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## **Uncertainty and the Precautionary Principle concerning Problems about Radiation Exposure**

*–A Thought on Life and Death in a Disaster–*

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My aim in this article is to raise a question of what kind of harm we Japanese actually suffered from radiation caused by the serious nuclear power plants accident in Fukushima happening as a result of the 3.11 disaster that struck Japan in 2011, and examine the significance of applying the precautionary principle to this particular case of 3.11. I only focus upon problems about how exposure to radiation in this case could affect human health, completely independent of the complicated (sometimes even political) issue of whether we should keep the nuclear power plants system or not.

There are three possible answers to that question of what kind of harm we Japanese actually suffered from radiation after the 3.11. First, the very fact that radioactive matters are emitted is nothing but harm we suffered. However, we have to notice the conceptual difference between accident and harm. Accidents could happen even if no human being exists there, whereas the concept of harm must be related to humans. An unmanned space satellite could be involved in an accident, but it gives no direct harm to anybody. In this respect the emission itself of radioactive matters is definitely just an accident, which shouldn't be regarded as harm. Rather it must be the cause of harm. Second, many people are actually exposed to additional doses of radiation by nuclear plants accident in comparison to normal situation, so this additional exposure to radiation must be the very harm we suffer. This answer sounds reasonable, because it is scientifically true that radiation like  $\alpha$ -ray,  $\beta$ -ray, or  $\gamma$ -ray physically hits our body and ionizes our body's molecules. That is to say, radiation somehow changes biological conditions of our physical body. Then, can we say that this is the very core of harm in this case? Probably it is hard to say so. Some points should be noticed. Initially we

should recognize, as a matter of fact, that doses of radiation exposure, internally and externally, even in the case of people living in Fukushima, is quite low; more than 90% of them externally suffered less than 5mSv of radiation in total, and internally 0.16mSv at maximum, according to publicly announced information. Should we judge that this low dose of radiation exposure will seriously affect our human body to cause more cancer death or leukemia death than usual? Considering the data about the history of human's radiation exposure, it is not necessary to judge so. In this context, we also have to confirm that the problem we should focus upon is not whether we are exposed to additional radiation or not, but how the radiation exposure affects our health. It is one thing to be exposed to radiation, but it is another thing to have cancer to die because of that additional radiation exposure. Furthermore, we should recognize that radiation exposure is not unusual in our normal lives. The world is always full of radiation, so that it is impossible for us to suffer no radiation exposure at all. Additional radiation exposure is not unusual either, particularly to the extent of doses corresponding to the Fukushima's case. We are exposed to additional radiation, even apart from radiation exposure in medicine, for instance, in climbing mountains, using gas-mantles at camping, or drinking hot spring, and so on.

The third possible answer is that; many people evacuated from areas close to the Fukushima nuclear power plants have been already involved in some kinds of serious hardship; many elderly people died in the process of evacuation, more people committed suicide than usual in the temporary shelters, some families were evacuated separately from their family members, agricultural products in Fukushima were hated despite being certificated to be not dangerous, children who were evacuated from Fukushima to other prefectures were discriminated, and so on. It is absolutely true that this is the real harm people have actually suffered, so it is strongly required in many senses to resolve the harm as quickly as possible. However, what should be confirmed here is the clear cut distinction between two kinds of harm, namely, the harm by radiation exposure and the harm by avoiding radiation exposure. Obviously harm accompanied by the process of evacuation must be classified as the harm by avoiding radiation exposure rather than that by radiation exposure itself. However, my original question, which seems to be what people are most seriously anxious about, is "what kind of harm we Japanese actually suffered from radiation?" In this respect, harm accompanied by the process of evacuation couldn't be an appropriate answer to my question. Thus, we fall into bewilderment.

In addition, we must admit that there are intrinsic uncertainties about this issue. First of all, there is uncertainty with regard to how to measure doses of radiation

exposure. It is unavoidable for something guessed to be included. Furthermore, sievert as a unit of radiation exposure is essentially uncertain, as the unit is empirically established so that it is changeable as science progresses. Moreover, a causal relation between low doses of radiation exposure and cancer death, which is the very crux of the matter, is intrinsically probabilistic and uncertain. At least, the causation is far from being necessary without exceptions.

Lastly, I explore the significance of the strategy of applying the precautionary principle (PR) to the case of Fukushima nuclear power plants accident. Many people insisted this strategy just after the accident. Generally, there are two kinds of PR; the strong one and the weak one. In a word, the strong PR asserts that everything should be avoided if the thing has non-zero probability to cause troubles, whereas the weak one claims that, as to any threats of irreversible damage, lack of full scientific certainty should not be used as an excuse to postponing cost effective measure to prevent damage. The strong PR is eventually nonsensical, as, adopting that, we mustn't try any scientific developments. The weak PR is also hard to accept instantly, because we must consider countervailing risks which is caused by applying the weak PR to avoid radiation exposure (that is called target risks in contrast to countervailing risks). Those hardships accompanied by evacuation that I mentioned above are nothing but a representation of countervailing risks in this case. Also it is doubtful whether the Fukushima accident should be regarded as irreversible damage or not.

In any case, we shouldn't require zero-risks, as that requirement rather causes other countervailing risks that threaten human lives. Phenomena of risks are somehow similar to the principle of the conservation of energy. If risks in one part were reduced, risks in other parts could be increased. We should always take those conditions into account to make better decisions. That's our life. We must recognize that we are always facing death, as Japanese samurais were once taught. That attitude leads to a noble way of living.

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