Reciprocity: Nuclear Risk and Responsibility [1)]

Paul DUMOUCHEL

Reciprocity

According to the official report of *The Fukushima Nuclear Accident Independent Commission* prepared for the National Diet of Japan, Sato Yuhei, Governor of Fukushima Prefecture at the time of the accident when interviewed by the commission at one point declared that: "National support has been broadly extended to Fukushina and its people since the disaster. To reciprocate, Sato said that he wants to contribute by building a community with the promise not to let a similar disaster ever happen again." [2)] At the personal level this is a very straight forward and clear illustration of the idea of reciprocity: you have done something for us, by helping us when we were in need, and in return we would like to do something for you. We wish to contribute to making sure that such a disaster never happens again. This comment implies in fact a rather complex and unusual form of reciprocity, which it hides, in spite of, or perhaps because of, its apparent evidence and transparency.

First, why, how, in what way does contributing to building a community where similar disasters will never happen again, constitute a form of reciprocity? Governor Sato assumes that this is evidently the case, but why is it so? The evident, but never explicitly stated answer is because similar nuclear accidents threaten all of Japan; preventing them is an important urgent task. At its beginning, the accident in fact threatened many more people than those who actually turned out to be directly affected by it. For a long time there was much uncertainty as to the extent of radiation contamination and therefore we did not know how many people were being directly affected by the accident. Moreover, there are some 54 nuclear reactors in Japan, and a similar accident, with perhaps even more dramatic consequences, could happen anywhere in this earthquake prone country, especially in view of the numerous failures of the operator and of the nuclear regulatory agency. Hence contributing to making sure this never happens again is a fundamental and urgent problem that concerns everyone in Japan (and even outside of Japan depending on the importance of the accident). This is the task to which we, the people of Fukushima, wish to contribute, said Governor Sato.

Reciprocity so understood requires, or entails, a community of destiny of some sort. Governor Sato rightly assumes that what has happened at the Fukushima Daiichi Nuclear Plant does not concern only the people of Fukushima prefecture, but everyone in Japan, or at least that it should concern them all. "Building a community with the promise not to let similar disasters ever happen

again" means precisely that: it means building a community where all are convinced that such disasters concern them all.

Second, how does Governor Sato propose to reciprocate? What does he propose to do in return? Contribute to building a community where similar disasters will never happen again, is the answer. Yet, how exactly is that *reciprocating* for special help that has been received in time of dire need? Anyone in Japan can do that. You don't have to have been a victim of the accident to consider this to be an urgent and important task. You don't need to have received help to commit yourself to this. Even foreigners can feel concerned and contribute. What can the people of Fukushima, and all those who were directly affected by the nuclear accident, bring to this common task that is different from what each and everyone can? That is to say, just has they received at the time of their distress something which others in Japan did not receive, what are the people who suffered from this disaster giving back to the rest of Japan, which it could not have otherwise and that constitutes their particular response for the help they received? What are they doing that is special, that is over and above what everyone should be doing? The answer is that their particular contribution to this urgent task – the 'something' which Japan and the rest of the world could not have without them – is that *they have been the victims of this accident*.

How is being a victim a contribution? How can being a victim be a form of reciprocation, are not victims the ones who need help, rather than those who give? However, in this case the answer seems evident. Without them, without the victims nobody would be saying that we need to build a community where accidental nuclear disasters should never happen again. More precisely, some people could be（and some have been）urging this, but nobody would be（or has been really）listening to them. These nuclear protesters were, and they still would in the absence of an accident that created numerous victims, generally be considered as ill informed paranoid ecologists – of course nuclear energy is safe – and as irresponsible dreamers who imagine that Japan can live without nuclear power. However, all of this has changed, in spite of much resistance and opposition by vested interest, what before was unthinkable, unimaginable, that Japan could in a foreseeable future abandon nuclear power, is today a real option. Yet, without the 150,000 or so victims, and without the fear, without the fact that at some point many more, millions felt themselves as potential victims of this accident it is unlikely that this would be the case. The victims' contribution is that they have been victims. This gives them, and also extends to everyone in Japan, the authority to say that nuclear energy is extremely dangerous, that both the government and the industry have acted in highly irresponsible ways, and that the repetition of such an event is something against which we need to be protected.

It is not just the accident that is at stake here, but essentially the victims, the large number of people it affected. Previous accidents, even quite dangerous accidents form a nuclear point of view, if they did not touch a sufficient number of people, never really constituted challenges to Japan's reliance on nuclear power. For example, the 1999 Tokaimura criticality accident in which two nuclear technicians died was rapidly forgotten in Japan, even if it was not forgotten by the

international nuclear community. [3] In this, which actually was the second Tokaimura accident, [4] the official report concluded that the immediate cause of the accident was human error; the technicians had not followed some of the prescribed procedures. In consequence, the general public's confidence in the safety of nuclear energy was not importantly shaken. First, because it seemed that if everyone had done what they should have done, nothing would have happened. Second, because the victims were among the very technicians who had taken liberties with the procedures and, in consequence, they were not really seen as 'victims', or if you prefer as 'good enough' victims. They were seen as, at least partially, responsible for their own demise. Finally, because apart from nuclear plant employees, many of whom were irradiated, only a few hundred persons were displaced for a short period of time as a precaution, it therefore seemed that even at the height of the accident "everything was under control". In the Tokaimura case, even though the accident involved a critical reaction, which constitutes an extremely dangerous scenario, because there appeared to be no real, purely innocent victims, the accident had very little influence on Japanese nuclear policy and industry.

The inability of this accident to influence nuclear energy policy in Japan can be seen by the industry and the nuclear regulator's reaction to the official findings of the cause of the accident. The NRC [5] review of the Tokaimura criticality accident, published one year later in 2000, allows us to see how little the lessons learned from this accident were actually heeded in Japan. Its second paragraph begins with the following evaluation of the accident's causes:

> The NRC staff agrees with the Government of Japan's conclusion that the general root causes of the accident were: (1) inadequate regulatory oversight; (2) lack of an appropriate safety culture; and (3) inadequate worker training and qualification. [6]

More than 10 years later all three elements – inadequate regulatory oversight, lack of an appropriate safety culture and inadequate worker training and qualification – were found by the *Fukushima Independent Commission Nuclear Accident Report* as foremost contributors to the disastrous unfolding of the Fukushima accident. It is not that the Japanese nuclear industry and its regulatory body learned nothing from the Tokaimura accident, to the opposite as the NRC reports clearly indicates, but they choose to ignore what they learned. Twelve years later little or nothing had been dome to remedy these problems which had been clearly identified. The origin of the Tokaimura accident was hidden behind the, true, pretext of a human error, just as attempts are made to hide the causes of the Fukushima accident behind the, also true, pretext of a massive earthquake and tsunami. However, this time given the large number of victims this smokescreen has become all but completely transparent.

Being a victim gives an authority not only to the victims themselves, but also to all those who claim to speak in their name, an authority that was clearly lacking before the Fukushima accident happened. The victims of the accident reciprocate for the help they have received to the extent that by being victims they give existence to an authority that makes possible a hitherto impossible common purpose. This is the contribution, which Governor Sato implicitly claims for himself and

for the people of Fukushima as a whole.

It is however, a strange and paradoxical contribution. First, this contribution is unintentional, no one planned and carried out the accident, in order to show how dangerous nuclear energy really is, it just happened. This lack of intentionality is furthermore indispensible in order for "being a victim" to constitute a contribution, in order for it to give rise to an authority. As we have just seen, victims who are responsible for the harm they suffer, individuals to whose intentional actions the accident may be attributed, are not *good victims*. They do not gain an authority, but receive blame. Second this contribution is involuntary. It is beside the point whether one wants or does not want to make this contribution; victims of the Fukushima nuclear accident inevitably bear witness to the danger and fragility of nuclear energy and it seems likely to suppose that in most cases, they would rather not! Finally this is not a contribution which they can make on their own, by themselves. This is true both of *making a contribution towards* making sure this never happens again, and of *making sure* that it does not happen again, neither is in their power, because both depends on how the rest of Japan will react, on the attention others will be ready to give to the plight of the victims, and to the danger to which they bear witness.

In short, their contribution is unintentional, it is involuntary and it is not in their power. Is it a contribution? Can we talk of reciprocity in such a case? I believe that we can, and the way in which we can illustrates the importance of what I called earlier 'a community of destiny'. At first sight there clearly is a tension between being a victim and being part of a community of destiny. Victims, by definition, do not share the same destiny as others, as those who are not victim. Yet, any help provided to them establishes between the victims and those who help, a community of destiny, or re-establishes *the* community of destiny that was broken by the accident, catastrophe, or violence of which they were victims. Not in the sense that this could have happened to anyone of us, but in the sense that those who help are actually saying to the victims "what happened to you, who is a victim, also concerns me, who is not a victim". It is only in consequence of this concern that there can be an "us", such that anyone of "us" could have suffered the same harm as you did. There is a circular relationship here, reciprocity creates or re-creates a community of destiny and the existence of a community of destiny facilitates the exercise of reciprocity.

In order for being a victim to be a contribution and a form of reciprocity we must make good on the promise to build a community in which such disasters will never happen again. To the extent that we do, their being victims was the means, and the price to pay, in order that we shall not be victims of such accidents. That is a real contribution: they became victims in order that we do not. Clearly we owe them something. However, it will be objected that this contribution is purely retroactive. It is only once we will have built this secure community that their having been victims of this accident will constitute a contribution. In the meantime, meanwhile they have contributed nothing; or if you prefer, they have not yet contributed even if it is already in the past that they became victims. It is thus our future that will give to their past the meaning of having been a contribution and that will make the help that we now provide them a form of reciprocity for what

they gave us by being victims. In other words, we project ourselves into the future（a community where such accidents will not happen again）, and, as Jean-Pierre Dupuy argues, we judge or evaluate our present from that future as if it were already the case and as we do this we simultaneously transform the past. [7] The main difference is that Dupuy chooses example of future scenarios which we do not want to happen, catastrophes, while in this case we retroactively change the past by aiming at a future which we desire, a community where such accidents will not happen again.

Strange as this form of reasoning may seem, if making sure that such nuclear accidents are not repeated is the most rational strategy that we can have for our future, then seeing the help we now provide the victims of Fukushima as reciprocity for a debt that we have already contracted towards them is just as rational. It is important to note that making sure such accidents are not repeated in the future is not logically equivalent to abandoning the use of nuclear energy. It may turn out, as I will argue later in this paper, that this is the best way to achieve that goal, but the two claims are not equivalent, the first does not logically entail the second. It follows that though there may be much disagreement concerning the continued use or abandon of nuclear energy, there is little reason why anyone would disagree with the goal of making sure such accidents do not happen in the future. Thus to the extent that we are committed to that goal we have reasons to see the help we provide to victims of Fukushima as a form of reciprocity, for what they have already done for us by becoming victims of this accident.

What makes this claim appear strange is the time inversion that is involved here. It is only our making good a promise in the future that now transforms their being victims into a contribution towards that promise. However, such time inversions are frequent in the adventures of reciprocity. In negative reciprocity, in particular, they constitute to a large extent the norm. By negative reciprocity, I mean violence and the justification of the ill-services we render each other by the ill-services we render to each other, just as positive reciprocity is the justification of the good intentions we have towards each other by the good intentions we have towards each other. This conception of reciprocity is implicit, as Gotoh argues, [8] in Rawls conception of justice and rationality when he writes, for example in *Political Liberalism*:

> Persons are reasonable in one basic aspect when, among equals say, they are ready to propose principles and standards as fair terms of cooperation and to abide by them willingly, given assurances that others will likewise do so. [9]

In a pre-emptive attack either in war or against suspected terrorists, similarly, the action of the（pre-emptive）attacker is 'rational', 'given assurances' of what the suspects or enemy *will do in the future*. This future is what justifies that which we now do, and which aims at preventing them from doing in the future that which now justifies our preventing them. In the case of a pre-emptive strike we use a possible future to act now in order to prevent that future from happening. In the argument concerning the victims of the Fukushima accident presented above, we use a possible future to bring about a past in order to make that future happen. That is to say, considering that being

victims of the nuclear accident is a contribution which requires reciprocity on our part is a step in bringing about the goal towards which it is a contribution: a future community where such accidents will not happen again. The reason why I insist on the proximity between these two forms of reasoning is that while most people are easily convinced by the argument in the case of negative reciprocity, and not bothered by the time inversion it implies, on average most of us are a lot more skeptical when it comes to positive reciprocity. Yet the two arguments are formally closely similar. The main difference is that in the positive case it is us who have to bring about the future which we seek to establish while in the negative case it is the other who can produce the future which we fear.

Nuclear risk

Whether or not "building a community where such accidents will not happen again" is for us the most rational goal to pursue depends on how we evaluate the risk of such accidents, and also on how we conceive the risks involved. The two are different. Ulrich Beck in *Risk Society* conceives risk, or more precisely the generalization of risk as a characteristic of advanced capitalist societies, which goes together with an increase in, and transformation of, individualism, at the same time as with the progressive dissolution of social classes.[10] Clearly risk understood in that sense is quite different from what it is when risk is conceived, as it usually is, as equivalent to the probability of the occurrence of an event（earthquake, accident, etc.）and the extent of damage that it may cause. Not that such a measure is meaningless, but even in the cases when it can be accurate, it fails to capture the societal dimension of risk, which is fundamental in the project of building a community with the promise that such accidents will not happen again.

Risk, Beck argues, is a characteristic of advanced capitalist societies. These societies produce and unequally distribute risks, just as they produce and unequally distribute wealth. Risk in the modern world is everywhere, in the food we eat, the air we breathe, the clothes we wear, on roads, in trains, on airplanes, in everything. Risk also pervades our social environment. Especially through the rise of out-sourcing and temporary employment the labor market has become much more insecure than it was not so long ago. Risk is a normal by-product of advanced capitalism, argues Beck, and one which progressively transforms the society that spontaneously produces it. This said, it is not necessary to accept all of Beck's theory of the risk society to agree that he has succeeded in identifying some very important aspects of modern risks.

First risks constitute a very particular form of dangers. Consider physical conflicts between persons or mountain climbing, the dangers inherent in such activities are evident not only to the agents involved, but also to onlookers. The dangers, and the opportunities, present are for the most part directly visible to the agents. They constitute an important part of the basis on which antagonists, or alpinists, construe and carry out their action. Risks, to the opposite, are generally not visible in that way. Not only is it the case that when we are exposed to different risks we are

often unaware of the danger involved, but even when we are aware that some danger is present we have little means to evaluate it directly. While in many dangerous situations, being in the situation is in itself sufficient to become aware that it is dangerous, this is not the case with many or most risks. Agents exposed to risks have to be informed by others, experts of various kinds, of the risks to which they are exposed. Risks are not self-evident, generally one cannot know just by doing this or that action, whether or not one has been exposed to a risk and the extent of the danger involved. In order to know that we must rely on experts, and experts often disagree with one another. Unlike many other dangers, risks are not cognitively transparent from a subjective, or rather from a first person's point of view.

This was painfully the case during the Fukushima accident. Radiation has neither odor nor color, nor does it make any particular sound. People did not know, and could not know by themselves whether they had been exposed to radiation or not, to what extent they had been exposed, and which measures to take in order to protect themselves. They were in consequence deprived of the conditions which allow agents to act rationally and autonomously, conditions which most societal theories – in economics, politics or ethics – simply take for granted. Agents had to depend on others, on numerous government agencies（which often gave contradictory information）, on information from international agencies, on the media, and on word of mouth to find out what was best for them to do.

Risks, on the one hand, make us all dependent on the specialized knowledge of various experts, and in this way, dispossess us of the autonomy to act. On the other hand, risks create a market for this knowledge. This market constitutes opportunities for experts whose knowledge empowers us, but in a different way. While evident shared dangers（that is dangers that are cognitively transparent from the first person's point of view）promote solidarity – we are all in this together – risks send everyone back to his or her own evaluation based on information that is hard to interpret and whose value is difficult to measure. In consequence, risks promote individual rather than group response. They do not tend to encourage, but tend to dissolve solidarity. An extreme example of the dissociating effect of risks is that of Takamistu Shiga who decided to remain in the exclusion zone after all other inhabitants had left Nagadoro village, while his daughter who lived 200 hundred kilometers away in Tokyo decided to evacuate to New Zealand![11] It is hard to judge that either one of these two radically different reactions was irrational. Agents decide individually on the basis of information that is generally incomplete, that comes from a variety of sources whose reliability is extremely difficult to evaluate and their decision takes into account their own personal situation: for example age, whether or not they are parents of young children, type of work, etc.

Thus, risks are socialized in a radically different manner than many other dangers are. This, of course is not only true of risks that arise from nuclear accidents, but also of all risks, for example, those related to environmental pollution, food safety, smoking or lack of exercise. The cognitive opacity of risks from the first person's point of view favors individual responses because it makes us

dependent on others who do not necessarily share the same risk as us. Shared dangers, to the opposite, promote solidarity because they imply identical situation relative to the danger and thus favor common evaluation of the situation. In Fukushima the shared hardship caused by the forced evacuation promoted solidarity, but as time went by, as the issue became for everyone more and more a question of managing the new risks created by the accident, solidarity was progressively replaced by individual responses.[12)]

Calculating risk as the probability of occurrence of an event and the potential damage it can cause tends to hide another important dimension of risk. This approach implicitly conceptualizes risk as a lack of knowledge, concerning whether or not, or when, the event will take place, and what its consequences will be. A lack of knowledge that will be lifted, should the event happen, that is to say, once the event takes place the risk disappears. Yet, as the Fukushima accident shows, this is not what happens. What the meltdown, explosions and the measures taken to keep the disaster under control have done is not to make the risks disappear, but to institutionalize them.

The risks may have changed, but they did not disappear and it would be false, rather than simply misleading, to consider that present risks as unrelated with those that existed before the accident. Now that we have the feeling that we have tamed the danger a little we are entering into a second phase, one where we measure and evaluate the risks created by the accident and start deciding which ones constitute "acceptable risks" and which ones do not. Hence we begin to plan which regions will become inhabitable again, and when, and which regions perhaps will never be inhabitable again. The same applies to the food from prefectures affected by radioactive fallout. The risks created by the accident do not disappear; they simply become integrated in the general calculus and management of risks that characterizes life in advanced modern societies.

This permanence is a fundamental aspect of the risk involved in similar accidents. The Fukushima nuclear accident has permanently changed the landscape of Japan, just as Chernobyl permanently changed the landscape of Ukraine and Belarus. It is still too early to say how much it has, but that it has, is certain. The present and the previous governments have engaged in a policy of decontamination of the most gravely touched or most sensitive (i.e. school yards) areas. The goal is to make it possible for people to return home and to live a normal life again. However, it seems that the number of people who say they want to return is not so large, less than 50% in some of the cases that were studied, and it is certain that even less will ever return.[13)] From either an economic, social or technical point of view, it is far from clear that the decontamination of such a large area as planned constitutes a very good policy choice. It is extremely expensive, the money could be used to help refugees start a new life elsewhere and even once it will be finished, the decontamination will only be partial and spotty; many areas, especially mountains and woodlands, will inevitably remain off limits.[14)] This policy has only one evident advantage: to the extent that it succeeds it will be *as if nothing had happened*. Its only advantage in other words is political. It asserts our ability to successfully deal with such accidents.

That however is the illusion. There are many types of nuclear accidents, some like the 1999

Tokaimura accident, mentioned earlier, can be erased by time, as can many, but not all, industrial accidents, environmental disasters[15], or natural catastrophes. In this case however, the risks are here to stay, and the issue now is that of managing those risks. Just as people who live in French Guadeloupe and Martinique must avoid eating fresh water fish for *the next few centuries* because of chlordecone pollution,[16] the Fukushima accident has created permanent risks, risks that will not disappear, and that can at best only be managed. What remains hidden in standard risk assessment procedure is the process through which risks are made permanent, and become lasting features of our social and natural environment. The Fukushima nuclear accident belongs to a particular type of accident, where risks do not disappear once the accident has happened, but to the contrary where the accidents itself creates new, permanent risks. By permanent risks, I mean risks that do not disappear because the event of which they are the risk has happened.

Let me explain. Suppose an old bridge on a river threatens to collapse under heavy traffic. We can measure the risk it presents, that is, the probability that it will collapse and the damage and destruction this would create. On the basis of this we can decide either to close the bridge or perhaps to regulate traffic on the bridge. If one day the bridge does collapse, the non-existent bridge will likely inconvenience a lot of people, but it will not present any risk to anyone. In this case, when the event happens, the risk disappears. Now if you are living in an area that was irradiated by the Fukushima nuclear accident we can also very approximately – that is not very precisely – calculate the risk that you will develop cancer.[17] If you do develop cancer, then the risk for you is zero now that you already have cancer. However, for everyone else the risk remains the same as before. The difference is that in the first case what we measure is the probability of an impersonal event, the bridge collapsing. In the second case what we measure is the probability of a personal event, your developing cancer. In the first case the event's happening erases the risk for everyone.[18] In the second case, it abolishes the risk *for you only*, the risk remains the same for everyone else,[19] and the fact that the reason why there is now no risk for you is that you have cancer, makes everyone else more aware of, and probably more afraid of, the risk. In spite of the apparent similarity due to the fact that we measure risk in the same way in both cases, we are dealing with radically different types of situations: which could be termed hazards in the first case and risks in the second.

The permanence of risks raises the question of justice across generations – to what extent are we at liberty to create hardships for our descendants? What responsibility do we have towards future generations when we create risks that remain as permanent features of their environment? These are difficult questions on which there is an extensive technical literature, especially in ethics and in economics. In this case however, I think that there is a more straightforward way of tackling the issue. In this case, the permanence of the risk involved creates a different situation which can be illustrated by the following question: What percentage of the territory of Japan, are we ready to accept can become permanently uninhabitable as a tradeoff for the use of nuclear energy?

This question is neither theoretical, nor is it excessively dramatic in view of what has

happened in Chernobyl and Fukushima, and it is about the present rather than the future, because it is not only about the negative consequences of some benefits we enjoy and of which they are excluded, but about a shared community of destiny. In fact, this question is presently being answered by the government's decontamination policy. The answer put forward by this policy that aims at turning back the clock, at making as if nothing had happened, is *none whatsoever*, we cannot accept that any, even the smallest portion of the territory of Japan could become uninhabitable because of a nuclear accident. This is an excellent answer, but it seems highly unlikely that this will turn out to be the case. As mentioned earlier, even if the decontamination policy does to some extent succeed, the question will remain because the risks created by the accident will not disappear and will need to be managed.

The permanence of risk means the risk of permanent damage, damage that can neither be erased nor remedied, not only in the foreseeable future, but for a time duration which is longer than human life by orders of magnitude. This discrepancy in the time frames involved is fundamental. It is part of what justifies, of what makes rational the time inversion implied in viewing "being a victim of this accident" as a contribution that requires reciprocity on our part. If the risk had disappeared with the event, there would be less reason to see the victims' plight as a contribution to our shared future. The permanence of risk creates a community of destiny between not only the victims of Fukushima and us, but also with our descendants.

Responsibility

When reading either the official government report[20], or various articles[21] and books[22] on the Fukushima accident there is a near universal agreement that the causes of the accident were neither the earthquake and tsunami that triggered it, nor a human mistake, but social: Failure of regulatory oversight, lack of an appropriate security culture, inadequate employee training and qualification. In short, the issues were management and governance.[23] In consequence, it seems clear that there is a collective social responsibility for the accident, the damages and suffering it caused. Steps were taken to remedy the problem, among other things a new regulatory body was created, more stringent safety measures were issued and inspection of all existing nuclear plants ordered. However, what caused the Fukushima nuclear accident is not a technical problem that can be solved once and for all, but an issue that must be addressed anew every day. Governance and management can be enhanced and facilitated by intelligent rules and regulations, but the problems and difficulties inherent to issues of governance and management can never be resolved for good. Questions of governance are never over; like risks they are permanent.

Nuclear reactor technology involves highly dangerous materials which will remain dangerous not only for hundreds or thousands of years, but for hundreds of thousands or even millions of years.[24] This is especially true of nuclear waste; it is also true in the case of accident, like the ones that happened in Chernobyl and Fukushima, that produce a large amount of dangerous waste. The

decommissioning of the Chernobyl nuclear plant is expected to be finished by 2064. For memory the accident happened in 1987, that is to say we expect the decommissioning to be finished a little less than 80 years after the accident. However, even then it will not be over. We are presently building a new sarcophagus around the abandoned reactor. It is an impressive, immense metallic structure that will surround the existing sarcophagus. This remarkable architectural and technical achievement, nonetheless will not solve the problem, it will simply bury and contain it. It will limit the radiation contamination emitted by more than 2000 tons of radioactive material that will remain radioactive longer than the human species has existed to this date.

That is at the root of the problem with nuclear technology, the time differential, between not only the life of an individual, but that of nations and societies and the technological process involved. More precisely that constitutes the one half of the problem. The second half of the problem comes from the fact that at this point we do not have the technology to deal with a nuclear meltdown. We simply do not know how to do it. The limits of our technology and knowledge are painfully evident in the efforts at cleaning up, and at keeping everything under control, at the Fukushima Daiichi nuclear plant. We can hope that our technology will become more advanced and that our knowledge will progress. Both certainly will, but we cannot know in advance what this progress will be, what new technological abilities we will gain, and we cannot count on this unknown future to decide on a rational course of action. If we had the adequate technology, then we could properly close, terminate, in a sense erase a major nuclear accident. In that case, our technology would in effect cancel the time differential between the duration of human life and societies and the technological process we set in motion, because we would be in a position to prevent the process from escaping us, or able to 're-capture' it should it escape us. As it is however, we cannot, and will not in the foreseeable future be able to, do this.

What this means is that nuclear technology and nuclear wastes will continue to present, while nuclear accidents will periodically create permanent risks that will have to be dealt with through governance, through institutional and political means. The United States legislation requires that nuclear waste be isolated from the biosphere for a million years.[25] This requirement would perhaps make sense if we had a technical solution to the problem, if for example we could bury the waste very deep in very stable ground that is unlikely to move for the next million years, and if we could make the cache impenetrable. However, given that all we have are institutional, rather than technical solutions what can this strange legal requirement mean? How can we even imagine that it can be satisfied in the absence of a technical solution? Will the United States or Japan still exist in one million years? Will there even be any creatures like us on the surface of this planet in one million years?

More to the point, institutional solutions are solutions which have to be repeated every day, that can fail at any time. They need to be reviewed, reformed and adapted regularly, and they inevitably will be, reviewed, reformed and adapted, but not necessarily for the best. We have no historical example of institutions that have lasted for more than a few thousands years, and always

during those centuries they experienced major upheavals, moments of near collapse, periods of inefficiency and profound transformations. Hence it is inevitable that at some time these institutional solutions will fail[26] and given that the risks involved in radiation are not in most cases cognitively transparent from the first person's point of view we have no idea of the extent of damage such failures may cause.

Nuclear decay is a very stable slow process that is insensitive to the contingencies that characterize institutional solutions. Whether we sleep, fight among ourselves, celebrate victories or try to simplify procedures, as did the technicians at the Tokaimura plant, print security manuals with incomplete and inaccurate information, as was the case at Fukushima, whether we grow excessively confident in our technical ability and in the safety of our technology, decide to outsource technically sensitive positions in order to reduce expenses, nuclear decay inevitably stubbornly continues. It is not that institutional solutions are fragile, in fact they can be extremely robust and reliable, but even if we could imagine them to last a million years, they are subject to variations and contingencies to which nuclear decay is totally indifferent: wars, economic crises, social upheavals, cultural changes, religious innovations, global warming, in short all of the uncertainties that characterize human life.

In consequence, we are not simply handing down to our descendants a problem which we cannot resolve, we are handing them a problem which they may never be able to solve, which they will need to permanently manage with institutional solutions, just as we do, solutions that will inevitably fail once in a while and these failures will create new more extensive permanent risks, dangerous situations that are not cognitively transparent from the first person's point of view. We are not simply bestowing hardships upon our descendants, tipping the balance of cost and benefits in our own advantage; we are laying traps for them to fall in.

Notes:

1）An earlier version of this text was presented at the International Conference "Justice and Catastrophe: Risk, Responsibility and Reciprocity" held at Ritsumeikan University, Kyoto on March 19 & 20, 2014.

2）*The Fukushima Nuclear Accident Independent Commission Report, Executive Summary*, National Diet of Japan, p. 81.

3）Constance Perin describes the Tokaimura accident as the nuclear industry's third shock, following first the Three Miles Island and then the Chernobyl accidents, indicating that the accident was taken quite seriously by the international atomic energy community. C. Perrin, *Shouldering Risks. The Culture of Control in the Nuclear Power Industry*（Princeton University Press, 2005）, p. 262.

4）There was a first Tokaimura accident in 1997 at the Donen plant where about 40 employees were exposed to radiation.

5）The NRC is the United States Government Nuclear Regulatory Commission that is responsible for the regulation of the nuclear energy industry.

6）*NRC Review of the Tokai-Mura Criticality Accident*, April 2000, Division of Fuel Cycle Safety and Safeguards, US Nuclear Regulatory Commission, p. 2.

7）J.-P. Dupuy, *Pour un catastrophisme éclairé. Quand l'impossible devient certain*,（Paris : Seuil, 2002）et

La marque du sacré（Paris : carnets nord, 2008）.

8）R. Gotoh, "Justice and public reciprocity" in Gotoh R. & P. Dumouchel, eds., *Against Injustice. The New Economics of Amartya Sen*（Cambridge University Press, 2009）, pp. 140-160.

9）J. Rawls, *Political Liberalism*（New York : Columbia University Press, 1993）, p. 49.

10）U. Beck, *Risk Society. Towards a New Modernity*, M. Ritter, tr.,（London: Sage Publications, 1992）.

11）T. Gill, "This Spoiled Soil: People and Community in an Irradiated Village in Fukushima Prefecture" in Gill, T., Steger, B. & D. H. Slater, eds. *Japan copes with calamity. Ethnographies of the Earthquake, Tsunami and Nuclear Disasters of March 2011*,（Bern: Peter Lang, 2013）, pp. 217-218.

12）T. Gill, "This Spoiled Soil", pp. 217-230.

13）T. Gill, "This Spoiled Soil..", pp. 220-233; also D. Pavaz, "Can Japan revive its nuclear ghost towns?" in *Aljazeera*, consulted on March 7, 2014 at http://www.aljazeera.com/indepth/features/2014/03/can-japan-revive-nuclear-ghost-towns-2014351401952134.html

14）See, *Japan copes with calamity*, p. 157 and pp. 220-232.

15）For example, the chlordecone pesticide pollution in French Martinique and Guadeloupe is expected to remain in the food chain for about seven hundred more years. The risk has become permanent and people living there, must take particular precautions when preparing local grown vegetables and avoid fresh water fish.

16）See note 12.

17）In fact it even is a little bit trickier than that, since the risk created by the nuclear accident is not equivalent to the probability that you will develop cancer, but to the increased probability that you will. The risk created by the accident corresponds to the difference in probability rather than to the probability itself.

18）Note that it cannot be the case that the bridge collapses for you only, even if you happen to be the only person on the bridge when it collapses. The bridge necessarily collapses for everyone simultaneously. To the opposite, your getting cancer, as an event is completely independent of anyone else getting or not getting cancer. This happens only for you.

19）It is true that if the event touches many people, if statistically numerous people develop cancer that will change our evaluation of the risk, note however that it will not make the risk disappear. Depending on how many people do develop cancer over time the risk will be either heightened or reduced, but the only thing that can make the risk disappear is if the event does not happen at all. In this case whenever the event of which the risk is a risk happens the risk does not disappear but is confirmed.

20）*The Fukushima Nuclear Accident Independent Commission Report, Executive Summary*, National Diet of Japan, 2012.

21）For example, M. Aoki & G. Rothwell, "A comparative institutional analysis of the Fukushima nuclear disaster: Lessons and policy implications" in *Energy Policy* 53（2013）240-47; M. Baba, "Fukushima accident: What happened?" in *Energy Policy* 55（2013）17-21; Y. Funabashi & K. Kitazawa, "Fukushima review: A complex disaster, a disastrous response" in *Bulletin of Atomic Scientists*（March, 2012）, Sage Publication, accessible at http://bos.sagepub.com ; A. Omoto, "The accident at TEPCO's Fukushima-Daiichi Nuclear Power Station: What went wrong and what lessons are universal?" in *Nuclear Instrument and Methods in Physic Research A* 731（2013）3-7; T.N. Srinivasan & T.S. Gopi Rethinaraj, "Fukushima and thereafter: Reassessment of risk of nuclear power" in *Energy Policy* 52（2013）726-36; Q. Wang & X. Chen, "Regulatory Failures for Nuclear Safety – the bad example of Japan – implications for the rest of the world" in *Renewable and Sustainable Energy Reviews* 16（2013）2610-2617.

22）For example, R. Broinowski, *Fallout from Fukushima*,（Melbourne: Scribe, 2012）or M. A. Schreurs & F. Yoshida eds., *Fukushima A Political Economic Analysis of a Nuclear Disaster*（Hokkaido University Press,

2013).

23) The recent fire that shutdown for nearly a month the Waste Isolation Pilot Plant in New Mexico which contains American defense nuclear waste, was also caused by issues of management and governance according to the report by the US Energy department Accident Investigation Board. See BBC News http://www.bbc.com/news/world-us-canada-26587349? Accessed March, 15, 2014.

24) For example the United States legislation concerning nuclear waste requires that it be isolated from the biosphere for one million years! See B. Taebi, S. Roeser & I. van de Poel, "The Ethics of Nuclear Power: Social experiments, intergenerational justice and emotions", p. 204.

25) See note 24.

26) See for example, the accident reported in note 23 and the conclusions of the report by the US Energy department Accident Investigation Board.