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Precautionary Principle (version 2)

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ABSTRACT
Ethical debate linking to the precautionary principle (PP) addresses underlying issues regarding the ethics of risk, uncertainty, and public policy. It has evolved quickly from an initial stage of skepticism and scorn, based on critique regarding unclarity, impracticality, and ethical unjustifiability. Nowadays, these points are incorporated into systematic debates on how to best understand and justify a precautionary approach to decision- and policy-making. The general ethical idea behind PP says that in the face of an activity that may produce great harm, we (or society) have reason to ensure that the activity is not undertaken, unless it has been shown not to impose too serious risks. Recent debate has highlighted an epistemic perspective, dividing the debate into two main areas: (a) epistemic precaution, and (b) ethics of risk, which may be related to each other in different ways. With regard to these dimensions, an ethical theory of precaution needs to clarify what determines whether an activity may produce great harm (actualizing both (a) and (b)), what determines whether or not some risk is too serious (actualizing (b)), and what is required to show that too serious risks are not imposed (actualizing (a)). Several competing basic suggestions are in play regarding these issues, actualizing questions about the relationship between traditional ethical theory and the ethics of risk. All suggestions have wide applicability to contested moral and policy areas regarding the use of technology and environmental action, but much work remains to clarify what difference a sound PP makes for these.

Keywords: *artificial intelligence; bioetechnology; climate change policy; cost–benefit analysis; decision theory; environmental policy; nanotechnology; precaution; risk; risk analysis; risk management; technology; uncertainty*

Following the statement in the United Nations' *Rio Declaration* of 1992 that countries should apply a "precautionary approach" in policymaking on environmental and technological issues, the notion of a precautionary principle (PP) gained ground in worldwide policymaking, thus catching the interest of ethics scholars. Although seldom explained in much detail, and resulting in quite different policy results in different countries and areas (O'Riordan et al. 2001; Sandin 1999; Trouwborst 2009; Zander 2010), PP is generally understood as a norm urging or permitting policymakers to take preventive action in the face of unknown, uncertain, or probable dangers, motivated by the experience of how seemingly valuable and promising practices may lead to seriously adverse consequences in spite of lack of solid evidence to this effect (Sandin 1999). In ethics debate, this idea has been applied not only to matters regarding the large-scale introduction and use of technology (e.g., regarding artificial intelligence, energy production, transport and communication, nano- or biotechnology, and so on) (*see* ARTIFICIAL INTELLIGENCE [WBIEE870]; BIOETHICS [WBIEE782]; BIOTECHNOLOGY [WBIEE291]; NANOTECHNOLOGY, ETHICS OF [WBIEE132]) with possible ensuing impact on the natural environment connecting to the notion of sustainability (*see* SUSTAINABILITY [WBIEE033), but also, for example, to abortion (*see* ABORTION [WBIEE226]), medical genetics, embryo experimentation (*see* EMBRYO RESEARCH [WBIEE691]),

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the treatment of animals (*see* ANIMAL EXPERIMENTATION [WBIEE778]), terrorism (*see* TERRORISM [WBIEE040]), and general research ethics (*see* RESEARCH ETHICS [WBIEE001]) (Munthe 2011, 2016). Many of these applications advocate strong conclusions in spite of the fact that PP or its normative justification have not been made very clear. At the same time, PP has been the subject of criticism, much of which boils down to three points: lack of clarity, lack of practicality, and/or ethical implausibility. Curiously, these critical points have often been made in conjunction, in spite of the fact that a clear sense of what PP means seems necessary for backing up the other two objections.

In opposition to claims that the unclarity of PP makes it a hopeless idea (Bodansky 1991; Morris 2000), closer analysis indicates that PP may be interpreted in a multitude of different, more precise ways, some of which convey ethical ideas that may accommodate much of the common criticism (Sandin et al. 2001; Sandin 2006). Building on a seminal analysis by Per Sandin (1999), further developed in Sandin (2004) and followed by several similar suggestions (Gardiner 2006; Manson 2002), PP offers a wide variety of possible interpretations of interest to many fields of study.

From the particular point of view of ethics, the interesting idea behind PP is best explained as the suggestion that *in the face of an activity that may produce great harm, we (or society) have reason to ensure that the activity is not undertaken, unless it has been shown not to impose too serious risks*. This *prescriptive* (Sandin 2004) or *strong* (Gardiner 2006) idea needs to be distinguished from what has been called the *weak* (Gardiner 2006) or *argumentative* (Sandin 2004) idea behind PP, which merely says that acting on weak evidence may be acceptable when much seems to be at stake. This latter idea has been used as a basis by Steel (2014) in a seminal attempt to clarify a rational epistemic framework for PP, where all specifications of PP fit into the conception of a "tripod" of *a knowledge condition*, *a harm condition*, and a *recommended precaution*, thereby separating two types of issues to be answered by any specific PP:

a. *Epistemic precaution*: How much do we need to know about risks and chances for our decisions to be justifiable?
b. *Ethics of risk*: What mixes of risks and chances may be justified given a certain epistemic state?

What more exact decisions and policy arrangements with regard to these two questions that may be justified remains to be worked out and requires substantial ethical argument. Such arguments start off from the mentioned prescriptive understanding of PP.

Besides general issues about what is to qualify as harm (*see* HARM [WBIEE186]) (actualizing basic issues, for example, in environmental and population ethics; *see* ENVIRONMENTAL ETHICS [WBIEE116]), further understanding of PP requires a basis for assessing:

1. what determines whether an activity *may* produce *great* harm (actualizing both (a) and (b) above;
2. what determines whether or not some risk is *too serious* (actualizing (b)); and
3. what is required to *show* that too serious risks are not imposed (actualizing (a)).

It is far from clear that these issues can be satisfactorily attended to using ready-made standard models in decision theory, ethics, and/or political philosophy. In particular, the recurring idea of modeling PP as a formal decision rule, such as the maximin strategy of decision theory (Bognar

2011; Gardiner 2006; Hansson 1997), is beset with problems (John 2007; Munthe 2011; Peterson 2006; Sandin 2004; Steel 2014).

The claim that PP is *impractical* comes in a strong and a weak version. The strong version claims that prescriptions supported by PP are impossible to satisfy because these are necessarily paradoxical, issuing inconsistent prescriptions and/or systematically issuing recommendations that are impossible to act on (Harris and Holm 2002; McKinney and Hammer Hill 2000; Sunstein 2005, 2008). This argument connects to the suggestion that PP is impossible to square with standard risk–cost–benefit approaches to decision-making (RCBA) that take into account variations in probability, outcome value, and so-called opportunity costs of options (see below). However, one could just as well view the argument as ruling out only such *specific interpretations* of PP. While the argument shows that avoiding paradox is a desideratum for a sound version of PP, it does not disprove that PP may be designed to avoid paradox (John 2007; Munthe 2011; Sandin 2004; Steel 2014). The weaker practicality-based criticism rather concerns whether the idea of PP as a single, directly applicable decision rule is a viable suggestion in light of the fact that different areas of practice operate under widely variable conditions. While philosophy of science-based analysis has tended to assume that PP must take such form (Hansson 1999; McKinney and Hammer Hill 2000; Steel 2014), ethicists have been more skeptical in this respect, viewing PP as a more general ethical principle that may recommend very different policy measures depending on circumstances (Hartzell-Nichols 2013; Munthe 2011; Sandin 2004). In relation to Steel's "tripod," this may be understood as allowing "recommended precautions" to be general policy measures of different kinds, going well beyond the sort of simple bans against technology that has often been assumed by critics. Such a general principle need not be a comprehensive ethical theoretical stance, however, but can be seen as a "mid-level" principle to be traded off against other considerations (Sandin & Peterson 2019). The question then arises how such a PP is to be grounded in more basic ethical theory for its justification.

Criticism claiming that PP is *ethically implausible* can regard either PP in general or some specific interpretation. Attempts to wield general knock-down arguments against PP link to the mentioned accusation of necessary paradox, and have taken three forms. The first assumes that, to avoid paradox, PP arbitrarily has to exempt the option of preserving the status quo from scrutiny, thereby faulting its own rationale (since the status quo may be very risky and dangerous) (McKinney and Hammer Hill 2000). The second assumes that, to avoid paradox, PP cannot take into account the fact that precautionary action will itself bring certain costs, risks, and uncertainties, but must take a rigid form where nuanced scientific information about the comparative riskiness of options is disregarded (Harris and Holm 2002; McKinney and Hammer Hill 2000; Sunstein 2005, 2008). The third conjectures that political implementation of PP would have to constitute a break with important political values, such as scientifically informed and outcome-sensitive policymaking or individual liberty – for example, by being incompatible with RCBA (McKinney and Hammer Hill 2000; Sunstein 2005, 2008). Sunstein (2005) has insisted that the only alternative to such flawed versions of PP is the standard RCBA approach, essentially expressing the decision-theoretical orthodoxy of maximizing expected utility, thus necessarily making PP into a child of irrational sides of human nature.

Such general attacks become less convincing when more nuanced treatments of PP are considered. As mentioned, the general ethical idea behind PP can be interpreted in a multitude of different ways, depending on what more precise answers are given to the questions (1)–(3) above, and the general arguments against PP seem to target only a subset of the possible

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interpretations that can be thus generated (Sandin 2006). For instance, PP may be as applicable to the option of preserving the status quo as to other options and the answer to question (1) may include a threshold of some sort that restricts the choices or options to which PP is applicable, although the form and basis of such a threshold has been debated (Alhoff 2009; Gardiner 2006; Holm 2018; Manson 2002; Munthe 2011; Peterson 2002; Sandin 2004; Sunstein 2009). One idea is to apply some variation on the classic *de minimis risk* theme from decision theory; another is to restrict the applicability of PP to options where some of the possible outcomes are especially sinister – often described in terms of catastrophe or irreversible damage – or when the evidential basis of decision-making is particularly weak. From an ethics point of view, what solution to prefer depends on what more exact idea can gain support from a plausible, underlying ethical theory.

The answers to questions (2) and (3) may furthermore allow comparative assessments on the basis of scientific information in such a way that it is compatible with the aspects of RCBA mentioned earlier, without necessarily making PP identical to RCBA in its standard form (John 2007; Munthe 2011; Sandin et al. 2001; Steel 2014), but possible to incorporate into standard approaches to risk analysis and management (Randall 2011). The conjecture that PP has to be the child of human irrationality would thereby seem to beg the question, since it assumes without argument that all possible versions of PP that are not identical to standard RCBA lack justification.

The general criticism against PP therefore primarily seems to support the idea of certain desiderata that a sound PP needs to meet. Besides the avoidance of precautionary paradox, PP also needs to be, in Steel's words, proportional and effective (Steel 2014). Within such a frame, there is room for arguments concerning which more precise idea satisfying these requirements is ethically justified. If such arguments can be given, the claim that a political implementation of PP must imply undue restrictions of individual liberty becomes less obvious. Just as harm to others (*see* HARM PRINCIPLE [WBIEE285]) is a generally recognized reason for justifying liberty restrictions, ethically unjustified impositions of risks to others may be a similar reason (Hansson 2013). This idea squares well with accepted policies and common-sense opinions in the area of policymaking (e.g., traffic rules, safety assurance of pharmaceuticals, and communicable disease management) and private life (inconsiderate, reckless, or negligent behavior imposing significant risks to the well-being or liberty of others). Although ethics or moral philosophy have not until recently focused their attention on this class of moral opinions (Hansson 2013), they are an obvious part of human moral thinking, dealt with, for example, in legal theory and practice, and linking to underlying general questions about morally responsible decision-making (Björnsson & Brülde 2017).

The task of clarifying the ethical idea behind PP actualizes three distinct challenges (Munthe 2011):

A. supporting the idea that lack of precaution has a moral price (i.e., that we have some reason not to impose or allow impositions of risks not shown to be sufficiently unserious);
B. acknowledging that also precaution has such a price (since any measure to prevent or reduce a risk will bring costs and risks of its own); and
C. that a plausible version of the ethical idea behind PP needs to be formulated by balancing (a) and (b) in a way that provides reason for believing this version to prescribe an *ethically acceptable price of precaution*.

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This balancing includes both the epistemic and the risk ethical aspect of PP, and is thus not only about weighting predetermined risks and chances of predefined alternative options (i.e., standard RCBA thinking). It also includes the question of how to assess the ever-present option of delaying the decision and instead improving the basis of information or knowledge that underlies any risk assessment, as well as what options there are. Actual policy suggestions based on PP are often about delaying the possible introduction of some activity until the available set of options has been reasonably settled and the risk–benefit profiles of these options have been made sufficiently clear and shown to be acceptable (Trouwborst 2009; Zander 2010). This issue becomes especially complex in cases where the activity is pondered for precautionary reasons – for instance, the case of using biotechnology with uncertain long-term effects on the ecosystem for overcoming current environmental problems (e.g., in farming or energy production), or using nuclear power to ensure access to energy without contributing further to climate change (*see* CLIMATE CHANGE [WBIEE355]) (Hartzell-Nichols 2017; McKinnon 2011; Munthe 2011).

Providing arguments to these effects requires a theoretical basis that allows for ethical assessment of risks *in their own right* (*see* RISK [WBIEE465]) and several independent arguments support the conjecture that this need cannot be met by standard solutions in either decision theory or ethics (Hansson 2013; Munthe 2011, 2019; Steel 2014). Attempts to provide ethical criteria for judging risks within the framework of standard ethical theories face the challenge that such theories usually assume the actions undertaken or the outcomes produced to be given at the outset of analysis, while what is needed for an ethics of risk and uncertainty is the very opposite of this. From the standpoint of any of the familiar classic ideals in ethics, an ethics of risk needs to provide criteria for when and why actions that *perhaps and perhaps not* meet the standards of ethical defensibility set by these ideals are ethically defensible. The question of to what extent classic approaches in ethical theory could be modified to apply to risky decisions is complicated, but has been assessed with skeptical results by Munthe (2011). Rights- and justice-based ethical theories (*see* RIGHTS [WBIEE228]; JUSTICE [WBIEE385]) have to *assume* rather than provide reason for the claim that being exposed to risk is equivalent to harm or loss. Consequentialist (*see* CONSEQUENTIALISM [WBIEE428]) theories encounter problems in justifying a credible notion of how the imposition of risks and chances is to be balanced against the occurrence of actual harms and benefits. Natural law (*see* NATURAL LAW [WBIEE346]) theories have problems of grounding an even elementary coherent notion of how risk impositions may be morally wrong in their own right. The clarification and justification of PP may thus require some ethical theoretical innovation with regard to risks and risk impositions, a task fitting the novel field of the ethics of risk (Hansson 2013).

Such a theory needs to observe the above-mentioned desiderata implied by the criticism against PP. Therefore, attempting to recreate absolutist natural law ethical ideas in the form of an ethics of risk, such as the pioneer attempt of German theologian Hans Jonas (1979), seem to fail at the outset. The idea of an absolute or very strong moral ban on the risking of certain upshots (Jonas's proposal is the extermination of humanity) regardless of the likelihood of their actual occurrence blocks rather than provides room for scientifically informed and ethically sensitive comparisons of the risks and chances of alternative options. The need for having a version of PP that is practically useful in a policy context provides further reason to the same effect (since whatever type of upshot is assumed to be absolutely forbidden to risk, all options will impose a slight such risk) (Sunstein 2008). Practical considerations also put into question the idea of modeling PP as expressing a virtue ethical ideal (Sandin 2005, 2009; *see* VIRTUE ETHICS [WBIEE616]). While a

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virtue of precaution may have a place in a general ethics of risk and uncertainty, personal qualities of decision-makers do not seem to be what should primarily be in focus when assessing overarching policy, but rather the qualities of options, upshots, evidence, and decision-making. An adequate theory thus needs to be *gradualist* rather than absolutist in its basic construction and to provide reasons connecting to decisions and risk impositions rather than decision-*makers*. Such a theory, then, should imply what it takes for a decision or risk imposition to pay an ethically appropriate price of precaution.

Building such a theory, elements from standard decision- and ethical theory can be used to some extent, but the endeavor also provides room for addressing problems that these areas have had difficulty tackling. This regards, not least, the problem regarding on what basis to decide when, and how much, to delay a decision in order to improve the quality of the basis of information underlying the risk assessment. This query links the ethics of PP to the ethics of belief (*see* ETHICS OF BELIEF [WBIEE044]) and is important for clarifying the relationship between the ethics of epistemic precaution (that, in the words of Peterson, "guides belief") and that of risk–chance balancing ("guiding action") (Peterson 2007). It is especially pressing in extreme risk and uncertainty scenarios, such as those involving so-called existential risk (Munthe 2019). While Steel (2014) primarily views this query as an epistemic problem, for the ethicist it is a more demanding issue to resolve, as any decision will affect the price of precaution in morally relevant ways. Therefore, the ethical analysis should view epistemic precaution as a special case of justifying a balance between risks and chances based on some ideal of responsible decision-making. The obvious proposal of counting as relevant the combination of the benefits and harms of possible outcomes and the likelihood of these outcomes given a certain decision (thus making PP sensitive to probability and outcome variation and attention to opportunity costs – thereby creating compatibility with RCBA) may be complemented by ideas to the effect *there is a moral downside to basing such a decision on information that could have been improved.* This downside could be seen as instrumental (Steel 2014), as a basic moral consideration in its own right (Munthe 2011), or as an outcome of acting out of virtue (Knutsson & Munthe 2017). At the same time, such a moral assessment may pay attention to the basic elements of risks, chances, likelihoods, and the quality of information in many different and potentially conflicting ways.

A basic issue regards to what extent such an assessment – as in standard RCBA – should observe *risk neutrality* (Hansson 1999). That is, should risks and outcomes be evaluated on the assumption that harms and benefits of equal magnitude balance each other out perfectly from an ethical point of view? The alternative would be an idea of an *increased moral weight of evil*: harms and benefits of equal magnitude are assessed differently in terms of moral importance or seriousness, so that risks involving the possible occurrence of worse consequences become more difficult to justify in terms of compensating benefits in a way disproportionate to their comparative magnitudes. This idea has been defended on the ground that the choices between lotteries with equal probabilities for winning or losing, but with radically different stakes (say, losing a modest amount of money or winning the same sum, as opposed to losing all your material possessions or doubling them) is not ethically indifferent, although this would be implied by the idea of risk neutrality (Munthe 2011). The idea of an increased moral weight of evil can be worked out further in different ways, however, and the analysis of what particular version has the most merit gives rise to a number of complex issues in the ethics of risk.

Another important question is if the underlying justifying basis of PP should take the form of an ethics of individual rights (Hansson 2013). This may be problematic, since a plausible version of PP would need to allow for trade-offs between competing interests (in terms of risks and

chances) not fitting inside the framework of rights–ethical thinking. Many of the risks that are relevant from the perspective of PP are the results of many individual actions taken together – thus making the responsibility for securing a plausible price of precaution a collective matter (*see* COLLECTIVE RESPONSIBILITY [WBIEE435]). PP may still uphold the view that exposing someone to a risk is a *moral reason* against an action. However, to secure defensible precaution, it may often be necessary to expose single individuals to loss, harm, or risk that cannot be balanced by the prevention of any such downside for any particular individual (since the contribution of each individual to the overall risk-picture if precaution is not applied is so insignificant). For this reason, precaution, in the context of policymaking, should be viewed and analyzed as a common or public good (*see* PUBLIC GOODS [WBIEE752]; COMMON GOOD [WBIEE608]).

The underlying ethical issues actualized by PP have so far been subjected to limited constructive analysis, although the situation has improved in recent years. Initial contributions to the issue of what a social implementation of PP may mean in general terms (Ahteensuu 2008; Cranor 2003; Gardiner 2006; Goklany 2001; Munthe 2011; Sunstein 2005; Whiteside 2006) have recently been complemented by analyses of what a *plausible* PP would imply regarding societal organization, technology, and environmental policy in particular contested areas such as digital-, nano-, and biotechnology, climate change, and artificial intelligence and robotics (Hartzell-Nichols 2017; McKinnon 2011; Munthe 2016, 2017; Resnik 2013; Steel 2014). One underlying basic issue, where one seminal theoretical attempt has been presented by Martin Peterson (2017), is about how precautionary moral reasons should be related to other types of seemingly valid ethical concerns when these pull in different directions with regard to practical guidance.

The overly polarized and rather simplistic situation of the early ethical debate on PP in terms of "for or against" has quickly progressed, thanks to growing recognition that PP is not one preset, clear-cut principle and that many underlying issues, perspectives and solutions are on the table. The ethical discussion has moved into a more constructive mode, probing both the philosophical underpinnings of ethically justifying specific variants of PP, and what practical guidance and recommendations can be supported in specific areas from PP. An area in need of more concentrated address is how this work, and the related work on the ethics of risk and uncertainty, is to be better integrated with other areas of ethical research, both basic ethical theory and applied ethics and political philosophy in different areas.

See also: ABORTION [WBIEE226]; ANIMAL EXPERIMENTATION [WBIEE778]; ARTIFICIAL INTELLIGENCE [WBIEE870]; BIOETHICS [WBIEE782]; BIOTECHNOLOGY [WBIEE291]; CLIMATE CHANGE [WBIEE355]; COLLECTIVE RESPONSIBILITY [WBIEE435]; COMMON GOOD [WBIEE608]; CONSEQUENTIALISM [WBIEE428]; EMBRYO RESEARCH [WBIEE691]; ENVIRONMENTAL ETHICS [WBIEE116]; ETHICS OF BELIEF [WBIEE044]; HARM [WBIEE186]; HARM PRINCIPLE [WBIEE285]; JUSTICE [WBIEE385]; NANOTECHNOLOGY, ETHICS OF [WBIEE132]; NATURAL LAW [WBIEE346]; PUBLIC GOODS [WBIEE752]; RESEARCH ETHICS [WBIEE001; RIGHTS [WBIEE228]; RISK [WBIEE465]; SUSTAINABILITY [WBIEE033]; TERRORISM [WBIEE040]; VIRTUE ETHICS [WBIEE616]

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