# Risk, Precaution, and Causation

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## 1. The notion of risk

We are always exposed to harm, for it is utterly impossible to enjoy perfect safety. During the pandemic, we received vaccines, knowing that we might suffer from side effects. Still, we did so because we could expect inoculation from the virus. Besides the pandemic, when, say, we are walking on the street, we are exposed to the danger of being hit by a car or falling victim to some random act of violence. Even when we are quietly reading a book in the library, there is still the possibility of a massive earthquake, and especially so in some countries like Japan. Considerations of this kind must make us realize that we are living, strictly speaking, in a dangerous world, one where we do not know, in any exact sense, what will happen next.

Many philosophers discuss this point by highlighting the fatal difficulty of making perfectly accurate predictions about the future. The problem lies in the intrinsic difference between the past and the future. For example, David Hume once clearly described this difference in the context of his arguments about our causal inferences based upon past experience.

> These two propositions are far from being the same, *I have found that such an object has always been attended with such an effect*, and *I foresee, that other objects, which are, in appearance, similar, will be attended with similar effects*. (Hume 1999, p.114)

Hume's insight strikes one as truly honest and philosophically precise. The past and the future, undoubtedly, are so ontologically heterogeneous that, strictly speaking, past events could never play the role of guaranteeing predictions of future events. The future is intrinsically uncertain, philosophically speaking.

Nevertheless, in our ordinary lives, we care little for such purely metaphysical heterogeny. Of course, this attitude should be judged as groundless from a

philosophical point of view. While it is true that this attitude has enabled successful human life in the past, theoretically speaking, we could say its success is simply accidental. Such an assessment might not be so extravagant, given that the history of human science is extremely short compared to the history of the universe. Our data must be understood, from this perspective, to be intrinsically limited. I am not certain of how we could explain our ordinary, optimistic attitude toward extrapolation (which exceeds our authority) despite its obvious, theoretical limitations. I can only surmise that one could explain it from an evolutionary point of view. In that sense, Hume's strategy of appealing to the function of our imagination or to belief seems to become reasonable.

Yet, even apart from the discussions of the philosophers, we human beings have not completely forgot our uncertainty about the future. Noteworthy is that such uncertainty in our daily lives does not lead directly to terror. How, then, do we face this uncertainty in a way compatible with such feelings to the contrary (i.e., feeling not too scared of the uncertainty)? We find recourse out of the sharp dichotomy between 'certainty' and 'uncertainty' in probability, or the statistical way of thinking, which offers a way of assessing uncertainty in numerical degrees. Indeed, this idea was crucial, enabling us to spend our lives as safely and comfortably as possible and to distinguish among uncertainties those things highly likely from those things unlikely, at least as far as our experience and feeling ('belief' in a Humean terminology) are concerned. That is to say, through probability and statistical thinking, we human beings, to a certain extent and not perfectly, have achieved a reasonable way of surviving this uncertain world.

Furthermore, where uncertainty seriously matters is where we might be somehow harmed. Thus, we have established how to make decisions about our actions or our social strategies, considering both numerical values of probabilities and severity of harm. That is to say, the notion of risk was invented.

According to Niklas Möller, the notion of risk has been variously understood, but recently defined as follows:

> Risk = the statistical *expectation value* of unwanted events which may or may not occur. (Möller 2012, p.58)

 

> The notion of expected value as such dates from the early development of probability theory in the seventeenth and eighteenth centuries, its application in the risk context is fairly new. It became common after the influential Rasmussen Report of 1975 and is now the standard definition of "risk" in risk analysis. The expectation value is the probability-weighted sum of the severity of harm. It measures the *magnitude* of the risk as the combination of two factors, the probability of an unwanted event, and its severity. It supplies an overtly *quantitative* sense of risk that is used both to compare risks, and to give a single magnitude of risk. (Möller 2012, p.59)

Risk, then, is notated as follows (where *e* stands for a particular relevant event):

$$\text{Risk}\,(e) = \text{probability}\,(e) \times \text{severity of harm}\,(e)$$

We can thereby make (practical, political, medical, etc.) decisions by taking into account the risks presented by each option considered. It is true that, exactly speaking, notions of probability and severity face some theoretical difficulties in precisely giving numerical values, but there is no denying that the notion of risk has supplied a quite useful tool to assist our decision-making.

## 2. Cost benefit analysis and decision making

Undoubtedly, risk seriously matters in our society. In both public and personal matters, risks are considered whenever we make decisions that could bring about some harm. Traffic systems serve as typical examples in which risks seriously matter. (Vaccination, in the medical context, could too.) For example, about 3,000 people are killed every year by car accidents in Japan. There are many possible causes: insufficient education on traffic safety, bad driving etiquette, traditional crossroad intersections, a shortage of street mirrors, the usual construction of brakes and accelerators, and so on. It is not so difficult to collect statistical data with regard to the correlations between those possible causes and the death rates of car accidents by applying, for instance, randomized controlled trials, and calculate each element's probability of resulting in

accidents if we adopt the frequency interpretation of probability. In this sense, as far as car accidents are concerned, we could quite easily come up with some effective measures to decrease the death rates. Those measures might include automatic emergency braking, which has recently been partially implemented.

In the case of car accidents, we find a situation where we can clearly identify a specific harm (i.e., death)[1] and assess the probability of the harm occurring. Thus, we could prevent this harm by considering assessments of the costs and probabilities involved in each measure. I have just taken the example of car accidents, but other problems, such as those related to crime rates, natural disasters, or environmental problems, could be treated in the same way, so long as we could make assessments of the related probabilities and costs. In any case, this line of arguments basically presupposes a kind of scientific or statistical investigation of past data.

When we make decisions in accordance with this line of argument, the costs of a given measure must be taken into account as crucial factors. As the traditional slogan goes: 'ought implies can'. In a financial sense, policies that are prohibitively expensive simply cannot be carried out. We have no Mallet of Fortune. Moreover, the notion of "cost" must be interpreted in a broader way that includes issues of human health as well as financial issues. It is utterly unjustifiable to achieve safety at the cost of the health of particular people. Thus, while it is true that we could solve the problem of car accidents by legally abolishing the use of cars altogether, under such a policy, some who need cars in urgent cases, like sudden illness, would have to be sacrificed, to say nothing of the many other conceivable negative side-effects such a policy would entail. For such reasons, it is morally unjustifiable to completely abolish the use of cars in our present societies.

Naturally, these arguments can be connected with what is called "cost-benefit analysis" (CBA) in economics and decision theory. According to Lewens, cost-benefit analysis is expressed as Risk Cost-Benefit Analysis (RCBA) and defined as "a method

[1] There is, of course, some controversy as to whether death is harmful or not. As is well known, Epicurus once argued that death is neither harmful nor beneficial by pointing out that, by definition, we would have no consciousness when we die, and so we would feel neither harm nor benefits in death. Indeed, this Epicurean idea may be at work in discussions on the problem of euthanasia, since its supporters seem to accept that we will escape from harm by dying. On this deeply metaphysical debate, Fischer (1993) and Warren (2004), for example, are worth studying.

 

which uses money as a common currency for measuring the value of consequences of very different kinds. RCBA does this by asking how much people would be willing to pay to have (or to avoid) those consequences. If I would be willing to pay £10 for a slightly better cycle helmet, but £1000,000 to own a Monet, this suggests that in some sense I value owning a Monet far more than I value a small increase in safety on my bike" (Lewens 2007, p.5). This idea seems to be similar to, for example, a classical idea, of which Frank Ramsey once proposed a refinement, on how to give numerical value of subjective probability (or degree of belief) in terms of thought experiments of betting (See Ramsey 1990, chap. 4).

## 3. Preventive principle

Social or political decisions based on notions of risk, cost, and benefit are often made in a way compatible with what is called the "Preventive Principle" (PVP), particularly in cases where some serious harm would probably happen unless some measures against that harm were implemented. Generally speaking, the Preventive Principle (also called the Prevention Principle) is understood to be clearly proposed in the Stockholm Declaration that was made in 1972.

The Stockholm Declaration (SD), which includes 7 proclaims and 26 principles, begins with this sentence[2]:

> The United Nations Conference on the Human Environment, having met at Stockholm from 5 to 16 June 1972, having considered the need for a common outlook and for common principles to inspire and guide the peoples of the world in the preservation and enhancement of the human environment. (Sohn 1973, p.434)

SD, then, clearly focuses on problems concerning the environment, which we are, of course, still discussing, now in terms of 'global warming'. In this sense, SD could be understood as an early stage of what would lead to the present SDGs, particularly goal 13 on "climate action".

What I notice in particular in SD is principle 18, which says:

[2] I refer to SD by relying on L. B. Sohn's detailed commentary paper on SD.

> Science and technology, as part of their contribution to economic and social development, must be applied to the identification, avoidance and control of environmental risks and the solution of environmental problems and for the common good of mankind. (Sohn 1973, p.434)

As this remark shows, SD seriously considers science, technology, and the notion of risk. That is to say, SD claims that we should progress science and technology to cope with environmental problems while taking into account the risks of both climate changes and our possible measures against them. This strategy is declared again in principle 20:

> Scientific research and development in the context of environmental problems, both national and multinational, must be promoted in all countries, especially the developing countries. In this connection, the free flow of up-to-date scientific information and transfer of experience must be supported and assisted, to facilitate the solution of environmental problems. (Sohn 1973, p.483)

According to Leslie-Anne Duvic-Paoli, who published the book on PVP,

> Despite the non-binding character of the Declaration, the text jumpstarted the development of international environmental law. The Stockholm Conference immediately acted for the creation of a new international legal order based on the preventive principle. (Duvic-Paoli 2018, p.46)[3]

At first glance, it might seem to be true that PVP works only in a negative way, preventing some human measures or strategies from being adopted in order to preserve natural environments, but such an impression is to be corrected. The notion of prevention in PVP is supposed to be primarily applied to the prevention of harmful

[3] The close relation between the notion of "prevention" and SD is confirmed in an expansion of principle 18 of SD proposed by Brazil, Egypt, and Yugoslavia, which says: "Science and technology, as part of their contribution to economic and social organization and development process, can and should be so directed as to contribute to the prevention and solution, or at least reduction, of environmental problems, including in respect of natural resources exploitation and the physical planning of human settlements" (Sohn 1973, pp.479–480).

 

climate change. Namely, what is prevented is the deterioration of environment rather than the application of science or technology. Of course, PVP implies that our measures towards protecting environments should be prevented if they were harmful in themselves and warns us that some technological advances and their applications should be stopped if their outcomes are scientifically ascertained to be harmful to the environment. Still, the prime function of PVP, at least in the initial context, was to prevent serious environmental problems by actively implementing measures that are based on scientific study, even if those measures involve some risk. Duvic-Paoli clarifies this point:

> The anticipatory rationale of prevention dictates a proactive approach to risk. States are not merely expected to exercise restraint vis-à-vis environmental harm but also to take positive steps to protect the environment. (Duvic-Paoli 2018, p.199)

That being said, PVP is not completely clear. Particularly, when PVP is applied to problems whose risk is difficult to accurately calculate, as in the case of the long-term effects of climate change (cases about which nobody knows precisely what will happen), PVP does not seem to work effectively. Duvic-Paoli points out that,

> The interpretation of preventive obligations through an inter-generational lens will be restricted by the fact that science has difficulties assessing the long-term impacts of a potentially harmful activity, especially if the assessment requires taking into account cumulative effects. (Duvic-Paoli 2018, p.293)

To put it another way, problems that demand decisions are divided into at least two types: those treated in terms of probability (i.e., risk) and those treated in terms of ignorance (i.e., uncertainty). If that is the case, and if we must make decisions on problems of the second type, then perhaps PVP alone is insufficient for guiding our decisions.

## 4. Risk and uncertainty

As a matter of fact, making a distinction between risk and uncertainty is a standard strategy with regard to the issue of decision making. This strategy originates from Frank Knight's argument (see Fischhoff & Kadvany 2011, p.10) and seems to work as a basic framework for discussing the problem of decision making.[4] So long as we investigate decision problems with this distinction, and so long as PVP depends entirely on the notion of risk (which intrinsically includes a calculation of probability), we have to introduce another principle to cope with problems whose probability is not measurable.

However, what kinds of problems should be precisely classified as belonging to the category of uncertainty? How about climate change? As I have suggested, it seems that the long-term effects of climate change, how, that is, the climate on the earth will be ten thousand years from now, cannot be predicted. But what about climate change two hundred years from now? It is quite reasonable to say that many kinds of academic or scientific studies propose some sorts of predictions about how the climate will be in a few hundred years and do so in a somewhat reliable way. For this reason, PVP was declared in SD with regard to the problem of climate change.

To be honest, I must confess that I personally cannot see what the decision problem amounts to in the case of pure uncertainty, cases where it is utterly impossible to assign probability. I have two kinds of questions about this issue. First, insofar as we consider the wide applications of probability, including both subjective and frequency theory, it is hard to imagine a case of pure uncertainty that would matter in a way that triggers decision problems. For instance, Michael Resnik offers one simple example of the uncertainty case. His example is the case of a student of physics who wonders whether she is able to successfully become a good physicist. He classifies this case as one of uncertainty, a case where probability cannot be measured. It is absolutely true that there is a kind of uncertainty belonging to this case, but simply speaking, even in this case, her own subjective probability (i.e., degree of belief) makes definite sense, and an assessment of frequency, based upon data concerning her

[4] For example, Resnik introduces the problem of choice by making a basic distinction of two phases, namely, "decision under ignorance" and "decision under risk: probability" (Resnik 1987). Resnik contrasts certainty with uncertainty, and includes both ignorance and risk into uncertainty, whereas Knight intends by "uncertainty," as differentiated from "risk," a situation whose probability could not be calculated (which is what Resnik calls "ignorance").

 

abilities, her supervisor's assessment of her work, and so on, is not absolutely impossible. As a matter of fact, university professors usually make assessments of their students' prospects in a sort of (subjective-) probabilistic way, basing such assessment on their students' works. In fact, every time their students progress in their studies and achieve new outcomes, professors' probabilistic assessments could be updated in a Bayesian way.

Second, even if we grant that there are cases of pure uncertainty, I still wonder how we should react to such cases. While it strikes me as extremely difficult to give an example of such a case, I will venture an example. What would happen to the human race if we made a law that ordered all people to take more than 6 hours of sleep at least once a year? Who could predict precisely what would happen in the first fifty years of such a law? What kind of harms should concern us? I think this gets us quite close to a case of pure uncertainty. Yet, there may be the possibility, however slight or merely theoretical, that someone perceives this law as a restriction to their lifestyle. Should we genuinely consider this possibility and contrive some measures to prevent it from being realized? I am not sure. But I would point out that, in this context, it is hardly plausible to talk about how to cope with cases of pure uncertainty such as this. Strictly speaking, the uncertainty case is, by definition, a case whose outcomes we cannot predict. Any outcome is fair game. If so, it seems that we have neither the ability nor need to consider such cases.

Nevertheless, I have to frankly admit that there is a notable difference with regard to preventability between the harms incurred through traffic accidents and the long-term harms of climate change, as far as our social policies are concerned. Obviously, the long-term harms of climate change are more uncertain than those of traffic accidents, in the sense that it is more difficult to specify those risks in terms of both probability and severity. Therefore, it seems that we still need another decision principle besides the preventive principle.

## 5. Precautionary principle

It seems to me that it is in this line of thought that the "precautionary principle" (PCP) was proposed. It is possible to have anxiety toward the potential, albeit unconfirmed,

harms of a particular technology or policy. Suppose, for example, that we decide to prohibit the use of mechanical typewriters from 2030 onwards, with an exception permitting their use in the movie industry as period props. Preparing to implement this policy, we might not come across any serious problem. Nevertheless, it is not completely unreasonable to imagine that someone might fear that this prohibition will have terrible consequences for the human race. This sounds similar to the case of pure uncertainty, where the notion of risk cannot function, since the severity and probability of a not unimaginable harm is intrinsically unknown.

PCP is considered to have been initially offered or exemplified in the following remark within the 1992 Rio Declaration (RD),[5] Principle 15.

> In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.

This principle sounds fairly moderate and highly convincing with respect to our practices in ordinary life. We generally try to practice care in avoiding predictable harm, by, say, locking the door when we leave our houses, wearing seatbelts while driving, buying life insurance, and so on. Such behaviors seem to be cases to which PCP could apply. Yet, we have to stop to ponder this carefully. These cases, strictly speaking, belong to the purview of PVP and not PCP, as it is perfectly possible in principle to assess probabilities of harm in terms of some statistical inquiry. That is, they are not cases of uncertainty.

The crucial point of PCP is that "lack of full scientific certainty" should not be used as a reason not to implement measures against harms like environment degradation. That is to say, only "threats of harm" could work as a reason for precautionary actions. It seems to me that the most naïve reaction or question to this idea of PCP is how to interpret "threats of harm." Who should judge whether "threats of harm" are really posed? On what grounds could such judgments be made despite a

5 https://www.un.org/en/development/desa/population/migration/generalassembly/docs/globalcompact/A_CONF.151_26_Vol.I_Declaration.pdf

 

"lack of full scientific certainty"? Would such judgments be in danger of being reduced to the subjective assessments of particular people? How, for example, should we apply PCP to deal with the above-mentioned case of prohibiting mechanical typewriters? If some felt that such a prohibition evinced a threat of harm, should we implement some precautionary measures based on PCP?

Such suspicion might be further fueled if we consider the following passages from the Wingspread Declaration (WSD) issued in 1998,[6] which is usually regarded as stating a strong version of PCP.

> We believe existing environmental regulations and other decisions, particularly those based on risk assessment, have failed to protect adequately human health and the environment - the larger system of which humans are but a part. We believe there is compelling evidence that damage to humans and the worldwide environment is of such magnitude and seriousness that new principles for conducting human activities are necessary. While we realize that human activities may involve hazards, people must proceed more carefully than has been the case in recent history. Corporations, government entities, organizations, communities, scientists and other individuals must adopt a precautionary approach to all human endeavors.

Evidently, WSD focuses on cases where risk assessment fails, in contrast to cases in which PVP can be applied, and continues by offering a strong version of PCP for such cases, formulated as follows:

> Therefore, it is necessary to implement the Precautionary Principle: When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically.

WSD is clearly much stronger than RD in that while WSD straightforwardly orders us to implement precautionary measures in cases where the causal relations of relevant issues are unknown, RD adopts more moderate and careful expressions, saying that lack of full scientific certainty should not be used as a reason for postponing cost-effective measures.

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[6] https://www.gdrc.org/u-gov/precaution-3.html

I think that perhaps anyone who is thinking about the principles objectively will easily recognize that, on account of the extreme posture of the PCP in WSD, it might result in some unreasonable proposals. Let's consider again the case of prohibiting mechanical typewriters. It is possible that some people might feel that a future in which this prohibition was effected evinces some threat of harm to human health, even though no link between such a prohibition and harm can be scientifically confirmed. It is a matter of human life that there are people in this world who think in peculiar ways, although I am not entirely sure that there are any who would be anxious about potential harms to human health brought on by prohibiting mechanical typewriters. Yet following WSD literally, our societies would have to implement some precautionary measures even in this case. Is this acceptable as a reasonable policy?

Another possible case is the issue of mobile phones. Often fears are expressed that the radio waves of these devices might be harmful to our brains in the long run, although such harm has not been confirmed scientifically. Should we adopt a policy to immediately prohibit mobile phones? Honestly, I have great doubts about the reasonableness of either of the above policies. It is not because I suppose that the feared harms are utterly impossible, but because I am afraid that adoption of such policies would come at an excessive cost, in many senses, since this policy would have to be expanded to many other social decision makings. Such policies bind our society too firmly to allow for flexibility.

Perhaps, when WSD expresses "an activity raises threats of harm", it might be tacitly assuming some probability of harm. In that case, WSD might sound plausible to readers in terms of an implicit distinction between probable harm and improbable harm (where, for example, harm caused by prohibiting mechanical typewriters is supposed to be improbable). Nevertheless, such a distinction appears fiercely opposed to the original spirit of PCP. If WSD virtually considers probability behind its literal expressions, it might become a sort of PVP about risk, rather than a PCP about uncertainty.

## 6. Sunstein's criticism and risk tradeoffs

 

As my arguments above suggest, PCP, especially that of WSD, is exposed to many kinds of theoretical doubts in spite of the fact that it has been successful in appealing to our psychological tendency to feel fearful about something seeming to be harmful. As far as I understand, PCP intrinsically depends upon the notion of uncertainty, where we cannot rely on the notion of risk, but since uncertainty itself is an unclear notion, PCP cannot be thoroughly convincing. On the other hand, PVP is not exposed to similar kinds of doubts because it seems that the notion of risk that comprises the core of PVP can be accepted as a notion more intelligible and realistic than uncertainty.

In order to understand which aspects of PCP are exposed to fierce doubts, it helps to refer to the arguments of American legal philosopher Cass R. Sunstein, whose reasonable examination of PCP is famous around the world.

According to Sunstein, PCP in WSD was paraphrased in a stronger way:

> The Precautionary Principle mandates that when there is a risk of significant health or environmental damage to others or to future generations, and when there is scientific uncertainty as to the nature of that damage or the likelihood of the risk, then decisions should be made so as to prevent such activities from being conducted unless and until scientific evidence shows that the damage will not occur. (Sunstein 2005, p.19)

I make two notes on Sunstein's interpretation. First, I draw attention to the fact that he, perhaps correctly, interprets the PCP in WSD as implying considerations based on the notion of risk, which seems, strictly speaking, to be opposed to the original idea of PCP. This interpretation encourages a reconsideration of the fundamental issue, namely, how to distinguish between risk and uncertainty. It seems to me that this distinction would, in reality, not be so sharp, so that it would be acceptable to talk about uncertainty as a kind of risk. Purely theoretically speaking, if we take uncertainty to be the assessment of a probability range, $0 < p < 1$, then it is possible to argue about risk and uncertainty in a compatible and seamless way. In fact, even probability would be used as a sort of range, e.g., from 70% to 90%. In this sense, it is not so strange for PCP to refer to probability.

Second, judging from WSD's expressions, we might have to take PCP as virtually intending to require the notorious idea of "zero risk". Sunstein points out precisely this issue, following the remarks quoted above.

> The words "will not occur" seem to require proponents of an activity to demonstrate that there is no risk at all----often an impossible burden to meet. (Sunstein, 2005, p.19)

It goes without saying that we are always involved in many risks. Therefore, if PCP requires "zero-risk", it must be arrant nonsense. In any case, Sunstein proposes his own tentative formulation of PCP, a working hypothesis that summarizes the essence of the PCPs in RD and WSD.

> When risks have catastrophic worst-case scenario, it makes sense to take special measures to eliminate those risks, even when existing information does not enable regulators to make a reliable judgment about the probability that the worst-case scenario will occur. (Sunstein 2007, p.119)

Some would like to apply PCP to a variety of cases, such as radiation exposure, although PCP was introduced, at least initially, to cope with environmental problems and GM foods.

Unfortunately, however, many crucial objections have been raised against applying PCP, at least when done so literally and without other reasonable provisos.[7] Indeed, it has been suggested that at worst, PCP actually exposes us to serious danger. The most fundamental objection is concerned with PCP's paying little or no attention to "risk tradeoff". Risks are like a balance, where, when one side is lower, the other is higher. When we try to reduce a particular risk, another new risk (sometimes unexpectedly) befalls us. The former risk is called the "target risk", and the latter "countervailing risk" (See Graham & Wiener 1997, Chapter 1). Sunstein raises an example about risk tradeoffs like this.

> Similar issues are raised by the continuing debate over whether certain antidepressants impose a (small) risk of breast cancer. A precautionary approach might seem to argue against the use of these drugs because of their

[7] As described later, PCP is usually applied together with other extra conditions or provisos. In that case, the name, "the precautionary principle," is not preferred, but the name, "the precautionary approach," is adopted particularly in the context of the US. As far as I understand, the precautionary approach is not the application of PCP itself at all, but rather some variant of PVP.

 

> carcinogenic potential. But the failure to use those antidepressants might well impose risk of its own, certainly psychological and possibly even physical (because psychological ailments are sometimes associated with physical ones as well). (Sunstein 2007, p.127)

Another example Sunstein gives is as follows:

> The Precautionary Principle is often invoked in connection with genetic modification of food—a plausible concern of multiple risks potentially created by that practice. But many people believe that a failure to allow genetic modification of crops might well result in many deaths. The reason is that genetic modification holds out the promise of producing food that is both cheaper and more nutritious—resulting, for example, in "golden rice," which might save many lives in developing countries. (Sunstein 2007, pp.127–128).

Sunstein thus concludes, with evident sarcasm, that:

> The real problem with the Precautionary Principle, thus understood, is that it offers no guidance—not that it is wrong, but it forbids all courses of action, including regulation. Taken seriously, it is paralyzing, banning the very steps that it simultaneously requires. If you accepted the strong version, you would not be able to get through a single day, because every action, including inaction, would be forbidden by the principle by which you are attempting to live. (Sunstein 2007, pp.125–126)

That is to say, for example, PCP prohibits the use of antidepressants, but simultaneously requires their use (i.e., prohibits non-use). Thus, PCP is intrinsically destined to fall into a contradiction. If this is the case, PCP, particularly the PCP in WSD, cannot work as a principle of decision-making at all.

Nevertheless, why does PCP attract so many?

> The appeal of the Precautionary Principle, in the face of risks on all sides, present many puzzles. (Sunstein 2007, p.133)

> The more interesting answer is that the principle seems to give guidance because people single out a subset of risks that are actually involved. In other words, those who invoke the principle wear blinders. (Sunstein 2007, p.131)

This is nothing but a kind of cognitive bias. People tend, for example, to focus on the worst-case scenarios that might be caused by allowing GM foods and to be blind to the many deaths caused by prohibiting GM foods. In this sense, PCP on its own surely has a dangerous side, contrary to its initial motivation (i.e., saving people's lives).

## 7. Realistic applications of the precautionary principle

How, then, about the PCP in RD, which is the weaker and more moderate version? In fact, some doubt has been aroused toward RD as well. In particular, the concepts used in RD are so fatally vague that it is not possible to clearly understand what RD claims. Julian Morris has listed five drawbacks of the PCP in RD. 1) What is meant by "threat" is not clear. Threat so loosely defined, he says, "can include everything from the risk of the Thames flooding (which is reckoned to occur twice a century, giving an annual probability of 1 in 50), to the mere possibility that there might be an alien invasion." (Morris 2000, pp.13–14). 2) The concept of 'damage' is not clearly defined. How could we distinguish 'damage' from mere 'change' like in the aging of bridges? 3) It is not clear what "irreversible damage" is in RD. The death of any person is, by definition, irreversible. Morris puts the point like this.

> All change (and hence all damage) is irreversible in the strict sense that the precise structure of the world that pertained before cannot once again come into being. This is a consequence of the second law of thermodynamics wherein it is observed that the state of disorder (or entropy) of the universe is constantly increasing. (Morris 2000, p.14)

4) The notion of seriousness in 'serious damage' in RD is clearly a subjective one. To prohibit mechanical typewriters sounds almost trivial to some people, whereas to others it may be serious. 5) This world is, as a matter of fact, full of uncertainty by definition. In that sense, strictly speaking, RD sounds empty (ibid.). If I add another point, even the PCP of RD (as well as that of WSD) tends to focus only on one aspect of the relevant phenomena, thinking little of countervailing risks.

 

Therefore, insofar as we consider only the initial formulations of PCP itself, and do so literally, we should come to judge that the PCP is self-contradictory and useless as a decision principle. Indeed, rather we should be afraid of the potential harm that PCP poses. If we force a PCP through, applying it to one single risk with little thought given to countervailing risks, PCP could expose us to more dangerous circumstances. As a matter of fact, PCP, construed literally, has not found universal acceptance, probably on account of the drawbacks discussed.

This point is confirmed in the light of the famous debates going back to the 1990s between the EC and US on "the European Community's ban on meat products treated with hormones" (Sunstein 2005, p.40). In this debate, the EC simply applied PCP, whereas the US admitted a PCP (that of RD) but in a different way. According to 'EC Measures concerning Meat and Meat Products (Hormones)' by WT/DS26/AB/R issued by World Trade Organization in 1998, the US claims:

> In the view of the United States, the claim of the European Communities that there is a generally accepted principle of international law which may be referred to as "the precautionary principle" is erroneous as a matter of international law. The United States does not consider that "the precautionary principle" represents a principle of customary international law; rather it may be characterized as an "approach"—the content of which may vary from context to context. (WTO 1998, p.18)

In this sense, it must strike us as strange that many still rely on PCP in spite of its drawbacks.

Sunstein, mentioning cases of catastrophe and our feelings of fear, points out correctly why this is.

> When intense emotions are engaged, people tend to focus on the adverse outcome, not on its likelihood. They are not closely attuned to the probability that harm will occur. They emphasize worst-case scenarios. The result is to produce serious distortions for both individuals and societies.
>
> At the individual level, the phenomenon of probability neglect results in indifference to small but statistically real risks, excessive worry, and unjustified behavioral change. Probability neglect also creates problems for law and regulation. (Sunstein 2005, pp.64–65)

"Probability neglect" is one main factor for why some apply PCP to many issues. This explanation fits well with PCP's original concern for uncertainty rather than risk. The problem of probability neglect, however, is that it might induce us to focus only on catastrophic outcomes whose probability is extremely low and not account for risk tradeoffs. Ironically, that might bring about another kind of catastrophic outcome, a result in opposition to the initial intentions of PCP.

Objectively speaking, however, there is a plausible reason that explains why many of those concerned strongly agree with PCP and would like to apply it to many cases. When concerned parties talk about PCP in actual and political situations, they in fact regard PCP as working, not in the simple form that contrasts with PVP, but in a way combined with PVP or other subsidiary provisos. As I have mentioned, European countries actually tend to accept PCP itself as almost universally applicable, but they do not neglect risk analysis. According to the 'Communication from the Commission on the precautionary principle':

> The precautionary principle should be considered within a structured approach to the analysis of risk which comprises three elements: Risk assessment, risk management, risk communication. The precautionary principle is particularly relevant to the management of risk. (Commission of the European Communities 2000, p.2)

If real-world application of PCP considers risk analysis, then PCP admits the introduction of some ways of thinking about probability, costs, and benefits. Indeed, the same document quoted above states that:

> Thus reliance on the precautionary principle is no excuse for derogating from the general principles of risk management. These general principles include: • proportionality, • non-discrimination, • consistency, • examination of the benefits and costs of action or lack of action • examination of scientific developments. (ibid. p.17)

PCP interpreted in this way could, in a sense, be assessed as a sophisticated version of PCP and, as a matter of fact, is clearly not so different from PVP or the standard cost-benefit analysis that includes considerations of risk. Its only proper character, as a PCP, focuses particularly on cases of uncertainty that follow after carrying out risk

 

analysis, although, as I previously argued, it is theoretically difficult to figure out what uncertainty is and how we should react to uncertainty in a reasonable way. Actually, the same document says:

> Decision-makers need to be aware of the degree of uncertainty attached to the results of the evaluation of the available scientific information. Judging what is an "acceptable" level of risk for society is an eminently *political* responsibility. (ibid. p.3)

PCP must be applied together with a judgment about the "acceptable level of risk". Thus, PCP in this sense could or should be regarded as one variant of PVP. Such a PCP is exempted from standard criticisms against PCP itself, but I am afraid that such PCPs might lose their proper, unique character as PCPs.

## 8. Catastrophes

Nevertheless, ordinary people, who are neither experts nor scholars, tend to accept PCP in a literal sense (without considering the sophisticated version that includes risk management) and apply it directly to many seemingly catastrophic issues that incite anxiety about possible harm. This phenomenon actually happened in Japan after the 2011 Great East Japan earthquake (GEJE) and its subsequent calamity, i.e., the Fukushima Daiichi Nuclear Power Station Accident (FDNPS accident). In the case of Fukushima, about 1600 people were directly killed by the earthquake and tsunami. But what I would like to focus on is the fact that, after the FDNPS accident, more than 2300 people died in a way they would not have if GEJE had not occurred. Such tragic deaths were referred to as "earthquake-related deaths". Naturally, then, we should raise the question, "What caused such tragic deaths?"

The initial, naïve answer is "radiation exposure due to the FDNPS accident", since the emission of radioactive materials and residents' exposure to radiation appear as the most striking characteristics of the Fukushima area after the FDNPS accident. The answer implies that more than 2300 people died of harmful radiation exposure. Yet, as a matter of fact, this answer is wholly mistaken in the light of objective data on the doses of radiation to which the people in Fukushima were exposed. To confirm

this point, nothing seems to compare to the *UNSCEAR 2020/2021 Report*. According to 'Table 10. Estimated ranges of municipality- or prefecture-average effective doses to adults, children and infants (as of 2011) over the first year, first 10 years and to age 80 years' (shown below), the effective dose of radiation, on the average, of people in Fukushima, from infants to adults is mostly less than 5mSv in the first year, and the average annual effective dose in the 10 years since the FDNPS accident is much less than 2mSv.

Table 10. Estimated ranges of municipality- or prefecture-average effective doses to adults, children and infants (as of 2011) over the first year, first 10 years and to age 80 years

| *Age group in March 2011* | *Ranges of municipality- or prefecture-average effective dose[a] (mSv)* | | |
|---|---|---|---|
| | *Group 2[b] – Fukushima Prefecture* | *Group 3[c] – neighbouring prefectures* | *Group 4[d] – rest of Japan* |
| 1-YEAR EXPOSURE | | | |
| Adult | 0.079–3.8 | 0.10–0.92 | 0.004–0.36 |
| 10-year-old | 0.10–4.5 | 0.13–1.1 | 0.005–0.43 |
| 1-year-old | 0.12–5.3 | 0.15–1.3 | 0.005–0.51 |
| 10-YEAR EXPOSURE | | | |
| Adult | 0.16–11 | 0.25–2.5 | 0.009–1.0 |
| 10-year-old | 0.19–12 | 0.30–2.9 | 0.008–1.2 |
| 1-year-old | 0.22–14 | 0.34–3.4 | 0.007–1.3 |
| LIFETIME EXPOSURE TO AGE 80 YEARS[e] | | | |
| Adult | 0.22–15 | 0.32–3.6 | 0.010–1.4 |
| 10-year-old | 0.24–17 | 0.38–4.0 | 0.009–1.6 |
| 1-year-old | 0.27–19 | 0.43–4.5 | 0.008–1.8 |

[a] The reported doses are ranges of the municipality-averaged doses for the Group 2 and Group 3 prefectures and the prefecture-average doses for the Group 4 prefectures. These estimates of dose are representative of the average doses received by people living at different locations and do not reflect the range of doses received by individuals within the population at these locations.

[b] Group 2 includes all municipalities or parts of municipalities of Fukushima Prefecture that were not evacuated municipalities.

[c] Members of the public living in the prefectures of Ibaraki, Miyagi, Tochigi and Yamagata.

[d] Members of the public living in the remaining 42 prefectures of Japan. This group now includes the prefectures of Chiba, Gunma, and Iwate, which were included in Group 3 in the UNSCEAR 2013 Report [U10].

[e] For adults, this is the dose from age 20 years at the time of the accident up to age 80 years.

(*UNSCEAR 2020/2021 Report*. table 10, p.66)

 

Thus, the UNSCEAR Report points out:

> the Committee also estimated in that report that, compared to the baseline risk in the general Japanese population of total solid cancer, and cancers of nearly all specific anatomical sites, a general radiation-related increase in the incidence of such cancers would not be expected to be discernible. (p.85)

We should therefore ask again, why did so many "earthquake-related deaths" occur? The UNSCEAR report suggests the following:

> the Committee also noted that nuclear accidents of the magnitude of the FDNPS accident, and the associated protective measures, tend to lead to distress and anxiety from, among other things, disruption of life, loss of homes and livelihoods, and social stigma, which can have major impacts on psychological and social well-being [U10]. The Committee pointed out that evaluating such effects is not part of its mandate, although they are important for understanding the broader health implications of the accident. It also noted that the evacuation following the accident caused immediate aggravation of the condition of already vulnerable groups. (p.84)

In line with this suggestion, there are many research articles that have found that, generally speaking, severe hardship during and after evacuation should be understood as a major factor in "earthquake-related deaths" (See Nomura et al. 2013 and Murakami et al. 2015). They at least clarify that, retrospectively, it was not the best policy to give number-one priority to evacuation over all else. If that is the case, the question that we should raise next is, "Why were many people urged to evacuate?"

## 9. Causation in the precautionary principle

Of course, people felt fear about radiation exposure just after the FDNPS accident. That is completely natural. I really sympathize with them, as most had never experienced an accident at a nuclear power station and many lacked both precise information about the doses of radiation emitted from the FDNPS and detailed knowledge about the health implications of radiation exposure. In addition, mass

media and some scholars emphasized the dangers of radiation exposure (unfortunately) without referring to the probabilistic nature of radiation's influence on human bodies in terms of the dose (i.e., quantity) of radiation exposure. As a result of these factors, many people were psychologically pushed to engage in evacuation, some of which were too excessive, at least seen retrospectively.

As far as I understand, such a syndrome of fear has been, consciously or unconsciously, prompted by a way of thinking that corresponds with PCP. People focus only on the possible harm of radiation exposure, taking it to be uncertain, in opposition to the standard scientific predictions based on long-term epidemiological research accumulated over some 80 years since the Hiroshima and Nagasaki tragedies. Actually, as far as the issue of radiation exposure is concerned, we need to think in a fundamentally quantitative way rather than simply following the original PCP taken in a literal sense.

I would like to propose an analysis of this issue that finds that PCP is supported by our idea of a causal relation between a particular behavior or strategy and catastrophe. This can be expressed in the following diagram, where the arrow stands for a causal relation.


WSD actually refers to a "cause and effect relationship", and RD seems to imply causation when it mentions "scientific certainty".

I have no choice but to skip over the details of the philosophy of causation here. For the time being, then, I adopt a conditional approach to causation, which is formulated as follows:

If C (cause), then E (effect)

I believe that my formulation is not necessarily unjustifiable. On the one hand, counterfactual conditional analysis has been one of the most dominant and influential approaches to the problem of causation (since Hume and Lewis).

 

O (*c*) □→ O (*e*) and ~O (*c*) □→ ~O (*e*)

(Lewis 1986, p.167)

O (*c*) means that event C occurs, and □→ works as a counterfactual conditional operator. According to the counterfactual analysis, if those sentences are true or satisfied, then we could judge that *c* is the cause of *e*.

On the other hand, if we accept what is called the "Stalnaker's Hypothesis", or more traditionally, the "Ramsey Test", then we can formulate the idea of "Probabilistic Causality", which could be one of the commonsensically acceptable views on causation, in terms of a conditional sentence. Pr (*q*) means the probability that an event *q* occurs, "→" works as an indicative conditional operator, and Pr (*q*|*r*) means the probability that an event *q* occurs on condition of *r*'s occurring.

Stalnaker's Hypothesis (See Stalnaker 1981, p.120)

Pr (C → E) = Pr (E|C)
for any C, E, such that Pr (C) > 0

This hypothesis is formed in indicative conditionals. We must then note the most basic formulation of "Probabilistic Causality" as follows:

Pr (E|C) > Pr (E | ~C)
which suggests that C could be a candidate of E.

Of course, we must face Lewis's "Triviality Results", if I hope to justify my adoption of the idea of probabilistic causality by Stalnaker's Hypothesis. I have no room to solve this big problem here, but I could suggest that Lewis's argument is proposed by basically presupposing truth-functionality, so that if we reject the truth-functional approach to conditional sentences, then we could, for the time being, apply the idea of probabilistic causality without being bothered by Lewis's attack.

I add my own point to these two philosophical viewpoints on causation. Typically speaking, I understand that counterfactual conditional analysis is basically concerned with causal judgments about past events (corresponding to "but for test" in

jurisprudence), whereas probabilistic causality tends to focus on causal inference towards future events from the present point of view. The main question for us, then, is, "To which category, causal judgment or causal inference, does the causal relation between 'a particular behavior or strategy' and 'catastrophe' in the PCP belong?"

## 10. Two kinds of conditionals

To clarify this point, we should understand the characteristics and differences of indicative conditionals and counterfactual conditionals. With regard to this distinction, I rely on Edgington's argument and Adams's arguments. Edgington argues as follows:

> One can suppose that A, taking oneself to know that not-A; and one can suppose that A, not taking oneself to know that not-A. Typically, the subjunctive or counterfactual conditional is the result of the first kind of supposition, the open or indicative conditional the result of the second kind. An apparent difficulty which actually clarifies the point: I take myself to know that the carpet I am now looking at is not red. I may say 'If it had been red, it would have matched the curtains'. But I may also say 'If it is red-well, I have gone colour-blind or am suffering some sort of delusion'. In the subjunctive, I am taking it for granted that I am right in thinking it is not red. In the indicative, I am supposing that I am wrong. I am considering it to be an epistemic possibility that it is red, despite appearances. (Edgington 1991. pp.178–179)

Adams puts the contrast like this:

> A typical situation in which the two conditionals differ is that in which their common consequent is known to be false, where the counterfactual is often affirmable while the indicative is not. . . .Two men are walking in the woods and spy a bird in the shadow in such a way that its color cannot be made out. One man might use the indicative in telling the other "If that bird is a canary it will be yellow". Now, however, suppose that the bird flies out into the sunlight, where it is clearly seen to be blue and not yellow. Under the circumstances the first man will be unlikely to continue to affirm the indicative—and indeed he should not, since learning the falsity of its consequent makes it too improbable to justify continued affirmation. On the other hand the first speaker will be likely to 'substitute the counterfactual for

 

> the indicative' and affirm "if that bird were a canary it would be yellow. (Adams 1975. p.104)

As far as typical cases are concerned, we could probably summarize the contrast between the two types of conditionals in the following way.

Indicative conditional (IC) fits in well with the case that we do not surely recognize what actually happened (corresponding to the antecedent) and will happen (corresponding to the consequent), thinking in a prospective way (towards the future from the present point of view) with probability (setting aside the case for IC to be used in the past tense). In other words, IC mostly works in "causal inferences" towards the future.

Counterfactual conditional (CC) fits in well with the case that we are basically supposed to surely recognize what happened/what did not happen (corresponding to the antecedent) and to surely recognize what actually happens (corresponding to the consequent), thinking in a retrospective way (towards the past), basically without the notion of probability (setting aside the problem of applying probability to CC and the complicated relation with subjunctive conditional). To put it another way, CC mainly functions in "causal judgments" about the past.

How about the causal relation presupposed in PCP? How should we understand such a causal relation as "if <a particular behavior or strategy> were adopted, then <catastrophe> would happen" (abbreviated as CRPCP)? Is this conditional indicative or counterfactual?

The first point to confirm is that this is obviously a future conditional (FC). This point seems to suggest that CRPCP is indicative by definition. In addition, in IC, both the antecedent and the consequent are not surely recognized. This character seems to conform with CRPCP. Is CRPCP thereby an indicative conditional? If so, CRPCP in the case of radiation exposure should be formulated as follows:

> If people will continue to be exposed to radiation for long term, they will face a catastrophe.

Yet, this formulation has a fatal drawback. PCP is characterized as the decision principle with "probability neglect" (please note that we focus on the original formulation of PCP in a literal sense, as with WSD or RD, since many tend to accept this formulation rather than the sophisticated version, as I pointed out). Contrary to this, an indicative conditional used in causal inference is basically formulated in terms of probability, as I have mentioned. Therefore, CRPCP has no affinity to IC.

Is CRPCP, then, a counterfactual conditional? At first glance, this interpretation seems to be very difficult to adopt, since CRPCP is a future conditional and CC is basically retrospective. It is certainly necessary to ponder this point. If we try to express CRPCP in the form of counterfactual conditionals according to Lewis's argument, it could be as follows:

> If we would have continued to be exposed to radiation long term, then we would have faced a catastrophe.
>
> or
>
> If we would not have continued to be exposed to radiation, then we would not have faced a catastrophe.

Both conditionals sound strange as CC, since both negations of the antecedent and the consequent seem to be not surely recognised. This situation appears to contradict the nature of CC.

However, let's stop to consider the consequent of this CC. Sunstein points out that:

> Visualization or imagery matters a great deal to people's reaction to risks. (Sunstein 2005, p.81)

and that,

> With respect of risks of harm, vivid image and concrete pictures of disaster can "crowd out" other kinds of thoughts, including the crucial thought that the probability of disaster is really small. "If someone is predisposed to be worried, degrees of unlikeness seem to provide no comfort, unless one can prove that

 

> harm is absolutely impossible, which itself is not possible". (Sunstein 2005, p.82)

This is the very ground of "probability neglect" and the "zero-risk" requirement in the original version of PCP taken literally. That is to say, there is a tendency to envision the worst-case scenario as if it were right in front of us, when the worst-case scenario is taken to actually happen in reality. This way of envisioning seems to form the innermost core of PCP.

## 11. The precautionary principle and causal narrative

If that is the case, then the consequent of CRPCP should be interpreted differently from how we initially understood it. That is to say, CRPCP could be understood as claiming that, "If we would not have continued to be exposed to radiation, then we would not have faced a catastrophe", where the negation of the consequent (i.e., we have faced a catastrophe) is surely recognized as true. That must fit in well with the nature of counterfactual conditionals. Certainly, it also seems to be true that CRPCP has the character of "probability neglect", perhaps in common with CC, because in this interpretation, events denied in the antecedent and the consequent appear to have been taken to have already happened, in which case, probability does not seriously matter.

Nevertheless, unfortunately, it cannot at all be denied that CRPCP is, formally speaking, a future conditional (FC), and CC works the best in a retrospective way. Furthermore, there is still a problem of how to understand the status of the antecedent in CRPCP (Is it, like in the case of the consequent, taken to be a true fact that we have already continued to be exposed to radiation?). It still seems to be hard to identify CRPCP as a kind of CC.[8]

[8] Actually, this indecisive situation might reflect how the debate about future conditionals (FC) proceeds currently. E.g. see Gibbard & Harper 1981 (which claims that FC is counterfactual), Morton 2004 (which argues that some FC are indicative, others are subjunctive.), and Bennet 2003 & DeRose 2010 (which propose arguments that FC is indicative).

Yet, in any case, very unfortunately again, recognition of catastrophe is not an authentic recognition but a pseudo-recognition. We should rather say that such a mental representation is no more than an illusion or imaginary fiction. In other words, this is a confusion of fiction with actuality. If so, we should say that CRPCP is highly irregular or utterly inappropriate as a causal claim. In contrast to "causal judgment" in counterfactual conditionals and "causal inference" in indicative conditionals, I would like to call the causal claim in CRPCP "causal narrative".

In addition, if the recognition or declaration of the CRPCP based on causal narrative somehow harmed other people by urging them to undertake the hardship like behaviours of evacuation as in the case of FDNPS accident, then we should raise a question about the moral (or even legal) responsibility of those who insist on this CRPCP. Perhaps, as far as I understand, their failure to examine (though not of course as experts) the health effects of radiation exposure in epidemiological research could be regarded as the cause of harm. That is to say, I suppose that the (higher order) cause of the causal narrative must also be scrutinized after confirming the context of the causal narrative. I mean to focus, in this line of thought, on negligence or omission at the epistemic level. I intend to investigate this issue in terms of "causation by absence", referring to "the ethics of belief", an area of discussion created by W. K. Clifford (See Clifford 1999).[9]

I add two final notes. First, if we take our psychological fear into account in order to understand hazard or catastrophe, causal narrative might be one factor to be considered when making decisions from a reasonable point of view. That is, there might be cases where such causal narratives must be treated as realistic in a not-straightforward way. Second, if we are more or less convinced that the original version of PCP taken literally is a decision strategy, in spite of the fictitious nature of its "causal narrative", we might tacitly and gradually step into the region of "causal

[9] The ethics of belief Clifford developed discusses moral assessments about an epistemic process, namely, the process of making beliefs, then claims that if we have beliefs only with insufficient evidence, we should be morally blamed. I reformulate this argument by focusing upon causal relation between checking evidence and making beliefs. That is to say, if we omit carefully checking the evidence for having a particular belief, then we have to be morally blamed. This line of argument sounds similar to what is called "virtue (vice) epistemology". However, virtue (vice) epistemology discusses the character of agents themselves from moral viewpoints, whereas the ethics of belief highlights an epistemic process (a kind of action or inaction) of agents.

 

inference" in which we consider probability from the point of view of the present. In other words, even if people seem to appeal to the original version of PCP in a literal sense, they virtually conceive of something close to the sophisticated version of PCP. However, as I noted before, the sophisticated version approaches the idea of PVP, in which case PCP might drastically lose its unique persuasive power. In any case, we should admit that the boundary between "causal narrative" and "causal inference" is intrinsically vague.[10]

In conclusion, some people virtually adopted PCP in the case of the 2011 FDNPS accident and chose to be evacuated promptly and/or long-term, resulting in miserable tragedy (like the large number of disaster-related deaths). Retrospectively, such an application of PCP was not recommendable, since it both led to harm and was not justifiable in a reasonable way. In times of disaster, we should consider risk tradeoff very carefully and not blindly appeal to PCP by focusing on only one risk. To be clear, I am acutely aware that such considerations would be hardly feasible in emergent situations, particularly like in the case of FDNPS accident, as many people did not expect such a severe accident and had no detailed knowledge on radiation exposures. All that I hope to propose here is that we could have reasonably considered risk-tradeoff some weeks or months after the accident by checking the information and studying the phenomena of radiation, which could result in somehow reducing earthquake-related tragedies. That proposal concerning PCP, I suppose, could be applied to any kind of disaster and accident.

Of course, the dead never return. But we should learn bitter lesson in preparation for some possible disasters and accidents in the future. To survive, we must step forward.

[10] Even from a theoretical point of view, we could say that obviously the boundary between "causal narrative" and "causal inference" is intrinsically vague, because causal narrative having the stance of probability neglect could be interpreted as a (special) kind of stochastic claim with probability ranging from 0% to 100%, and causal inference could be often offered with a range of assigned probability, e.g., from 80% to 90%, or extremely speaking, a range from 1% to 99%, which is virtually almost the same as the case of probability neglect. This point is corresponding to what I have suggested previously in the section 6 with regard to the vague distinction between risk and uncertainty.

▸This article is based upon chapter 6 of my book, *Philosophy of Life and Risk: Towards living resiliently in times with disease and disaster* (published by MYU in March 2021 in Japanese) and my presentation, "Disaster, Precaution, and Causation: In the Light of Cass Sunstein's Philosophy" (*The American Philosophical Association Pacific Division The 94th Annual Meeting,* online. 9 April 2021). The session where I gave the presentation was co-organized by APA and the Philosophical Association of Japan. I am deeply thankful for Professor Masato Ishida to arrange this session. In this article I made a drastic revision to my previous argument and added new points.

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