

MONIKA BOBBERT*

Environmental damage, climate change and the precautionary principle from an ethical perspective**

ABSTRACT: Preventing major damage or a disaster usually requires action before damage occurs, especially if this damage would be irreversible. The precautionary principle is central to environmental and climate issues, but has only recently become more important, for example as one of the four fundamental principles of the European Union. With regard to the precautionary principle, the open flanks and possible areas of dispute that characterise the debates on this principle are shown from an ethical perspective.

Firstly, the scope of the precautionary principle has expanded and with it the goods worthy of protection. Secondly, potential risks in many different areas need to be identified or researched - with the help of an interdisciplinary approach. Fourthly, the risks must be assessed in relation to ethical and legal norms. Psychological pitfalls must be avoided in the assessment. Fourthly, precautionary measures must be discussed in terms of their effectiveness and priority in view of other areas of risk.

KEYWORDS: precautionary principle, climate change, environmental ethics, risk assessment, uncertainty.

1. Introduction

1.1. On the question

Preventing major damage or a disaster usually requires measures to be taken before damage occurs, especially if these damages were irreversible.¹ Political precautionary concepts have been around for a long time, for

* Prof. Dr. theol. Monika Bobbert, Dipl.-Psych., Director of the Seminar of Moral Theology, Faculty of Catholic Theology, University of Muenster, Germany. <https://orcid.org/0009-0003-3378-127X>, m.bobbert@uni-muenster.de.

** This study was prepared as part of the linkage project of the Humboldt Research Group "On the systematisation of criminal responsibility of and in enterprises" led by the University of Heidelberg and the University of Miskolc (2020-2025).

¹ I would like to thank Verena Pfaff, Münster, very much for her competent English-language support.

example, in the field of public health in the 19th century. Even though the precautionary principle is central to environmental and climate issues, it has only recently gained in importance. This article examines the precautionary principle, highlighting the open flanks and possible areas of dispute that characterise the ethical and legal debates surrounding it.

In the 1970s, precaution became the guiding principle of German environmental policy, partly as a result of the forest dieback caused by air pollution.² As early as 1971, a kind of precautionary principle was listed in the German government's first environmental programme: Environmental protection should not merely react to damage that has already occurred, but must prevent future damage from occurring in the first place through precaution and planning.³ The benchmark for any environmental policy was defined as the protection of human dignity, which is considered threatened when human health and well-being are at risk, either now or in the future.⁴ In Germany, after several decades of discussion and legal development, the precautionary principle has become one of the core principles of environmental law.⁵

At the international level, the 1992 Rio Declaration on Environment and Development makes a clear reference to the precautionary principle in principle 15:

In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of

² The brief historical approach merely serves as an introduction to the topic. The focus is on developments in Germany and the European Union. Addressing the historical developments in other European or non-European countries in a comprehensive manner would exceed the scope of this contribution.

For the German government's environmental protection programme of 1969/1971, see Engels, 2006, pp. 275-293.

³ Cf. Deutscher Bundestag, 1971, p. 3.

⁴ Cf. Deutscher Bundestag, 1971, p. 9. Cf. also in 1974 the Federal Immission Control Act §1 (2), 2: The Act serves precautionary purposes.

⁵ The precautionary principle is expressly regulated in Article 34 (1) on environmental protection of the Unification Treaty of June 1990 as a voluntary commitment of the legislator and is therefore applicable federal law. The precautionary principle is also enshrined in Article 20a of the Basic Law of the Federal Republic of Germany: the state is tasked with protecting the natural foundations of life, also in responsibility for future generations, which may also require precautionary measures in addition to hazard prevention.

full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.⁶

The precautionary principle was first developed as a concept in 2000 in a communication from the EU Commission, which states that the precautionary principle requires a rapid response in the face of potential risks to human, animal, or plant health, or in regard of the need to protect the environment:⁷ In particular, in cases where the available scientific data do not allow a comprehensive risk assessment, the precautionary principle could be used to impose a marketing ban or a recall of products that are harmful to health. More recently, in 2010, the growth strategy adopted by the EU, the Green Deal, also refers to the precautionary principle in the context of addressing climate change.⁸ This concept aims to reduce net greenhouse gas emissions in the European Union to zero by 2050, making it the first ‘continent’ to become climate neutral.

Today, the precautionary principle is widely recognized as one of the four fundamental principles of the European Union’s environmental policy, although it is interpreted with varying emphases. For example, the European Parliament’s brief overview of environmental policy states: ‘If an action or policy has the potential to cause harm to the environment or public health, and there is persisting scientific uncertainty about its effects, this action should not be applied until further evidence is provided.’⁹

This is distinguished from the second principle of prevention: This principle is ‘a tool aimed at preventing environmental damage, rather than reacting to it. This requires preventing measures to be taken to anticipate and avoid environmental damage.’¹⁰

In turn, a summary of the European Commission on the principles of EU environmental law explains the precautionary principle as follows:

Where there is uncertainty about the risk of environmental harm, the precautionary principle allows or requires protective

⁶ United Nations General Assembly 1992, principle 15.

⁷ European Union, 2000.

⁸ European Union, 2019, chapt. 2.1.1, p. 6 (but here is used the term “prevention” instead of precaution).

⁹ European Parliament 2025, p. 2.

¹⁰ European Parliament 2025, p. 2.

measures to be taken without having to wait until the harm materialises. There is a set of factors shared in every definition of the precautionary principle - existence of danger and scientific uncertainty. As a result, the precautionary principle always deals with potential harm and serves as a tool to bridge uncertain scientific information and a political responsibility.¹¹

In the meantime, numerous national regulations have taken up the precautionary principle. However, the contours of the precautionary principle in terms of areas of application, objectives, prioritisation, and kind of measures continue to be the subject of political debate, legal interpretation disagreements and ethical-normative discussions.

The precautionary principle is linked to the developments of a modern society, which the German sociologist Ulrich Beck labelled a “risk society” in 1986.¹² He states that Western industrialised societies bring forth new technologies such as nuclear energy, biotechnology and nanotechnology, as well as social risks such as unemployment, and therefore have to deal with varying degrees of uncertainty: On the one hand, the full extent of the effects and risks of new technologies is unknown; on the other hand, uncertainty cannot generally prevent the use of new technologies. However, the lack of reliable knowledge must lead to precautionary measures aimed at preventing the emergence of risks or the occurrence of harm. Precautionary measures are necessary, particularly in view of long-term damage or irreversible damage that could also affect subsequent generations. Beck also points out that risks are always the result of a social construction process: It is not the abstract risks themselves that are perceived as threatening, but the way they are communicated by mass media and their schemata of safety and danger.¹³ The phenomena of irrational responses to risk will be discussed further below. The sociologist Ulrich Beck has not only pointed out problems but has already articulated ethical normative demands himself.

1.2. Application-related ethical judgements as mixed judgements

Since the 1970s, environmental ethics and ecologically sensitive economic ethics have developed within the field of ethics. In addition, ethical questions concerning the responsible handling of new biomedical and

¹¹ European Commission, 2025.

¹² Beck 1992; 1986 originally in German.

¹³ Beck 1992, p. 56.

technological developments have been discussed. When forming ethical judgements, such application-related or area-related ethics consistently refer to empirical statements and problem descriptions that can already be questioned as such or whose benefits and potential risks of harm can also be the subject of debate.

Application-related ethical judgements are therefore always so-called mixed judgements, i.e. they are based on certain presuppositions, refer to ethical norms and at the same time are based on more or less contested statements about facts.¹⁴ For example, one might assert that biodiversity is ethically significant (prior assumption) and that it is being reduced by intensive agriculture (empirical assumption). However, it would first have to be shown empirically how animals and plants or, more broadly, the environment and climate are damaged, in order to then argue from an ethical point of view that biodiversity must not be reduced, e.g. in relation to relevant norms of nature and animal ethics as well as fundamental moral rights and duties of humans. Furthermore, the perception of the problem interacts with the ethical evaluation: 'Data gain their ethical relevance only against the background of norms and values being deemed appropriate, which assume not only a justifying function but also an orientating function.'¹⁵

2. The precautionary principle in relation to environment and climate

Before addressing the open flanks and possible areas of dispute that shape the ethical and legal debates surrounding the precautionary principle, it should be distinguished from similar principles: The precautionary principle in politics and law pursues the goal of risk avoidance. This must be distinguished from aftercare and hazard defence.

2.1. Aftercare in the event of damage

If damage to humans and the environment has already occurred, the only option is to remedy it through aftercare. The necessity of a precautionary principle has been demonstrated, for example, by the experience with halogenated hydrocarbons, which destroy the ozone layer. Although the problems had already been recognised in the 1970s, it was not until the mid-

¹⁴ Bobbert 2012, pp. 174-197; Bobbert, 2015; Dietrich, 2008.

¹⁵ Dietrich 2012, p. 513.

1980s that measures were taken.¹⁶ Because action was not taken until late, major damage was caused that required extensive aftercare. For instance, the chlorine content in the stratosphere – which today is six to seven times higher than it was in 1950 – is a contributing factor to the so-called greenhouse effect. In addition, the holes in the ozone layer are leading to a sharp increase in the rate of skin cancer worldwide due to increased UV radiation. In the next 50 years, as today's children grow up, there will be several thousand more cases of skin cancer than before, as they will have been exposed to stronger UV radiation. This UV radiation penetrates the earth's atmosphere through holes in the protective ozone layer created by chlorofluorocarbons (CFCs) and other synthetic chemicals.¹⁷

2.2 Hazard prevention in the event of known risks

If a hazard exists, i.e. if damage to humans and the environment is foreseeable with a certain degree of probability, hazard prevention requires that its occurrence be prevented. Nuclear power plants, for example, are subject to numerous regulations due to the risk of excessive radiation exposure for the surrounding population and the potential danger of a nuclear worst-case scenario, i.e. a maximum credible accident.

2.3 The precautionary principle in the face of potential risks

The precautionary principle goes further than hazard prevention: the aim is to prevent hazards from arising in the first place. It requires recognising potential risks and taking proactive measures at an early stage to prevent harm to humans and the environment. The precautionary principle includes the two dimensions of risk prevention and resource precaution:

Risk precaution means taking preventive action in the event of incomplete or uncertain knowledge about the nature, extent, probability and causality of environmental damage and hazards in order to avoid them from the outset. Resource precaution means that we treat natural resources such as water, soil and air with care in order to safeguard them in the long term and preserve them in the interests of future generations.¹⁸

¹⁶ European Union 2001, pp. 76-83.

¹⁷ European Union 2001, p. 3.

¹⁸ Umweltbundesamt, 2021 (translated by the author).

3. The precautionary principle in practice: open flanks and possible points of contention

The precautionary principle is well established in Germany and at the EU level with regard to emissions, food, animal feed and chemical substances. In these areas, the precautionary principle is comparatively limited because it concerns substances, products or emissions that should not have any negative consequences. The corresponding measures typically involve preventing the distribution of a substance or product, recalling it, or refraining from operating a facility or halting its operation. In this context, both the causes and their possible consequences are relatively straightforward. Moreover, the focus is primarily on protecting the life and health of people currently living.

The German Supply Chain Act¹⁹ from 2021 and the European Supply Chain Directive²⁰ from 2024 also contain the precautionary principle. However, in this context, the scope of application is significantly broader and therefore more difficult to define. The difficulties begin with the fact that the entire company, and not just a single product or a specific production branch, is to be considered in its entirety.

The scope or context of the precautionary principle can therefore be seen to have been extended. The following section will outline the points of contention that are emerging in this regard and where the precautionary principle has open flanks.

3.1. Scope of the precautionary principle: a debate on objectives and the nature of risks

The precautionary principle is very broad in terms of its objectives. What are the legally protected goods to be protected and how should tensions between different legally protected goods be dealt with?

The protection of humans and animals, but also biodiversity, the environment, safeguarding climate compatibility and the protection of future generations of humans are usually cited as objectives. Should or must these objectives be prioritised? How do national and international perspectives relate to one another? What time period should be taken into account?

¹⁹ Deutscher Bundestag, 9 June, 2021.

²⁰ European Union, 2024.

Unless there is already reason to assume a potential risk, the perception and analysis of potential risks depend on the social or political focus: Which objectives are currently attracting heightened sensitivity?

The very fact that only selected disciplines are surveyed for potential risks represents a preliminary decision on the type of risks to be identified: Medicine focuses on human health risks, biology, among other things, problematises the threat to biodiversity and the destruction of ecosystems, geosciences and agricultural sciences raise the alarm with regard to soil or water contamination and meteorology identifies weather disasters and climate shifts.

Indications of problems also depend on implicit weightings concerning the objectives: Contemporary societies and nations tend to focus primarily on the health of currently living people or their energy and mobility needs and less on the abstract of future generations lacking resources essential for survival, such as clean water or raw materials.

The perception of problems is also currently shifting because the protection of animals and the intrinsic value of functioning ecosystems are gaining importance in ethical debates, in some legal discourses, and among political stakeholders. Anthropocentric national and international law prioritises the life and health of people currently alive. From an ethical perspective, there are good reasons for this. However, exploring this issue in depth is beyond the scope of this article.²¹ However, an anthropocentric prioritisation is no longer universally accepted, at least in animal and environmental ethics.²² For example, it must at least be discussed: Do animals have rights comparable to those of humans? Do biodiversity and functioning ecosystems have intrinsic value or do they still have to be related to humans?

The precautionary principle may therefore be subject to tension with regard to objectives and potential risks, which should be discussed and justified not only in factual terms, but also from an ethical-normative and legal perspective. Implicit preliminary decisions in relation to the protected good, place and time must be clearly communicated and ultimately at least plausibly justified.

²¹ For a justification of fundamental individual rights and duties, see Gewirth, 1978, and for anthropocentric animal ethics, see Lintner, 2017, esp. chap. 3; 4 and the overview articles on this question by Petrus, 2018; Basaglia, 2018.

²² See articles in the section „Theories of Animal Ethics“ in Ach et al., 2018.

It will also have to be determined in more detail whether potential risks relate to lifestyle and thus - ethically speaking - to goals of the good life that are only associated with a particular claim to validity, or whether potential risks affect fundamental legally protected goods or fundamental moral rights and thus, ethically speaking, norms that are associated with a universal claim to validity. With regard to questions of the good life, examples include mobility during the holiday season or the year-round availability of seasonal vegetables and fruit. However, if potential risks relate to the basics of life, such as clean air, clean water and sufficient food for people and societies currently living, these are ethical-normative questions that deal with unconditional moral obligations.²³

3.2. The precautionary principle: knowledge of potential risks to be considered and sought

The precautionary principle is inevitably related to knowledge of potential risks. What existing knowledge must be taken into account and what degree of certainty must be given? There is also the challenge of working interdisciplinarily in order to prudently gather and integrate knowledge relevant to the precautionary principle across various fields of expertise. In addition, it must be determined in which areas of human life, the environment and the climate there may still be a lack of knowledge that needs to be researched.

Experience from the past 100 years has led us to the principle of precaution. For example, reports of radiation damage date back to 1896 and the first clear and credible warnings about asbestos, which damages cells and therefore has a carcinogenic effect, followed two years later, in 1898.²⁴ However, precautionary measures were only taken half a century later and then only gradually.

The precautionary principle is applicable today precisely in cases where risks appear possible or, in other words, where their occurrence is more or less probable but there is little scientific knowledge or no scientific consensus.

But when is this knowledge sufficient? What knowledge can be considered reasonably certain, so that it must be taken seriously as a warning? These questions will remain controversial. The probability of a

²³ Cf. for more details on the distinction between ethical questions of the good and successful life and ethical-normative questions see Düwell, 2008, here pp. 37-41.

²⁴ European Union, 2001, pp. 31-37; pp. 52-63.

risk occurring, but also the question of how serious the occurrence of damage to humans, animals, the environment, etc. is considered to be, will also be the subject of debate.

Now it is absolutely necessary to turn to the individual sciences and bring together relevant findings from relevant disciplines. In doing so, it is important not to close our minds to questions about the reliability of findings. The significance of different scientific methods will repeatedly be a topic of discussion. With regard to the concern to be able to refer to scientifically proven knowledge, however, the tendency to narrowly focus on quantitative research approaches in the natural and social sciences and more specifically on experimental methods must be countered. Potential risks can also be identified through experiential knowledge, which may even be transferable to other scientific domains, provided that such experiential knowledge is subject to critical scrutiny and is open to scientific explanation and verification.

Furthermore, analysing specific examples of damage from the perspective of a precautionary principle has shown that the simple science of linear and mechanistic interpretations must be supplemented by the dynamic and constantly evolving characteristics of systems science.²⁵ In this respect, lessons have been learnt from the past 100 years, in which problems that were long ignored despite clear evidence – such as the extreme decline in marine fish stocks, environmental damage caused by halogenated hydrocarbons and sulphur dioxide and health damage caused by substances such as asbestos, benzene, polychlorinated dibenzofurans (PCBs) and growth-promoting hormones in animal husbandry – have been addressed. The potential systemic instabilities of such complex phenomena as climate change, such as factors that determine the stability of the Gulf Stream, or the behaviour of human cells that become genomically unstable due to radiation exposure, could be decisive, but perhaps unpredictable, determinants.

However, there are not always indications that draw attention to potential risks. In some cases, research must first be conducted in order to assess risks at all. Such research can be carried out in advance – e.g. in conjunction with the requirement of a moratorium, as an accompanying measure or as an evaluation at a defined point in time. The potential damage identified, its severity and probability of occurrence, will be decisive in deciding whether the use of a particular technology is justifiable. For example, during the further development of reproductive medicine in the

²⁵ European Union, 2001, p. 4.

1970s to 2000s, moratoria were repeatedly demanded for new techniques such as intracytoplasmic sperm injection (ICSI) or pre-implantation genetic diagnosis (PGD) in order to clarify whether biotechnologically induced damage to germ cells and embryos might occur.

An example where specific research and consideration of the precautionary principle are lacking is the legalization of the drug cannabis in Germany²⁶: this law represents an experiment with an open outcome with regard to young adults. By legalizing the possession of cannabis for personal use, legislators are initially accepting known and potential risks, particularly with regard to young adults, even though there is evidence that the physical and mental well-being of young adults in particular can be permanently endangered by cannabis use.

As mentioned above, the perspectives of different disciplines also lead to different findings with regard to potential risks. In this respect, a risk analysis should adopt a multidisciplinary approach as comprehensively as possible. In addition, selected questions relating to the objectives or even legally protected goods of the precautionary principle must be addressed to these scientific fields. For example, geosciences can investigate either changes in biodiversity in groundwater stocks or toxic residues in river water that also have an impact in neighbouring countries.

If scientific data is available, its significance and the degree of uncertainty must be determined. The extent to which a potential risk affects the precautionary principle must ultimately be decided. However, the state of knowledge is often inhomogeneous. In addition to contradictions on the merits, power interests and academic disputes can play a role in the scientific community. It is therefore essential to establish procedures that enable a serious scientific debate in which scientific disagreements – for example regarding assumptions or interpretations – are made transparent. Particularly in the case of divergent scientific findings, it is important to understand where the disagreements lie in detail. For an appropriate determination of the degree of scientific uncertainty and an evaluation based on this, the ambiguities and open questions in particular must be articulated.

Distorting research interests or entanglements between science and politics can lead to scientists interpreting their findings in ways that support non-scientific interests. Therefore, effective procedures must be established to disclose such conflicts of interest. One way to establish scientific distance

²⁶ In Germany, adults have been allowed to have up to 25g of cannabis in public and up to 50g at home since 2024 – cf. Deutscher Bundestag, 27.03.2024.

or ‘impartiality’ in order to be able to select and evaluate knowledge is, for example, to bring together scientists from related fields who can easily familiarise themselves with the contested area in order to review the findings.²⁷

3.3. The precautionary principle and risk analyses: spatial and temporal extension of the analysis as well as intra- and interdisciplinary scope

How far must the view extend in terms of space and time and what level of intra- and interdisciplinary complexity of the search of risks does the precautionary principle demand?

Given the globally relevant and future-oriented goods such as “future generations” and “climate protection,” potential risks must be assessed over broad spatial regions and extended time periods. In addition, as part of the risk analysis, consideration must be given to which areas of human life and which aspects of the earth and its atmosphere are to be included. It is therefore an important preliminary decision which scientific disciplines are consulted for the risk analysis. These will be risk scenarios, i.e. the degree of scientific uncertainty will be difficult to determine in some cases. Nevertheless, the nature of possible damage, its severity and the costs of any precautionary measures must be assessed and, finally, decisions must be made on the implementation of certain measures, which will be characterised not only by ethical or legal norms, but also by pragmatic aspects – such as financial viability, rapid implementation or a good cost-benefit ratio.

3.4. Risk perception and risk evaluation as psychological pitfalls of the precautionary principle

Potential negative consequences or damage can be identified and are already leading to precautionary measures. However, there are numerous psychological pitfalls when analysing potential risks that may cause precautionary efforts to fail.²⁸

²⁷ The theological ethicist Lars Ostnor in Oslo has realised this in an exemplary way with regard to embryonic stem cell research by inviting not only scientists from embryonic stem cell research, but also scientists from neighbouring fields of molecular biology to assess the opportunities and risks competently and at the same time more impartially. See Ostnor (ed.), 2008.

²⁸ Vgl. e.g. Sunstein, 2001; Sunstein, 2005.

- Acute risks are perceived more strongly than creeping, long-term risks.
- A serious risk is overlooked because the focus is on combating a marginal risk.
- There is a widespread tendency to overestimate dangers that stand out cognitively – either due to their acute visibility or because people are not yet accustomed to them.
- In addition, localised risks are often rated higher than distant risks. In Europe, for example, the risk of a local storm is perceived as a serious and significant threat. The risk of a sharp global rise in sea levels – caused by climate change – and its consequences for Europe as well, are less focussed on.
- Most people can only visualise a linear rather than an algorithmic increase in risk.
- Many people cannot weigh up different probabilities against each other, i.e. they cannot distinguish between a risk of 1 in 1 million and a risk of 1 in 20 million.
- However, there is also the opposite effect of overestimating barely assessable abstract risks in comparison to more probable concrete dangers: For example, the government of Zambia rejected an American donation of several thousand tonnes of grain, citing the precautionary principle and the risks of genetically modified food, thereby exposing around 3 million people to the risk of starvation.²⁹

Overall, a rational analysis and assessment of risks can therefore be made more difficult due to psychological effects.

3.5. Precautionary measures: questions of effectiveness and necessity

Which measures are effective can also be the subject of disputes, and it must also be decided whether a measure is merely recommendable or necessary. This in turn depends on the assessment of the effectiveness of the measures, the evaluation of possible damage and the assumed probability of occurrence in each case. Unlike a moral or legal prohibition, the precautionary principle, even in its strictest form, does not require a specific

²⁹ Vgl. Bohannon, 2002.

measure. However, any measure taken under the precautionary principle should at least fulfil certain requirements:³⁰

- Firstly, the effectiveness of a measure in relation to a precautionary goal should be analysed or given a certain probability.
- Secondly, the advantages and disadvantages associated with taking or not taking action must be weighed. Like any medical treatment, an intervention should not cause harm or cause more harm than non-intervention.
- Thirdly, an intervention should be proportionate to the level of protection sought.
- Fourthly, it should be decided who should bear which measure – as well as the associated costs.
- Fifthly, the effectiveness and the actual advantages and disadvantages associated with the measure should be continuously monitored – if necessary, through accompanying research.

However, in view of the high solution-orientation of these minimum requirements, which is appropriate in medicine, which can largely refer to the rules of the art, but which cannot do justice to the complexity of most problems in which the precautionary principle is applied, one important aspect should not go unmentioned: The precautionary principle responds to potential risks for which there is insufficient knowledge. It is in the very nature of the principle that measures, which may be highly cost-intensive and aimed at preventing a potential risk, might prove to be ineffective or unnecessary in retrospect. A psychological ‘hindsight bias’ – in which one assumes superior knowledge after the fact and retroactively judges earlier decisions as erroneous – should be avoided. On the other hand, it is also conceivable that the analysis and assessment of risks and the decision to take measures were ‘negligently’ wrong, as one could have known better at an early stage.

In many areas of climate protection, it is no longer the scientific findings or the potential risks or risk scenarios that are controversial, but rather the type of measures, the weighing up of their positive and negative consequences and the question of at whose expense or cost the measures should be implemented.

³⁰ The prerequisites mentioned here are derived from considerations on treatment decisions in medicine, on which the author has worked. Cf. e.g. Bobbert, 2012; Bobbert, 2017.

The example of lithium shows that the even assessment of precautionary measures, which have both positive and negative consequences, can be controversial: lithium is required for solar cells and batteries, for example in smartphones, laptops and electric vehicles. The largest deposits are located in South America, where lithium is extracted via evaporation processes in salt lakes. However, the water consumption in this process is very high, causing local populations to fear for their water supplies, both for personal use and for their livestock.³¹

An example of disagreement regarding the type of measures and the question of who bears the associated costs or burdens can be found in the statistical correlation between climate change and the growing world population. In some cases, a reduction in the global population is proposed as an effective measure for climate protection. In this proposal, it should not be overlooked that a reduction in the birth rate would affect the economically weaker nations on the continents of Africa and Asia. What is more decisive for CO₂ emissions, however, is the way we live and produce.³² In contrast, the proposal to reduce resource consumption and CO₂ emissions would impact the living standards of Western industrialised nations. But this comparison of measures – apart from questions of power and justice – does not adequately capture the complexity of the problem, as the question of effectiveness is already more complex:

Africa, with its rapidly growing population, currently contributes around four per cent of global emissions and per capita emissions in Africa are generally less than one tonne per person. This amounts to roughly one-tenth of the average emissions in Europe and one-twentieth of those in North America. China, currently the world's largest CO₂ emitter, has a relatively stable population and yet its CO₂ emissions are rising. The education of women, their position in society and their rights are decisive for a falling birth rate.³³ For example, the population growth rate in Kenya, an economically somewhat more successful country compared to other African countries, has halved and population growth in China is now also declining.

However, another approach is also sensible: A global coal phase-out is considered essential for climate protection.³⁴ This would require financial

³¹ Among others Health, 2025.

³² Edenhofer et al, 2019, p. 27.

³³ Cf. e.g. Adhikari et al., 2024, Lutz, 2011.

³⁴ Cf. Edenhofer et al., 2019.

support from industrialised nations to assist poorer countries. New technologies and a circular economy with renewable energies and a more efficient use of raw materials would also have to be introduced.

4. Summarising sector-related decisions from a resource and justice perspective

Every measure is associated with ‘costs’ in both a concrete and figurative sense, be they disadvantages and burdens or financial expenditure that is not available elsewhere. This is because every nation has only limited financial and other resources at its disposal.

4.1. Summarising sector-related decisions

In view of limited budgets, decisions on measures can only be made after considering all sub-sectors. For example, investing in costly precautionary measures in the food sector in order to protect the health of citizens when financial resources for precautionary measures are lacking in other areas must be well justified. Very unlikely risk scenarios may have to be postponed in favour of other scenarios with very high damage potential. Depending on which assets are at risk and to what extent, it may also be necessary to take greater precautions in one area than in another.

4.2. Global justice

For reasons of justice, western industrialised countries and other countries, such as China or India, which are consuming increasing amounts of energy and producing significant emissions, must bear the main burden of the costs of environmental and climate measures.

Overall, the precautionary principle will probably require people in Western industrialised countries to accept a loss of prosperity in the future because the livelihoods and fundamental rights of current or future people in other regions of the world are irreversibly threatened. Under certain circumstances, new technical developments, e.g. in the circular economy or artificial intelligence, could lead to the discovery of new effective measures.

From a justice perspective, nations must implement hazard prevention measures (cf. global warming with its many negative consequences) and precautionary measures in line with their ecological footprint. Not least for reasons of effectiveness and pragmatism, i.e. to ensure that something is

implemented, Western industrialised nations must support poorer countries in the ecological restructuring of their economies.

5. Conclusion

Case studies of harm to humans and the environment over the last 100 years show that both early warnings and loud and late warnings have often been ignored.³⁵ The increasingly legally codified precautionary principle, as complex and controversial as it may be in some areas, can ensure that the political will to act, but also company management and other decision-makers, contribute to reducing risks to the environment and climate – and thus to people.

The art of taking the first smart steps and weighing up the numerous necessary precautionary measures will certainly include identifying and implementing those measures that promise a major positive effect with little effort. In addition, those measures that can prevent potential ‘worst case’ scenarios relatively reliably should be prioritised.

Overall, the precautionary principle calls for new forms of cooperation to be established with scientists from relevant disciplines. For a constructive, application-related debate on scientifically controversial issues (in relation to potential risks and effective measures), procedures should be established to ensure that open questions and uncertainties in risk analyses and precautionary measures are reliably identified and communicated. In most cases, there will be no clearly correct solutions, but potentially better and worse ones.

³⁵ European Union, 2001, p. 3.

Bibliography

- [1] Ach, J. S., Borchers, D. (eds.) (2018) *Handbuch Tierethik. Grundlagen – Kontexte – Perspektiven*, Stuttgart: Metzler; <https://doi.org/10.1007/978-3-476-05402-9>.
- [2] Adhikari, S., Lutz, W. (2024) 'Forecasting Africa's Fertility Decline by Female Education Groups', *PNAS*, 121(46), e2320247121; <https://doi.org/10.1073/pnas.2320247121>.
- [3] Basaglia, F. (2018) 'Kantische Ansätze' in Ach, J. S., Borchers, D. (eds.) *Handbuch Tierethik. Grundlagen – Kontexte – Perspektiven*, Stuttgart: Metzler, pp. 89-94; https://doi.org/10.1007/978-3-476-05402-9_15.
- [4] Beck, U. (1992) *Risk Society: Towards a New Modernity*, London: Sage.
- [5] Bobbert, M. (2012) *Ärztliches Urteilen bei entscheidungsunfähigen Schwerkranken*, Geschichte – Theorie – Ethik, Münster: Mentis; <https://doi.org/10.30965/9783957439567>.
- [6] Bobbert, M. (2017) 'Ethical Criteria of Treatment Decision Making for Cancer Patients no Longer able to Give Consent', in Bobbert, M., Herrmann, B., Eckart, W. U. (eds.) *Ethics and Oncology*, Freiburg/Br: Albers, pp. 121-132; <https://doi.org/10.5771/9783495813430-121>.
- [7] Bobbert, M. (2015) Urteile in der (Bio-)Medizin- und Pflegeethik sind „gemischte“ Urteile, in Ammicht Quinn, R., Potthast, T. (eds.) *Ethik in den Wissenschaften*, Tübingen: IZEW, pp. 299-306.
- [8] Bohannon, J. (2002) 'Zambia Rejects GM Corn on Scientist's Advice', *Science*, 298(5596), pp. 1153-1154; <https://doi.org/10.1126/science.298.5596.1153a>.

- [9] Dietrich, J., Lutz, R., Hilscher, M., Manoharan, D., Matute Giron, I., Mauser, J., Schweizer, S., Bellows, A. C. (2012) 'The Ethical Matrix as an Instrument for Teaching and Evaluation', in Potthast, T., Meisch, S. (eds.) *Climate Change and Sustainable Development: Ethical Perspectives on Land Use and Food Production*. Wageningen: Wageningen Academic Publishers, pp. 511-516; https://doi.org/10.3920/978-90-8686-753-0_78.
- [10] Dietrich, J. (2008) Ungewissheit in der ethischen Urteilsbildung – ein Überblick in Thomas, P., Benk, A. (eds.), *Negativität und Orientierung*, Würzburg: Königshausen & Neumann, pp. 65-78.
- [11] Düwell, M. (2008) *Bioethik. Methoden, Theorien und Bereiche*, Stuttgart: Metzler; <https://doi.org/10.1007/978-3-476-05008-3>.
- [12] Edenhofer, O., Jakob, M. (2019) *Klimapolitik, München*: C.H. Beck, 2. Aufl. (1. Aufl. 2017); <https://doi.org/10.17104/9783406736162-2>.
- [13] Engels, J. I. (2006) 'Naturpolitik in der Bundesrepublik. Ideenwelt und politische Verhaltensstile in Naturschutz und Umweltbewegung', pp. 1950-1980, Paderborn: Schöningh.
- [14] Heath, V. (2025) *Lithium: the 'White Gold' Powering the World in Geographical* 17.02.2025 [Online]. Available at: <https://geographical.co.uk/science-environment/lithium-the-white-gold-powering-the-world> (Accessed: 11 June 2025).
- [15] Lintner, M. (2017) *Der Mensch und das liebe Vieh: Ethische Fragen im Umgang mit Tieren*. Innsbruck: Tyrolia.
- [16] Lutz, W. (2011) 'Wachstum der Weltbevölkerung: Bildung der Frauen entscheidend', *Demografische Forschung*, 8(4), pp. 1-2.
- [17] Ostnor, L. (ed.) (2008) *Stem Cells, Human Embryos and Research. Interdisciplinary Perspectives*, Dordrecht: Springer.

- [18] Petrus, K. (2018) 'Rechte-Ansatz', in Ach, J. S., Borchers, D. (eds.) *Handbuch Tierethik. Grundlagen – Kontexte – Perspektiven*, Stuttgart: Metzler, pp. 83-88.
- [19] Sunstein C. R. (2005) *Laws of Fear: Beyond the Precautionary Principle*, Cambridge/New York: Cambridge University Press; <https://doi.org/10.1017/CBO9780511790850>.
- [20] Sunstein, C. R. (2001) Probability Neglect: Emotions, Worst Cases, and Law in Chicago Working Papers in Law and Economics, University of Chicago Law School, pp. 1-35. [Online]. Available at: https://chicagounbound.uchicago.edu/cgi/viewcontent.cgi?article=1384&context=law_and_economics (Accessed: 11 June 2025); <https://doi.org/10.2139/ssrn.292149>.
- [21] Bundesrepublik Deutschland, Umweltbundesamt, Vorsorgeprinzip, 21.0.1.2021: [Online]. Available at: <https://www.umweltbundesamt.de/vorsorgeprinzip> (Accessed: 11 June 2025).
- [22] Deutscher Bundestag, 09.06.2021, Drucksache 19/30505. Das Gesetz über die unternehmerischen Sorgfaltspflichten in Lieferketten (LKG) wurde 11.06.2021 verabschiedet und trat am 01.01.2023 in Kraft. [Online]. Available at: <https://dserver.bundestag.de/btd/19/305/1930505.pdf> (Accessed: 11 June 2025).
- [23] European Commission (2025) Principles of EU-Environmental Law. [Online]. Available at: https://www.era.com.eu/Introduction_EU_Environmental_Law/EN/module_2/module_2_10.html (Accessed: 11 June 2025).
- [24] European Parliament, Fact Sheets on the European Union, Environment Policy: General Principles and Basic Framework. [Online]. Available at: https://www.europarl.europa.eu/erpl-app-public/factsheets/pdf/en/FTU_2.5.1.pdf (Accessed: 11 June 2025).

-
- [25] European Union (2019) Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions, The European Green Deal, COM/2019/640 final, Document 52019DC0640. [Online]. Available at: eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52019DC0640 (Accessed: 11 June 2025).
- [26] European Union (2000) Communication from the Commission on the precautionary principle, document 52000DC0001, COM/2000/0001 final. [Online]. Available at: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A52000DC0001> (Accessed: 11 June 2025).
- [27] European Union, Directive (EU) 2024/1760 of the European Parliament and of the Council of 13 June 2024 on Corporate Sustainability due Diligence and Amending. [Online]. Available at: <https://eur-lex.europa.eu/eli/dir/2024/1760/oj> (Accessed: 11 June 2025).
- [28] European Union, European Environment Agency (2001) Late Lessons from Early Warnings: Environmental Issue Report No 22 01/2001, Copenhagen. [Online]. Available at: https://www.eea.europa.eu/en/analysis/publications/environmental_issue_report_2001_22 (Accessed: 11 June 2025).
- [29] European Union, European Environment Agency (2001) Late Lessons from Early Warnings: Environmental Issue Report No 22 01/2001, Copenhagen. [Online]. Available at: https://www.eea.europa.eu/en/analysis/publications/environmental_issue_report_2001_22 (Accessed: 11 June 2025).
- [30] United Nations General Assembly (1992), Rio Declaration on Environment and Development, A/CONF.151/26 (Vol. I), Principle 15. [Online]. Available at: https://www.un.org/en/development/desa/population/migration/generalassembly/docs/globalcompact/A_CONF.151_26_Vol.I_Declaration.pdf (Accessed: 11 June 2025).