact be burdened with deficits of at least around 2,040.5 billion yen. Crushed by debt, legal liquidation procedures including the application of the Corporate Rehabilitation Law would have to be seriously considered.[36]

From the point of view of environmental economics, we cannot overlook the report's extremely debatable (and highly dubious) forecast of the amount of damages that are likely to be incurred. As there has so far been no case of exposure, the amount of damage caused by radioactivity has been estimated as zero.[37] At the same time, three scenarios for the running of nuclear power plants have been prepared. In the case where nuclear power plants cease to operate, the report claims that a fund-increase from 4 to 8 trillion yen will be needed, and that if there is no significant increase of electricity rates, the formulation of a viable business plan will be compromised.[38] Such a claim represents the biggest problem. If the whole thing is nothing more than a forced choice between the restart of nuclear power plants and the increase of electricity rates, then the argument that efforts are being taken to minimize the burden on citizens is just an empty slogan. It is necessary to go back to the beginning and reconsider the prerequisites: we should consider, amongst our choices, the legal liquidation of TEPCO, the responsibility of the supporting financial institutions, compensations paid by the profit on sales of business of electric power generation and transmission and liberalization of the electric power industry. To say that the restart of nuclear power plants and the increase of electricity rates are necessary in order to avoid TEPCO's insolvency is a flagrant example of the confusion of the means for the end. In fact, the conditions laid down by the three megabanks for additional financing to TEPCO (scheduled April 2012) are a price hike and the restart of nuclear power plants.[39] Priority is clearly being given to the profits of financial capital. And the responsibility of the lender who has been unable, or has failed, to evaluate the risk of nuclear power exploitation remains unquestioned.

11. The theoretical principle of "countermeasures" as applied to a nuclear disaster, The reality of "a cold shutdown condition" and "accident contained" declarations

In a statement on the Fukushima Dai-ichi Nuclear Power Plant issued on December 17, 2011, the government announced a cold shutdown condition and claimed that the accident (had been) contained. But this announcement was made while the government and TEPCO were still working to achieve the "cold shutdown condition" by the end of the year, as had been agreed on in the second phase (step 2) of the roadmap towards restoration after the accident. The prerequisite for a cold shutdown condition requires that temperature at the bottom of the pressure vessel inside the reactor should be held at less than 100 degrees C and that the leakage of radioactive materials should be kept under control. But since the expression cold shutdown has always been used only when operations in a nuclear reactor are temporarily stopped, for example to perform periodic inspections, it implies a safe situation when the reactor is hermetically sealed and the water is cooling not boiling. So, use of the expression cold shutdown for a reactor that has suffered an accident is not in line with the usual definition. Moreover, the accident has been declared contained even though there is no prospect of return for the residents. The governor of Fukushima Prefecture, Yuhei Sato, has reacted indignantly to the declaration and has signified that: "the accident is not yet contained." Governor Sato has also explained that the residents feel anxious about the leakage of treated water and that the amount of contaminated water continues to grow.

Even the chairman of the Nuclear Safety Commission, Haruki Madarame, has admitted that: "This is not a normal nuclear reactor facility anymore. As we do not know what is happening inside and what has become of the reactor core, it is extremely difficult to properly anticipate what might happen next."[40] So why, when it is quite obvious that the accident is far from being contained, should a cold shutdown condition and accident contained declaration have been made at this particular moment? The answer is of course obvious, and it is perhaps hardly necessary to say that at the root of such an announcement lie such issues and the concerns they raise as to when to restart the nuclear power plants now stopped nationwide for periodic inspection and when to lift the evacuation orders to residents in the vicinity of the nuclear power plant. The basic factors when dealing with pollution cases are (1) the elucidation of the cause of pollution and its source, (2) countermeasures to the source of the pollution emission, and finally (3) a study of damage and the relief of victims.

On each of these matters, the investigation of the Fukushima disaster is still in its early stages.

(1) As for elucidation of the cause of pollution and its source as applied to the nuclear disaster, The results of the investigation headed by The Investigation Committee on the Accident at the Fukushima Nuclear Power Stations of Tokyo Electric Power Company must challenge not only the adequacy of the safety regulations and countermeasures at the Fukushima Dai-ichi Nuclear Power Plant but also how these apply to all the nuclear power plants across the country. Stress tests that rely only on simulations will not be acknowledged as valid or adequate.

(2) Furthermore, measures to counter the source of pollution emissions are problematic, too. We are still quite ignorant of many important features of the contamination of underground water or seawater that is being brought about by the radioactive pollution emitted by Fukushima Dai-ichi Nuclear Power Plant; and since, as Chairman Madarame admits, it is not possible to go onsite or discover the actual situation within the reactor, we cannot predict how the state of the plant will evolve. Yet the release of contaminated water into the ocean is still permitted.

(3) Even if we consider only the damage caused by the nuclear pollution and the compensation that must be given to victims, we recognize that further huge efforts are needed. The current state of study of radioactive contamination is insufficient and many residents in the vicinity have great anxiety because of the abnormally high levels of radiation in their regions. Even among those living at about 60km distance from the plant, anxiety about high levels of radiation persists. While it is necessary to give priority to evacuation and decontamination, it should be done carefully so as to avoid spreading pollution over a wider area.

Although, as we see, none of the three basic conditions for dealing with cases of pollution have at this stage been met, the authorities have declared a cold shutdown condition, and have claimed that the accident (has been) contained. The timing of these statements raises suspicions. Rather than quick statements of reassurance, we require measures that address the true reality of the Fukushima disaster and that attempt to grasp what is really going on at the plant. Yuko Endo, mayor of Kawauchimura, a village that has been forced to evacuate in its entirety to Kohriyama City, stated that the accident can only be considered contained "when the removal of fuel, the decommissioning of the reactor and the process of residents return has been completed." If we consider this nuclear disaster to be the world's largest and worst case of pollution, then we should be prepared for its resolution to take time as well as huge efforts and

costs. If we are over-eager to announce that the problem is over, the damage in the long run could be even greater.

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