Environmental Risks, Uncertainty and Intergenerational Ethics

KRISTIAN SKAGEN EKELI

Department of Philosophy
NTNU – Norwegian University of Science and Technology
7491 Trondheim, Norway
Email: kristian.skagen.ekeli@hf.ntnu.no

ABSTRACT

The way our decisions and actions can affect future generations is surrounded by uncertainty. This is evident in current discussions of environmental risks related to global climate change, biotechnology and the use and storage of nuclear energy. The aim of this paper is to consider more closely how uncertainty affects our moral responsibility to future generations, and to what extent moral agents can be held responsible for activities that inflict risks on future people. It is argued that our moral responsibility to posterity is limited because our ability to foresee how present decisions and activities will affect future people is limited. The reason for this is primarily that we are in a situation of ignorance regarding the pace and direction of future scientific and technological development. This ignorance reduces our responsibility in a temporal dimension because in most areas it is impossible to predict the interests and resource needs of future generations. In one area, however, we have fairly reliable knowledge about future people. It is reasonable to assume that future human beings will have the same basic physiological (physical and biological) needs as we have. On this basis, it is argued that we can be held responsible for activities causing avoidable damage to critical resources that are necessary to provide for future physiological needs. Furthermore, it is suggested that it is *prima facie* immoral to impose risks upon future generations in cases where the following conditions are fulfilled: (1) the risk poses a threat to the ability of future generations to meet their physiological needs, and (2) the risk assessment is supported by scientifically based harm scenarios.

KEYWORDS

Moral responsibility, future generations, uncertainty, environmental risks, reasonable and unreasonable risks

Environmental Values **13** (2004): 421–48
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1. INTRODUCTION[1]

In several areas, recent scientific developments have increased our knowledge about the future environmental effects of our activities. Nevertheless, the way our decisions and actions can affect the interests and life-conditions of future generations is surrounded by uncertainty. There are several reasons for this. In many cases, we do not know for sure how human activities will affect various ecosystems, and this makes it difficult to predict the long-term environmental effects of present actions and policies. Moreover, since it is impossible for us to foresee the pace and direction of future scientific and technological developments, we are in a situation of ignorance regarding the ability of future generations to deal with pollution, energy needs and declining stocks of natural resources. Such considerations demonstrate that it is difficult, in many cases impossible, to foresee how our activities will affect the welfare of posterity. From a philosophical point of view, such uncertainty raises difficult problems with regard to our moral responsibilities to future people. This is primarily because it is widely acknowledged that a moral agent can only be held responsible for an action if it is possible for the agent to foresee the consequences of the action. This can be termed the *foreseeability condition.*

The aim of this paper is to consider how uncertainty about the future consequences of our actions affects our moral responsibility to future generations, and to what extent moral agents can be held responsible for activities that inflict risks on future people. In part 2, I will give an account of the foreseeability condition and its role in moral and legal assessments of what can be termed subjective responsibility. Taking the foreseeability condition as a point of departure, the subject of part 3 is to consider how uncertainty about the future affects our subjective responsibility towards future generations. It will be argued that due to uncertainty and ignorance about the future we can only be ascribed a limited moral responsibility to future human beings. More precisely, moral agents can only be held morally responsible for decisions and actions that can affect future people if it is possible to foresee that such decisions and actions can harm critical resources, that is, resources that are necessary to provide for the physiological (physical and biological) needs of future generations. In part 4, I will discuss the following question: in which cases can the infliction of risks upon future generations be justified and in which cases can this not be justified? Or, in other words, where should the line be drawn between reasonable and unreasonable risks? On the basis of the discussion in part 3, it is argued that it is *prima facie* immoral to inflict a risk upon future generations in cases where the risk poses a threat to the ability of future generations to meet their physiological needs, and the risk assessment is supported by scientifically based harm scenarios.

2. THE FORESEEABILITY CONDITION AND SUBJECTIVE RESPONSIBILITY

In moral philosophy it is widely acknowledged that a moral agent[2] can only be held responsible for an action if it is possible for the agent to foresee the consequences of the action. This can be called the *foreseeability condition* of moral responsibility. I will use the following formulation of this condition as a starting point:

(F1) Moral agents can only be held subjectively responsible for an action if it is possible for the agent(s) to foresee that the consequences of this course of action can inflict harm upon the interests of others.

The foreseeability condition concerns evaluations of subjective responsibility, not of objective responsibility.[3] This distinction is made both in moral and legal assessments of responsibility. The question of *objective responsibility* pertains to whether a person has in fact acted in conflict with moral or legal norms. In the context of criminal law, the question is whether it can be proved that the accused person has caused the *actus reus* (the outward act of crime). In order to determine whether the accused is blameworthy or culpable, it is not sufficient to demonstrate that he is objectively responsible. In addition, it is necessary to consider the agent's subjective responsibility.

The question of *subjective responsibility* concerns evaluations of the agent's blameworthiness or culpability on the basis of *mens rea* elements, that is, mental elements such as the agent's intentions, knowledge and foresight. An agent may not be blameworthy in a legal or moral sense even if she has inflicted severe harm upon another person. Whether a person is blameworthy for such a harmful act depends on the agent's state of mind, that is, the person's intentions, motives, knowledge of facts, foresight of the harmful consequences, and so on. Both in a moral and legal context a distinction is made between degrees of subjective responsibility.

2.1 Degrees of subjective responsibility: Intention, recklessness and negligence

With regard to moral and legal considerations of degrees of subjective responsibility, one can make a distinction between three kinds or levels of culpability: intention, recklessness and negligence. This classification of culpability is hierarchically ordered. Thus, causing harm intentionally is regarded as a more severe form of wrongdoing than causing the same harm recklessly or negligently. Similarly, reckless conduct is considered to be more grave than negligent conduct.

The difference between intention (*dolus* – intentional wrongdoing) on the one hand, and recklessness and negligence (*culpa* – unintentional wrongdoing)

on the other hand, is primarily drawn on the basis of the agent's intentions, knowledge and foresight with regard to the consequences of his action. In the literature one can find several different definitions of the terms 'intention', 'recklessness' and 'negligence'. For the purposes of this paper, I will take the following definitions as a point of departure.[4] An agent is said to act *intentionally* if the agent acts in a certain way with the purpose or conscious objective to bring about a certain result (for instance a certain harmful consequence), or if the agent knows as practically certain (or with a high degree of probability) that his action will have a certain result (such as a harmful consequence). In the latter case, the harmful effect need not be the objective of the agent, but it is foreseen as a practically certain side-effect of his action. An example can illustrate the difference between these two forms of intention. Bill decides to blow up a plane on which Mr. Brown will be a passenger, and to blow it up in mid-flight with enough explosives to destroy the plane. In this case, it is only Bill's purpose or conscious objective to kill Mr. Brown, but he also foresees the practically certain deaths of the other passengers and the crew. Thus, Bill kills Mr. Brown purposely, and he kills the passengers and the crew knowingly.[5]

A person acts *recklessly* when he consciously or knowingly disregards a substantial and unjustifiable risk. Whether a risk is substantial or not depends on such factors as the gravity of the risk of harm, the number of persons that can be endangered or harmed by the risk, and the probability of harm. It is important to note that a reckless agent does not intend to cause harm to the interests of others. Neither does he know as practically certain that his conduct will inflict harm on others. According to Joel Feinberg, 'what is known in recklessness is the existence of a *risk*. When the actor knowingly runs the risk, when he is willing to gamble with the interests of others, then, providing the risk itself is unreasonable, his act is reckless'.[6] In other words, a person acts recklessly when he is aware of a risk but proceeds despite that awareness.

In contrast, an agent acts *negligently* when he could and should be aware of a substantial and unjustified risk but is not. Negligence can therefore be described as a form of culpable ignorance. Thus, the difference between recklessness and negligence concerns the knowledge and foresight of the agent. A reckless agent knows what can go wrong although he is uncertain about the outcome of his conduct, while a negligent person is ignorant about the possible harmful consequences of his action.

2.2 The foreseeability condition and ignorance as an excuse

The foreseeability condition implies that, in cases where it is impossible to foresee the future consequences of our actions, we cannot be blamed or held subjectively responsible. In such situations, it can be argued that *ignorance* is an excuse. In moral philosophy this idea is expressed already in Aristotle's theory of moral responsibility. In the *Nicomachean Ethics*, Aristotle claims that

a person can only be held responsible for a voluntary action. For Aristotle an action is voluntary only if performed without force or ignorance.[7] Similar ideas play an important role in legal considerations of culpability.

It must be underlined that, according to the foreseeability condition, a person's *actual* ignorance of harmful consequences is, in itself, not necessarily an excuse that excludes responsibility. Ignorance is an excuse only if it is *unavoidable* ignorance. If an agent acts *negligently*, he can be blamed or held subjectively responsible for an unforeseen risk of harm provided that he could and should have been aware of the risk. This implies that negligence presupposes that it is possible for the agent to foresee the harmful consequences at the time the action was performed. Thus, negligence can be described as a failure to take reasonable precautions against a foreseeable risk of harm. The following example can illustrate such negligent conduct. A person fires a shot at another in the belief that there were no bullets in the magazine. The victim dies as a result of this conduct. Even if the agent therefore neither intended nor foresaw such an outcome, the person can be held responsible for not having examined the magazine before pulling the trigger.[8]

As pointed out by C.T. Sistare, all forms of culpable ignorance involve some culpable failure to know or to be aware of the risks one imposes on others.[9] But in some cases it may be difficult to determine what should be regarded as culpable ignorance.[10] Ian Hacking has discussed this problem with regard to possible harmful effects of new technologies. In accordance with the foreseeability condition, his starting point is that one cannot be held responsible for harmful consequences that it is impossible to foresee. At the same time, he claims that the introduction of new technologies creates new challenges for traditional concepts of culpable ignorance: 'As we produce more and more technology, and as we recognize the constant generation of all sorts of unexpected effects, we clearly have a duty to guard more and more against what is almost a complete unknown. We have no way of foreseeing those cases in which laws of nature and new phenomena will interact in a single technological achievement in a harmful or even catastrophic way. Are we then culpable if we introduce new technology in this ignorant way?'[11]

Even though it is not possible to hold a person responsible for such unpredictable effects on the basis of the foreseeablity condition, I share Hacking's intuition that we may have a precautionary duty in such situations of unavoidable ignorance. According to Hacking, the reason for this is that previous experience demonstrates that we may expect harmful consequences from introducing new and unfamiliar technology, even if it is impossible to predict the specific effects of such technologies. Hacking's reflections on responsibility and ignorance may, for example, be relevant for decision-making in the face of unforeseeable effects of new forms of biotechnology.[12] Although such considerations are relevant for the discussion of our responsibilities to posterity in situations marked by ignorance

of future technological effects, the following discussion will primarily focus on our responsibilities in the light of the foreseeability condition.

3. RISK, UNCERTAINTY AND MORAL RESPONSIBILITY

Although recent scientific developments in several research areas have increased our knowledge about the future environmental effects of our activities, the way our decisions and actions can affect future generations is still surrounded by uncertainty. This is evident in current discussions of environmental risks related to global climate change, biotechnology and the use and storage of nuclear energy. For this reason it is important to consider more closely to what extent moral agents can be held morally responsible for decisions and actions that impose risks of harm on future people. On the basis of the foregoing discussion of the foreseeability condition, the aim of this part is first to assess to which degree uncertainty regarding the consequences of an action affects our moral responsibility in general, and then discuss how uncertainty about the future affects our responsibility towards future generations in particular.

3.1 Risk, uncertainty, and ignorance

In order to consider how uncertainty affects moral responsibility, it is necessary to take a closer look on different types of decision-making situations. The terms 'risk', 'uncertainty', and 'ignorance' are used in different ways. For the purposes of this paper, it is necessary to clarify the use of these terms in the following discussion.

(1) *Risk* (in a narrow sense): This form of uncertainty corresponds to what in decision theory is called 'decision under risk'. First, in such a decision-making situation one has knowledge about possible consequences that can result from various courses of action. Second, one has sufficient information in order to attach numerical probabilities to the harmful consequences that can follow from each course of action. I will call this a *probability risk*, that is, a risk where we know the likelihood of the various consequences.

(2) *Uncertainty* (in a narrow sense): This form of uncertainty corresponds to what in decision theory is called 'decision under uncertainty'. In such a decision-making situation, the agent is assumed to have enough information to know the possible harmful consequences of any given course of action, but not enough information to assign any quantitative probability to these outcomes. This can be termed an *uncertainty risk*.

(3) *Ignorance*: In a decision-making situation that is marked by ignorance, one does not know the possible consequences that can follow from each course of action because one does not know what can happen or go wrong.

For the purposes of the following discussion, it can be useful to distinguish between what can be termed decision-making situations marked by ignorance on the one hand, and decision-making situations marked by uncertainty on the other. A *decision-making situation marked by ignorance* corresponds to (3) above. A *decision-making situation marked by uncertainty* (in a wide sense) corresponds to (1) or (2) above, that is, situations where one faces either a probability risk or an uncertainty risk. In such situations we can foresee what can go wrong (or the possible harmful consequences of each course of action), whether we know the quantitative probability of such an outcome or not. This does not mean that there is no difference between these two types of risk and that they cannot represent two different forms of uncertainty. The point is to stress that it is uncertainty – not ignorance – that is attached to both types of risk. Against this background, the term 'risk' in a wider sense can be used to refer to uncertain harmful consequences whether we know the quantitative probability of such an outcome or not.

At this point, it is important to make at least two clarifications with regard to environmental decision-making in face of uncertainty. First, in a variety of situations it can be difficult, if not impossible, to reduce uncertainty about potential harm to a probability risk using a quantitative risk analysis. This is the case in all situations where we are considering how different courses of action can affect future people. One important source of this uncertainty is indeterminacy pertaining to the complex nature of social and natural systems.[13] An example of indeterminacy is unpredictability related to how human activities will affect complex ecosystems over time. Another example, which will be discussed more closely below (in section 3.3), concerns the adaptive and innovative capability of humans and social systems. Second, more knowledge does not mean less uncertainty and vice versa. As pointed out by Marjolein van Asselt, the reason for this is that uncertainty is not simply the absence of knowledge. Uncertainty can still prevail in situations where a lot of information is available. Moreover, new information can either decrease or increase uncertainty. New knowledge on complex natural and social processes may reveal the presence of uncertainties that were previously unknown or were understated. In this way, more knowledge illuminates that our understanding is more limited or that the processes are more complex than thought before.[14]

3.2 Risk and moral responsibility

The foreseeability condition excludes that one can be held morally responsible for the consequences of an action that it is impossible to foresee. In view of this, an agent cannot be held morally responsible for an action if the decision-making situation is marked by *ignorance* of the potential harms of an action. This is the case provided that the agent cannot be blamed for negligence or some other form of culpable ignorance.[15] From an ethical point of view, a decision-making situa-

tion marked by ignorance is relevantly different from a situation of *uncertainty* about whether an action can inflict harm upon others. In such a situation, where one faces a probability risk or an uncertainty risk, one is aware of the fact that one's action may inflict harm upon others. If one chooses to perform such an action, then one cannot use the excuse that one was ignorant of the potential negative consequences of that action.

A person who acts in such a way can be blamed for *recklessness* provided that this course of action exposes others to a substantial and unjustifiable risk. Such an act is reckless because the agent *knows* or is *aware* that his action can inflict risk of harm upon others. An example of recklessness is driving too fast in the vicinity of a school or in a residential area where children are playing. Even if one did not have the intention to harm others, one can foresee that such an action can inflict serious harm upon others. To expose others to a risk that is a threat to their safety will often be regarded as culpable, regardless of whether the risk is realised or not.

There are also other reasons for interpreting the foreseeability condition in a way that makes it possible to hold persons responsible for the risks they impose on others. One argument is that it is unreasonable to interpret the foreseeability condition in such a way that it demands absolute certainty regarding the harmful consequences of an action. Such an interpretation is unreasonable because it will exclude the possibility that a person can be held responsible for his or her actions at all. Absolute certainty about the consequences of an action is impossible in principle. It is always a possibility that unpredictable side events (events that have nothing to do with the agents or the object of the act) may affect the consequences of our actions and policies.[16] Moreover, such a requirement of absolute certainty would correspond poorly with widely acknowledged moral intuitions and legal considerations of responsibility. In 'Taking Risk Seriously' (1986), Douglas Lackey presents an argument that supports the moral intuition that one can be held morally responsible for the infliction of risk:

> What is of moral interest in what we ordinarily call 'the infliction of harm' is itself nothing other than the infliction of a risk. Any infliction of harm can be decomposed into some basic action, not by itself the infliction of harm, and certain causal and perhaps conceptual consequences that constitute the harm. Since the basic action cannot suffice to produce the causal consequences, all it does is to increase the probability that the harm will ensue. ... All our moral attention must center on the basic act, evaluated in terms of the risk it generates. To take risk seriously, then, is to treat the infliction of risk as morally akin to the infliction of harm. Where there is a moral rule against inflicting harms, there is a moral rule against imposing risks, regardless of whether the risk is realized.[17]

If one accepts the preceding arguments, the foreseeability condition can be reformulated like this:

(F2) Moral agents can only be held subjectively responsible for an action if it is possible for the agent(s) to foresee that this course of action can inflict harm or risk of harm upon the interests of others.

This does not imply that every risk that is imposed on others is immoral. Both the infliction of harm and risk is only *prima facie* wrong, justifiable or excusable on various grounds. Problems pertaining to the justifiability of imposing harm and risk on others will be discussed more closely in part 4.

3.3 Future generations and the scope of moral responsibility

The reformulated version of the foreseeability condition makes it possible to argue that moral agents can be held morally responsible for decisions and activities that can impose risks upon future generations. This seems to follow from the *principle of formal equality*: cases that are relevantly similar should be treated in a similar manner; a differential treatment requires a relevant difference. On this basis, it can be argued that it is immoral to inflict a risk upon future human beings in cases that are relevantly similar to cases where it is immoral to inflict a risk upon present human beings. All else being equal (*ceteris paribus*), this implies that in cases that are relevantly similar, there is no ethical ground for a differential treatment of present and future human beings.

(i) The assumption of time neutrality and ontologcial status problems

This line of argument is based on two fundamental assumptions that will also serve as premises in the following discussion. The first is that there will exist people in the future that can be harmed by our actions. The second is that the temporal location of future people, in itself, does not constitute an ethically relevant difference between present and future generations. Thus, I assume that the moral status of present and future generations are equal, despite their different temporal positions. This can be called the assumption of *time neutrality*. Time neutrality does not rule out that there are cases where a differential treatment of present and future people can be morally justified. Rather, as pointed out by John Rawls, the assumption is that 'the different temporal positions of persons and generations does not in itself justify treating them differently. ... (W)e are not allowed to treat generations differently solely on the grounds that they are earlier or later in time'.[18] The assumption of time neutrality implies that if one makes a decision to store nuclear waste in a way that is not safe so that one can foresee that it can impose a serious risk on others, it is not ethically relevant whether such a risk is realized in a serious harm during the coming decade, five hundred years or several thousand years from now. From an ethical point of view, it is crucial *whether* an agent is culpable for such conduct, and not *when* a potential harm will occur.[19]

At this point, it is important to underline that the assumption of time neutrality is philosophically controversial in view of what Ernest Partridge has termed

'*ontological status' problems*, that is, questions concerning the ontological status of future persons.[20] There are several extraordinary moral and metaethical problems pertaining to the ontological status of future persons, and among the most important are the following: First, since future persons, *qua* future, do not exist *now*, when the alleged burdens of responsibility fall upon the living, the following questions emerge: Can non-actual future persons have moral status (or moral standing)? Can present moral agents have duties to non-existent persons, and if so, do these duties correlate with the rights of future persons?

Second, present actions and omissions can affect not only the welfare and life-conditions of future persons, but also their existence, number and identity.[21] This fact about the contingency of future people raises a perplexing problem that Derek Parfit has called the 'non-identity problem'.[22] The essence of this problem is that alternative environmental policies will not make particular future individuals worse off in cases where these policies affect the identity of future populations. For example, if we choose a policy of depletion, we do not harm anybody because if we had chosen an alternative policy of conservation of resources, a different future population would exist. This implies that we can choose policies that have bad outcomes, even very bad outcomes, yet leave no one worse off.[23]

Another problem facing the assumption of time neutrality concerns discounting of the future. Discounting of future benefits and costs is implicit in cost-benefit analysis that is the basis of most public policy decisions. To discount the future implies that current interests and preferences count for more than those of future generations. Against this background, the following question arises: Should we discount the future, or should the interests of near and remote future generations count equally as those of present generations?[24]

I do not believe that the above mentioned problems significantly affect the moral standing of future generations and our responsibilities to posterity. This must, of course, be argued, but it is not possible to pursue such an argument in this paper. For this reason I will set aside these problems in the forthcoming discussion in order to focus on the problem of how uncertainty and ignorance affect our moral responsibilities to future generations.

(ii) Future harm scenarios and responsibilities to posterity

Assuming time neutrality and leaving ontological status problems aside, one can on the basis of the foreseeability condition (F2) and the formal principle of equality argue that it is immoral to inflict a risk upon future people in cases that are relevantly similar to cases where it is immoral to impose a risk upon presently living persons. All else being equal, this seems to imply that there is no reason to demand a higher standard or degree of knowledge and foreseeability regarding the consequences of risky activities that could harm future human beings than of the activities that can inflict harm upon existing human beings. In this context it is important to emphasise that not every pessimistic speculation about

the future harmful effects of our activities are sufficient to meet the requirements of the foreseeability condition. This raises the epistemological question pertaining to what standard of knowledge with regard to the future consequences of our actions, the foreseeability condition requires. Although it is difficult to give a general answer to this question, I will suggest that an agent can only be held responsible for the risks he imposes on future generations, provided that *scientifically based harm scenarios* support the assumption that such a risk can pose a threat to future people.[25] Such harm scenarios must be based on scientific risk assessments (that is, risk identification and estimation) that can be made the subject of systematic and critical investigations and discussions. In the absence of such knowledge, it is difficult to justify the implementation of extensive and expensive efforts to protect future generations.

In cases where scientific research supports a given harm scenario, the situation is different because scientific knowledge and information can, at least in most situations, be regarded as more reliable than alternative sources of knowledge and information. This is not to suggest that scientific knowledge is certain and infallible. My claim is only that it is our most reliable source of knowledge and that it would be ethically questionable to ignore scientifically based harm scenarios that provide a reason to believe that an activity can inflict serious risks on future generations. In such cases we cannot be certain about the harmful consequences of our decisions and actions, but we are aware of what can go wrong.

If one accepts the foregoing considerations, one can argue that the scope of our moral responsibility in a temporal dimension is relative to our scientific knowledge about the future effects of our activities. This position faces the difficulty of scientific disagreement regarding the tenability of various risk assessments as well as competing future scenarios. This is a crucial problem that I will discuss in more detail in part 4.

(iii) Technological fix and ignorance of the future

An important objection to the position presented above is that we are in a decision-making situation that is marked by *unavoidable ignorance* of how our actions and policies can affect future generations. If this is correct, the foreseeability condition would exclude the possibility that we can have moral responsibilities to posterity. One way to support this objection is to argue that we are in a situation of ignorance with regard to the following important factors: (1) the interests of future generations, (2) future resource needs (both natural resources and human-made resources), and (3) the pace and direction of future scientific and technological development.

There are convincing arguments in support of the claim that we are in a situation of ignorance regarding future scientific and technological development, and it can be argued that this has important implications for our responsibility in a temporal dimension. First, this implies that we cannot foresee to which degree future generations will be able to deal with what we today regard as environ-

mental problems and technological challenges. Second, our ignorance in regard to the pace and direction of scientific and technological development makes it impossible to foresee future resource needs in several areas. This is partly because the relative value of natural resources depends on available technologies and institutions. For all we know the value of energy resources like fossil fuels, that play a crucial role in the present, may be low or insignificant in the future because future generations will have cheap solar energy at their disposal.

At this point, it might be argued that since it is likely that future generations will develop technological countermeasures, there is no reason to worry about the life-conditions of future generations. In this way, expected technological progress can serve as a justification for seemingly risky activities carried out today. This can be termed the *technological fix position*, and it rests on the faith in human ingenuity and ability to develop countermeasures in order to cope with emerging threats to their welfare. Based on historical experiences, it seems reasonable to expect future scientific and technological advances that may enable future people to overcome environmental problems that appear insurmountable today. Such optimistic predictions are, for example, defended by Julian Simon, Wilfred Beckerman and Joanna Pasek.[26]

Nevertheless, from an ethical point of view, it is questionable to rely on future technological fix. First, although it is plausible to assume that more and better technologies will be available to future generations, we cannot know for sure that such technologies will be sufficient to deal with environmental risks created by our activities. Second, technological innovations may lead to new and unexpected environmental risks. Third, since we do not know the pace and direction of future scientific and technological development, it is a fallacy both to assume that future generations will develop technological countermeasures and to assume that they will not. This is the fallacy of *argumentum ad ignorantiam*.[27] Fourth, technological advances do not occur on their own. As pointed out by Christopher D. Stone, this is particularly true of innovations that commercial markets will not reward. According to Stone, 'the more massive and expensive and large-scale the technical fix, the more heavily it will have to lean on an express political commitment to get it off the ground, especially at the research and development level'.[28]

These responses to the technological fix position do not resolve the problem whether our ignorance of future scientific and technological development makes it impossible for us to foresee how our activities will affect future people. If it is the case that such knowledge is unattainable, it is problematic, on the basis of the foreseeability condition, to claim that present moral agents have moral responsibilities toward posterity. As we have seen, a good case can be made for the position that we are in a situation of ignorance regarding the future impacts of our actions. In response to this position, I will argue that we, at least in some areas, have sufficient knowledge about future interests and resource needs. This

enables us, at least to some degree, to foresee how our decisions and activities can inflict serious risks upon succeeding generations.

(iv) Future physiological needs and 'critical resources'

Future generations will probably have a number of interests and needs that we cannot predict today. The further we look into the future, the more difficult it becomes to imagine how the life-conditions of future generations will be and which interests and needs they will have. If one had lived a hundred years ago, it would have been impossible to foresee how people today live their lives. This corresponds to our relation to future generations. In view of this, one can claim that our knowledge about the needs of future generations in most areas decreases the further one tries to look into the future, and this will reduce our responsibility in a temporal dimension.[29]

However, in one area we have fairly reliable knowledge about the needs of near and distant future generations. It is reasonable to assume that future human beings will have some of the same physical and biological needs as contemporary humans. The class of needs I refer to here can be called *physiological needs*, that is, certain physical and biological human needs that must be met in order to survive and to avoid serious and life-threatening diseases. It seems to be widely acknowledged that such needs include the need for food, water, oxygen (air), protection from the elements, and sleep.[30] These needs are related to the physical and biological constitution of human beings. For the purposes of this paper, the most important physiological needs are the need for adequate nutrition and an environment that does not transmit life-threatening diseases. If such physiological needs are not met over time, a person's physical health and normal biological functioning is seriously threatened regardless of socio-cultural conditions and individual preferences. I believe that it is reasonable to assume that the same will be the case in the near and distant future.

At this point, it is important to underline that I do not claim that the class of physiological needs are the only needs that we can predict. My position is that it seems to be convincing arguments in support of the assumption that we *at least* have reliable knowledge about the physiological needs of both near and remote future generations. This seems to be a rather uncontroversial assumption. In the literature on intergenerational ethics, there are a number of proposals regarding foreseeable future interests and needs. Usually these proposals contain what I have termed physiological needs in addition to several other interests and needs. In view of our ignorance of future scientific, technological and institutional developments, I do not believe that we have much reliable knowledge about the interests and needs of posterity – especially with regard to remote future generations – beyond their physiological needs. But I will not rule out the possibility.

On the basis of available scientific knowledge about physiological needs, one can identify a set of *critical resources*, that is, resources that are necessary to meet physiological needs. Once these critical resources are identified, one

can foresee to a certain degree how our decisions and activities will affect future generations. It is important to emphasise that both certain natural and human-made resources (such as knowledge, technology and social institutions) may be 'critical' in the sense that they are crucial for meeting physiological needs. Even if the following discussion primarily focus on critical *natural* resources, I agree with Allan Holland that 'you would need to go back to before the time when the human race started to use tools to find a period when at least some human-made capital was not 'critical".[31] Today, it is difficult, if not impossible, to imagine how, for instance, human nutritional needs could be provided for without currently available knowledge and technology.[32]

Although the relative value of critical natural resources also may depend on available technology, I think it is reasonable to assume that actions causing damage to such resources can have serious negative consequences for the life-prospects and life-conditions of future generations. For that reason we can be held responsible for decisions and actions that can lead to irreversible damages of ecosystems that are crucial for meeting future physiological needs. Moreover, it implies that we should avoid causing reversible harms to ecosystems that can be restored only at a very high cost and thus pose an indirect threat to the ability of future human beings to meet their physiological needs. Even if we cannot know for certain that the actions under consideration will have a serious impact on the welfare of future people, we are aware of the risks of harm. On account of this, an agent who knowingly disregards such substantial risks can be blamed for recklessness, unless he has very good reasons to do so.

One might argue that such a risky course of action can be morally justified in cases where it is possible to compensate future generations in an adequate way. Compensation can be made by setting aside human-made resources that may enable future generations to cope with the threats we impose on them. But the issue of compensation raises at least two difficult problems that I shall only mention briefly. The first emerges because compensation presupposes the possibility of substitutability. To what extent is it possible to substitute critical natural resources with human-made resources? Another problem with compensating future generations for the risks we impose on them is that it is impossible for future people to agree in advance to an acceptable level of compensation. According to Kristin Shrader-Frechette, this is the case even if one assumes that the level of compensation is in principle ethically acceptable.[33]

Some might object that physiological human needs can also change over time and that it is possible that future generations may be more resistant to, for example, air and water pollution than anyone can imagine today. Another possible scenario would be that advances in biotechnology creates unthought-of methods of food production that can provide for the satisfaction of future nutritional needs. All this is conceivable, but as long as new scientific knowledge does not make such scenarios likely, it is, from an ethical point of view, reasonable to base present decisions on the following assumptions: future generations will

have the same basic physical and biological needs as we have, and they will therefore need what can be identified as critical resources that are necessary in order to meet such physiological needs.

If one accepts the preceding argument, the following conclusion can be made: Due to our knowledge regarding future physiological needs and critical resources, we have a *limited responsibility* towards future generations. This implies that we can be held responsible for decisions and activities that we can foresee that can harm critical resources essential for meeting future physiological needs.

4. REASONABLE AND UNREASONABLE RISKS

One important question remained unanswered in part 3: in which cases is it immoral to inflict a risk upon future generations, and in which cases is this permissible? Or, in other words, where should the line be drawn between unreasonable and reasonable risks? My answer to this question is based on the widely acknowledged principle of nonmaleficence. This principle can be regarded as a *prima facie* norm and can be formulated like this:

- *The principle of nonmaleficence*
  If an activity can inflict avoidable harm or risk upon others, then one should abstain from that activity.

In what follows, I will first take a closer look on this principle and then consider how it can serve as a basis for the justification of more specific precautionary norms.

4.1 The principle of nonmaleficence

The principle of nonmaleficence implies that one has a *prima facie* duty not to inflict avoidable harm or risk upon others. In moral philosophy it has often been assumed that such negative duties have a more stringent or binding character than positive duties, which involves that one has to perform some positive action to help others.[34] It has also been claimed that such negative duties have priority in cases where they conflict with positive duties.[35] This view is perhaps correct in many situations, but it can be questioned whether the priority thesis is justifiable in all cases. This is evident in several situations where there is a conflict between the negative duty not to inflict harm upon others and the positive duty to prevent harm. One example can illustrate this. One can imagine a vaccine that will inflict serious harm upon very few people but can prevent that many people die from a serious disease. In this and relevantly similar cases, it is not obvious that the negative duty not to inflict harm should have priority and outweigh the positive duty to prevent harm.

Even if one regards the principle of nonmaleficence as a *prima facie* norm and thus rejects the priority thesis, there is still reason to emphasise that negative duties not to inflict avoidable harm or risk upon others always constitute an important ethical consideration in a given decision-making situation.[36] Such duties should always be followed impartially, unless competing ethical considerations outweigh the norm in a concrete situation. From an ethical point of view, this implies that it is never permissible to inflict harm or risk upon others unless one has very good reasons to do so.

At this point, it is important to consider in which cases the principle of nonmaleficence may be justifiably overridden. In order to do this, it is necessary to examine what sort of reasons (or moral principles) that are sufficiently weighty to justify the infliction of harm and risk. In *The Case for Animal Rights* (1983), Tom Regan presents an interesting discussion of this problem. He argues that it is not permissible to inflict harm upon innocent moral subjects even if such a course of action either a) reduces the sum of harms inflicted upon the affected parties, or b) increases the sum of utility/welfare of all concerned. From a deontological point of view, Regan rejects this consequentialist principle of minimizing harm because it is in conflict with the 'principle of respect', which states that all moral subjects who have inherent value should be treated as ends in themselves, never merely as means.[37] According to Regan, the principle of respect rules out that it is justifiable to harm others merely on the grounds that this is necessary to bring about optimal aggregate consequences for all involved. Against this background, he proposes instead two alternative principles for when it may be permissible to inflict harm. The first can be called the 'principle of number', and the second the 'principle of seriousness/gravity'. These principles can, for the purposes of this paper, be formulated like this:[38]

- *The principle of number*
  If a moral agent has to choose between two courses of action that have equally serious consequences for the affected parties, and one of them will affect fewer moral subjects, then the agent has a duty to choose this course of action.

- *The principle of seriousness/gravity*
  If a moral agent has to choose between two actions, and one will have more serious consequences than the other, then the agent has a duty to choose the alternative that has the less serious consequences, even if this affects a greater number of moral subjects than the alternative course of action.

In view of Regan's principles, one can grade the consequences of alternative courses of action on the basis of how the harm will affect more or less vital interests. In this context one can distinguish between *vital human interests*, connected to physical health (or physical survival) and autonomy[39] on the one hand, and *non-vital interests*, for example the wish to improve one's welfare beyond vital interests, on the other. This implies that a course of action that can

affect vital human interests has more serious consequences than a course of action that can affect non-vital interests.

Regan's principles are probably best suited to deal with the problem of when it is justifiable to inflict harm upon others in cases where we are practically certain that harmful consequences will follow from our decisions and actions. With regard to the discussion of the *relative reasonableness of risks*, one can object that his principles do not provide sufficient guidance because such situations often involve more complex considerations. Whether a risk is reasonable or not in a concrete situation depends on the weighing of several factors. Among the most important are the following: 1) The social value of the risky activity or the risky conduct. 2) The gravity of the harm, that is, the seriousness of the harm that can be the outcome of a risk. 3) The extent of harm, that is, the number of persons that can be endangered or harmed. 4) The probability or the likelihood of harm.

In many concrete cases it is by no means straightforward how the relative weight of such factors should be determined. The complexity of such considerations makes it difficult to defend a general principle that can establish when it is immoral to impose a risk upon others. Despite such difficulties, the aim of the next section is to propose a norm that can be used as a guideline in order to determine when it is immoral to inflict risks upon future generations.

4.2 The risk norm

The principle of nonmaleficence can serve as a basis for the justification of more concrete and specific precautionary norms that can be applied in decision-making situations marked by both uncertainty and ignorance. Here I will consider one such precautionary norm that is meant to apply to decision-making situations marked by uncertainty. Based on the preceding discussion (in part 3), this norm can be formulated like this:

- *The risk norm R*
  If scientifically based harm scenarios indicate that an activity can inflict a risk upon future generations that threatens their ability to meet their physiological needs, then one should either abstain from this activity or regulate it in such a way that the probability of future harm is reduced and/or provision should be made to set aside resources (including knowledge) for future generations to deal with these threats.

This norm can serve as an ethical guideline for assessments of whether it is immoral to expose future generations to a risk. According to the risk norm, it is immoral to impose a risk upon future generations in cases where the two following conditions are fulfilled: (1) The risk poses a threat to the ability of future human beings to meet their physiological needs. This condition concerns the gravity of the risk. (2) The risk assessment (that is, the risk identification and

estimation) is supported by scientifically based harm scenarios. This condition pertains to the probability of harmful consequences, although it may be impossible to attach numerical probabilities to such scenarios.

On the basis of the risk norm, one can justify legal norms which involve that the freedom of existing moral agents ought to be limited in order to prevent risky activities that may seriously harm future people. One can find support for such a position in John Stuart Mill's well-known *principle of liberty*.[40] According to this principle, there are *prima facie* good reasons to introduce legal norms that limit the freedom of action of individual and collective actors in order to prevent that they inflict serious harm or risk upon the vital interests of other human beings. This implies that the risk norm can be regarded as an ethical requirement that applies both to how individuals should act and how social (e.g. legal) institutions should be organised. The risk norm can therefore serve as a basis for ethical evaluations of both actions and institutions.[41]

If the risk norm is used to assess how just political, legal, and economic institutions ought to be organised in order to regulate risky activities, it can be regarded as a norm of justice. In view of the risk norm, a framework of institutions is unjust if it is organised in a way that allows individual and collective actors to cause avoidable damage to critical resources essential for meeting future physiological needs. If the risk norm is regarded as such a norm of justice, it can be justified as follows:[42]

(i) An empirical argument regarding how social institutions would work and which consequences they will produce in the absence of the risk norm.

(ii) An argument which suggests that the consequences produced by social institutions in the absence of the risk norm are unjust and morally unacceptable because this would allow activities that pose a threat to the ability of future generations to meet their physiological needs.

(iii) An empirical argument about how social institutions that regulate risky activities in accordance with the risk norm would produce a different outcome. This implies that social institutions organised according to the risk norm can contribute to the prevention of activities that may harm future people.

With regard to the second part of this justification scheme (ii), it can be argued that the burden of justification rests on those who advocate the position that it is morally acceptable to inflict a risk upon others that can pose a threat to their ability to meet their physiological needs. If one chooses a course of action where it is possible to foresee that it can inflict such a serious risk upon others, then one can be blamed for recklessness, regardless of whether such catastrophic consequences occur or not (see 3.2 above).

This does not imply that it is always immoral to impose risks on future people that threaten their ability to meet their physiological needs. In certain situations competing ethical considerations can outweigh the risk norm. It might be argued

that this is the case when there is a conflict between the physiological needs of present human beings and future generations. First, unforeseen advantageous developments may come to the rescue of future human beings and avert the risks we inflict upon them.[43] Second, it is only our generation that can meet present physiological needs, but there will be several generations that can contribute to the satisfaction of future physiological needs.[44]

Against this background, the risk norm should not be regarded as an absolute norm or a strict rule. Such norms prescribe that if the norm condition (the 'if-clause') is fulfilled, the norm theme (the 'then-clause') shall apply without any reservations, that is, regardless of competing ethical considerations in a concrete situation. Rather, the risk norm should be regarded as a *prima facie* norm or a guideline. This implies that if the norm condition is fulfilled, the norm theme should apply, other things being equal (*ceteris paribus*).[45] In order to determine whether such a general *prima facie* norm is binding or valid in a concrete situation, it is necessary to consider whether there are competing ethical considerations that might override the norm in this situation. When all relevant circumstances have been considered and the pros and cons of setting aside the norm have been weighed, then it can be determined whether the norm is binding in a concrete case, all things considered.

These considerations imply that if one faces a concrete case where the norm conditions of the risk norm are fulfilled, then the norm theme should apply with reservations. But in some cases it can be difficult to determine whether these norm conditions are fulfilled. This problem emerges when there is scientific disagreement about the tenability of risk assessments and harm scenarios.

4.3 Scientific disagreement about risk assessments and harm scenarios

In some important cases it is difficult, if not impossible, to reach an agreement among scientific experts upon what constitutes a fairly reliable harm scenario. Several decision-making situations that we face today are not only marked by scientific uncertainty regarding the possible consequences of our activities, but also by fundamental scientific disagreement about the tenability of harm scenarios and risk assessments. Such controversies make it difficult to determine whether the norm conditions of the risk norm are fulfilled. In such situations, some experts may think that an activity can represent a serious risk, whereas others question the tenability of this harm scenario. It can be claimed that the discussions about risks related to global climate change and new forms of biotechnology are characterised by such scientific disagreement. The role of science as a source of knowledge is threatened in decision-making situations marked by scientific disagreement because it becomes problematic to rely on the information provided by scientific experts that defend different and competing 'truths'.[46]

In what follows, I will consider three possible approaches to this problem of scientific disagreement. Something can be said for each of these strategies but they also face serious difficulties.

The first approach can be called the '*wait-and-see strategy*'. In cases where there exists scientific disagreement about the seriousness of an environmental risk, this strategy recommends that the decision regarding implementation of measures should be postponed until there is a better basis of information, that is, until fairly reliable or certain scientific knowledge is obtained. In this way, one can avoid to implement costly measures, which could have a negative impact on short-term economic and social interests, before one has obtained more reliable knowledge about the given environmental problem. Thus, one avoids implementing measures or reforms that may later be regretted if it turns out that the risk was not as serious as some had assumed. The problem with this strategy is that in many cases where there is scientific disagreement it can take considerable time before, if at all, agreement is reached about the existence of reliable scientific knowledge – and then it may be too late to implement effective measures. In some cases it can be expected that our decision-making situation will be marked by both scientific uncertainty and disagreement for many years to come. In cases where one faces the risk of causing irreversible damages to critical resources, it can be morally questionable to act on the basis of this strategy.

The second approach can be called the '*the worst-case avoidance strategy*'. In 'Some Ethical Aspects of Recombinant DNA Research' (1979), Dagfinn Føllesdal discusses this approach to scientific disagreement: 'Where we have several competing theories, which give different predictions, all these theories should be regarded with suspicion and we should be prepared for a risk that is higher than what is predicted by any of the theories'.[47] According to this strategy, one should act *as if* the worst possible consequences of our activities will occur. Such a precautionary strategy would shift the burden of proof from those who claim that an activity can have harmful future consequences to those who assume that an activity will not have any harmful effects. This implies, for example, that the burden of proof is on those who claim that human CO_2-emissions will not represent a threat to future generations and their ability to meet physiological needs. The worst-case avoidance strategy may be reasonable in situations where the stakes are high, and this is undoubtedly the case when a risk constitutes a threat to meet future physiological needs. This strategy faces the problem that it seems to support decision-making based on the most pessimistic harm scenarios regardless of competing considerations. When one is confronted with environmental risks that can pose a threat to future physiological needs, this implies that the concern for the well-being of future generations is favoured at the expense of short-term social and economical interests. It can be difficult to defend this strategy in cases where there is scientific disagreement about risk assessments and where considerable short-term benefits have to be sacrificed.

The third approach can be called the '*democratic strategy*'. According to this strategy, the question whether a risk is unreasonable should be decided in a forum consisting of both scientific experts and the parties affected by the risk.[48] The affected parties should consist of both those who could be harmed by the risks and of those who would benefit from permitting the activities that impose risks upon others. In this way, the affected parties will have the opportunity to consider competing scientific harm scenarios and make a decision from their respective points of view. In cases of scientific disagreement, this seems to be a just procedure to draw the line between reasonable and unreasonable risks.

One important objection to the democratic strategy is that it is impossible for future generations to give their informed consent to risks that can affect them.[49] One solution to this problem is to find ways to represent the interests of future generations. However, such representation raises new problems. Who should represent future generations, and how should such representatives be elected or nominated? What should be the task and the mandate of those representatives? How should these representatives weigh the interests of different future generations, and which generations should have priority? One problem in this context is, as Christopher D. Stone points out, that the interests of different future generations can come into conflict:

> Consider one credible climate change scenario which (rightly or not) has it that relatively unconstrained use of carbon and other greenhouse gases will, on net, benefit humankind for the next several generations. Those presently alive and their immediate descendants will be spared the costs of constraints and forego few benefits, but at some more remote period – after 200 years, say – the accumulated congestion will trigger a host of non-linear positive feedback mechanisms with dire consequences for populations then living. Where such conflicts among future generations are possible, there would be the question to resolve, which should the guardian consider his principal?[50]

Provided that representation of future interests is feasible, the democratic strategy can only be regarded as a just procedure if their interests are represented. This follows from the widely acknowledged assumption that the burden of justification rests on those who hold that some affected parties should be excluded from taking part in decision-making processes that significantly bear upon their lives. But representation of future generations requires a solution to the mentioned problems of representation.

The preceding discussion illustrates that it is difficult to resolve the problem of scientific disagreement. It turns out that there are considerable problems related to these three strategies. However, the preceding discussion suggests that it is an important challenge to find ways to represent future generations in decision-making procedures that affect their life-prospects and life-conditions.

5. CONCLUSION

In this paper I have considered how uncertainty and ignorance of the future affect our moral responsibility towards future generations, and to what extent moral agents can be held responsible for activities that inflict risks on future people. If one takes the foreseeability condition as a point of departure, one can draw the conclusion that the scope of our moral responsibility towards future generations is coextensive with the ability of science to foresee the possible future consequences of present decisions and actions. This responsibility is limited because our ability to foresee how our decisions and activities will affect future generations is limited. The reason for this is primarily that we are in a situation of ignorance regarding the pace and direction of future scientific and technological development. This ignorance reduces our responsibility in a temporal dimension because in most areas it is impossible to foresee the interests and resource needs of future generations. This is especially the case with regard to distant future generations. In one area, however, we have fairly reliable knowledge about future generations. It is reasonable to assume that future human beings will have the same physiological needs as we have. On this basis, it has been argued that we can be held responsible for activities that can cause damage to critical resources that are necessary to provide for future physiological needs. Furthermore, it is suggested that it is *prima facie* immoral to impose risks upon future generations in cases where the following conditions are fulfilled: (1) the risk poses a threat to the ability of future generations to meet their physiological needs, and (2) the risk assessment is supported by scientifically based harm scenarios.

NOTES

[1] I would especially like to thank Matthias Kaiser, Ernest Partridge and Jon Wetlesen for valuable comments and suggestions. In addition, I thank Peder Anker and Runar Torgersen for useful comments on an earlier draft of this paper.

[2] A moral agent here refers to a person who is able to take moral responsibility for his or her actions and who can be held responsible for them.

[3] This distinction between objective and subjective responsibility is made in Norwegian criminal law. Despite the fact that these terms are not used in Anglo-American criminal law, they are reflected in the distinction between *actus reus* (the outward act of crime) and *mens rea* (the mental state of the agent). H.L.A. Hart describes the importance of this distinction like this: 'All civilized penal systems make liability to punishment for at any rate serious crime dependent not merely on the fact that the person to be punished has done the outward act of crime, but on his having done it in a certain state or frame of mind or will. These mental or intellectual elements are many and various and are collected together in the terminology of English jurists under the simple sounding description of *mens rea*, a guilty mind' (Hart 1968, p. 114).

[4] These definitions are based on several sources. The most important are Feinberg 1975; Hart 1968; Sistare 1989; Cane 2002; and *Model Penal Code: Official Draft and Explanatory Notes*, Philadelphia:The American Law Institute, 1985.

[5] This example is taken from Sistare 1989, p. 104.

[6] Feinberg 1975, p. 71. See also Cane 2002, pp. 80–81.

[7] See Aristotle's *Nicomachean Ethics*, book III. J. M. Fischer and M. Ravizza call this the 'Aristotelian conditions' of moral responsibility: 'The 'epistemic condition' corresponds to the excuse of ignorance. It captures the intuition that an agent is responsible only if he both knows the particular facts surrounding his action, and acts with the proper sort of beliefs and intentions. The second condition of moral responsibility corresponds to the excuse of force; it pertains not so much to cognitive matters but affective, volitional, and executive features. We shall call the second condition, the 'freedom-relevant condition', or perhaps the 'control condition'. It specifies that the agent must not behave as he does as the result of undue force; that is, he must do what he does freely' (Fischer and Ravizza 1998, p. 13). The foreseeability condition can be regarded as an 'epistemic condition'.

[8] As Ernest Partridge has pointed out to me, culpable ignorance is presumably subject to the three degrees of subjective responsibility mentioned above. If this is correct, one can be intentionally, recklessly or negligently ignorant. This seems to imply that a person is culpable if he fails to take reasonable precaution against a foreseeable risk because he remains intentionally, recklessly or negligently ignorant of available knowledge.

[9] Sistare 1989, p. 59.

[10] See Zimmerman 1997 for a discussion that demonstrates the complexity of this problem.

[11] Hacking 1986, p. 153.

[12] A number of interesting contributions to the discussion of precaution with regard to the introduction of new technologies are found in Cottam et al. (eds.) 2000; Kaiser (ed.) 2002; and Tickner (ed.) 2003.

[13] Indeterminacy as a source of uncertainty is discussed more closely in Wynne 1992 and in a number of contributions in Tickner (ed.) 2003. An interesting and extensive discussion of different sources of uncertainty is found in van Asselt 2000, ch. 3A.

[14] See van Asselt 2000, p. 81.

[15] See the discussion of culpable ignorance in section 2.2.

[16] See also de-Shalit on unpredictable side effects. de-Shalit 1995, p. 78.

[17] Lackey 1986, pp. 636–7.

[18] Rawls 1971, pp. 294–5.

[19] A similar point is made by Derek Parfit: 'Suppose that I leave some broken glass in the undergrowth of a wood. A hundred years later this glass wounds a child. My act harms this child. If I had safely buried the glass, this child would have walked through the woods unharmed. Does it make a moral difference that the child whom I harm does not now exist? ... Remoteness in time has, in itself, no more significance than remoteness in space' (Parfit 1984, pp. 356–7).

[20] See Partridge 2000.

[21] As Ernest Partridge has pointed out to me, the category of future (presently non-existent) persons can as a result of this contingency be divided into several sub-categories: (a) 'eventuals' (those who will exist), (b) 'possibles' (those who may or may not exist

– depending upon choices of present-day 'actuals'), and (c) 'mere possibles' (those who could, but won't, come into existence).

[22] See Parfit 1984.

[23] In addition to Parfit's extensive analysis of the non-identity problem, there are a number of interesting discussions of this problem and its implications. See, for example, Schwartz 1978; Kavka 1982; Grey 1996; Partridge 1998; and Carter 2001.

[24] There are a number of discussions pertaining to discounting of the future. See, for example, Parfit 1984; Cowen and Parfit 1992; O'Neill 1993, pp. 49–59; and Beckerman 1996, ch. 11.

[25] This requirement of knowledge regarding possible future harm is inspired by NENT 1997, ch. 3.; and Kaiser 1997 and 2003. A number of interesting contributions to the debate on the role of science in environmental and technological decision-making are found in Kaiser (ed.) 2002 and Tickner (ed.) 2003.

[26] See Simon 1996; and Beckerman and Pasek 2001. Beckerman and Pasek write that 'we do not believe that vital interests of future generations will be permanently threatened by environmental degradation' (2001, p. 113). Among the most important reasons for this are expected future technological and scientific innovation as well as an increasing rate of diffusion of innovation and technical progress (See 2001, ch. 6). A critical discussion of Julian Simon's position is found in Partridge 2001.

[27] Cp. NENT 1997, p. 117.

[28] Stone 1993, p. 30.

[29] Some have argued that our limited ability to foresee the life-conditions and needs of future people provides a basis for the position that we can only have moral duties to our immediate posterity and not towards distant future generations. This position is advocated by Golding 1981 and Narveson 1978.

[30] A similar concept of physiological needs is found in the works of Abraham Maslow. See Maslow 1970.

[31] Holland 1999, p. 53.

[32] What I have termed critical natural resources are one kind of what Andrew Dobson has called 'preconditional environmental goods'. More precisely, such critical resources can be regarded as preconditional environmental goods in the sense that they are essential for human existence and survival. See Dobson 1998, pp. 75 and 125.

[33] See Shrader-Frechette 2002, p. 111.

[34] W. D. Ross puts it like this: 'It seems to me that non-maleficence is apprehended as a duty distinct from that of beneficence, and as a duty of a more stringent character' (Ross 1930, p. 21).

[35] This view is expressed by J. Rawls 1971, p. 114 and W. Frankena 1973, p. 47.

[36] If one wants to defend the priority thesis, the principle of nonmaleficence must be regarded as an absolute norm in relation to positive duties, not as a *prima facie* norm. The distinction between absolute and *prima facie* norms will be discussed more closely in section 4.2.

[37] See Regan 1983, pp. 248–250.

[38] Regan 1983 calls the first 'the miniride (minimize overriding) principle' (p. 305) and the second he terms the 'worse-off principle' (p. 308). Both are formulated in terms of

rights. I have reformulated them in terms of duties in a way that is similar to those found in Wetlesen 1999, pp. 312–313.

[39] Here vital human interests refer to what Doyal and Gough have termed 'basic human needs': 'Basic human needs stipulate what persons must achieve if they are to avoid sustained and serious harm. ... Since physical survival and personal autonomy are the preconditions for any individual action in any culture, they constitute the most basic human needs – those which must be satisfied to some degree before actors can effectively participate in their form of life to achieve any other valued goals' (Doyal and Gough 1991, p. 50 and 54).

[40] See Mill 1859 and Feinberg 1984.

[41] This is subject to the proviso that future persons have the same moral standing as present persons – i.e. that this standing is not compromised by their ontological status. See above section 3.3.

[42] This is a revised version of T.M. Scanlon's scheme for the justification of rights. See Scanlon 1988, p. 84.

[43] Cp. Malnes 1995, p. 105.

[44] Cp. Attfield 1999, p. 163.

[45] Interesting discussions of this distinction between absolute and *prima facie* norms are found in Ross 1930; Searle 1978; Wetlesen (in Thommesen and Wetlesen 1996); and Zimmerman 1996.

[46] Schomberg 1992 describes this point as follows: 'Die funktionale Autorität der Wissenschaft wird bedroht, wenn es in der Wissenschaft eine Kontroverse von disziplinüberschreitendem Charakter gibt. Das Vertrauen in die wahrheitsübertragende Funktion der Wissenschaft kann ja nicht in unterschiedlichen Wahrheiten verschiedener Expertengruppen gegründet sein. Der Diskurs der Wissenschaft kreist dann um die Frage, wie neues Wissen erworben werden kann. Dabei ist ein je schon verfügbares Wissen Kontrovers: die Angemessenheit traditionell akzeptierten Wissens wird bezweifelt oder als unzureichend angesehen. Der Diskurs der Wissenschaft kann in diesem Fall auch einen Methodenstreit beinhalten. Auch ist nicht immer klar, welche wissenschaftliche Disziplin sich der Problematik am besten annehmen kann' (Schomberg 1992, p.262.).

[47] Føllesdal 1979, pp. 405–6.

[48] Similar approaches are proposed by Shrader-Frechette 1991 and Funtowicz and Ravetz 1993 and 1999.

[49] See Shrader-Frechette's discussion of this problem, 2002, pp. 105–113.

[50] Stone 1998, p. 68.

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TITLE: Environmental Risks, Uncertainty and Intergenerational Ethics
SOURCE: Environ Values 13 no4 N 2004
WN: 0431508173002

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