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**Precaution and risk reduction –  
Politics and expertise.**  
**Some reflections on the precautionary principle**

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## ***1. Introduction***

Humans have always been exposed to different types of risk such as natural disasters with negative effects. Even if such risks sometimes have been caused or increased by human action they have mostly been seen to be produced by non-human forces. Modern risks, on the other hand, are the product of human activity.

The modern society has often also been called a “risk society”. This is a term used to describe a society that is organized in response to risk. According to sociologist Anthony Giddens (1999) it is "a society increasingly preoccupied with the future which generates the notion of risk". Risk can be defined in the risk society as a systematic way of dealing with hazards and insecurities induced and introduced by modernization (Beck, 1992). Thus risk has to be governed, and it will be shown in this report that “precaution” has become an important element in the governance of risk.

The point of departure for the CARGO project is that there is a need for more knowledge about the governance of risk. Three work packages of the CARGO project represent three approaches to risk governance. Risk informed decision making is more based on quantitative assessments than the other two. The precaution and risk reduction approaches involve both qualitative (value – laden and ethical) principles and more traditional risk assessment. The deliberative approach refers to processes aiming to include lay people in discussions over science and technology and risk.

In all decisions, positive and negative factors have to be taken into account and be weighted against each other. The more aware the decision-makers and the public are about both, the better the decisions. In terms of the development of analytical instruments and research in social and natural sciences, much more attention has been given to risks than to benefits. This should not be surprising, nor is it illogical. The driving force for technology development, or in fact most kinds of human action, is potential benefits, and they are often quite obvious. More analysis is needed to identify, assess and manage the risks of these technologies. Moreover, in many cases the risks of new technologies are not discovered and fully understood until the technologies have been implemented and established in the market economy. Managing risk then comes up on the political agenda and becomes a government responsibility. The increasing understanding of this mechanism of delay in risk identification is one reason for the introduction of the precautionary principle as a means of reducing risks.

In this report we explore how the origin of the precautionary principle has developed to be included in European and international law (section 2). In section 3 the role of the precautionary principle is briefly described in comparison with other risk management approaches. Section 4 deals with issues in the application of the precautionary principle in some example areas. We then put the question in section 5 what makes a risk unacceptable. In section 6 we discuss a number of issues such as the roles of different actors in the application of the precautionary principle and concerns raised about the precautionary principle. Section 6 concludes with some key issues that we believe are needed to be taken into account while applying the precautionary principle.

## ***2. The precautionary principle in European and international law***

Whiteside (2006, p 146) describes the history of the precautionary principle which was given a name in Germany:

*“There, Vorsorge was transformed into a general rule for achieving heightened environmental protection. In the 1980s and 1990s, the precautionary principle spread throughout Europe. In the last decade of the twentieth century, nations around the world agreed to use the principle as the basis for settling cases of international environmental degradations where the scientific evidence is incomplete or disputed. By the year 2000, the precautionary principle had made its way into some sixteen international treaties and documents.”*

At international level, the precautionary principle was first recognized in the World Charter for Nature, adopted by the UN General Assembly in 1982. It was subsequently incorporated into various international conventions on the protection of the environment. The principle was incorporated at the 1992 Rio Conference on the Environment and Development, during which the Rio Declaration was adopted, whose principle 15 states that:

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

The precautionary principle as cited above deals with protection of the environment; however, in different forms it is used in many other areas, especially in human health protection. Since 1992, the principle has been implemented in various environmental instruments for areas such as global climate change, ozone-depleting substances and biodiversity conservation. It is action-oriented, meaning that persistent dissent among scientists can not be taken as an excuse not to take action.

Thus, the United Nations' Framework Convention on Climate Change and the Convention of Biological Diversity both refer to the precautionary principle. Principle 15 is reproduced in similar wording in the preamble of the Convention of Biological Diversity (United Nations 1992. *Convention on Biological Diversity*)

*Noting also that where there is a threat of significant reduction or loss of biological diversity, lack of full scientific certainty should not be used as a reason for postponing measures to avoid or minimise such a threat*

The same type of wording is also found in Article 3 (Principles) of the Convention of Climate Change (United Nations 1992. *Convention on Climate Change*):

*The Parties should take precautionary measures to anticipate, prevent or minimise the causes of climate change and mitigate its adverse effects. Where there are threats of serious or irreversible damage, lack of full scientific*

*certainty should not be used as a reason for postponing such measures, taking into account that policies and measures to deal with climate change should be cost-effective so as to ensure global benefits at the lowest possible cost.*

At the Conference the year 2000 of the Parties to the Convention on Biological Diversity, the Protocol on Biosafety concerning the safe transfer, handling and use of living modified organisms resulting from modern biotechnology the precautionary principle was explicitly referred to. The Cartagena Protocol on Biosafety (Convention on Biological Diversity, 2000). says:

*"Lack of scientific certainty due to insufficient relevant scientific information . . . shall not prevent the Party of import, in order to avoid or minimize such potential adverse effects, from taking a decision, as appropriate, with regard to the import of the living modified organism in question."*

At European Union level, the only explicit reference to the precautionary principle is to be found in the environment title of the EC Treaty, and more specifically Article 174. However, as Articles in the Treaty indicate one cannot conclude from this that the principle applies only to the environment. As is said in the European Commission Communication on the Precautionary Principle (European Commission, 2000, p3):

*But in practice, its scope is much wider, and specifically where preliminary objective scientific evaluation, indicates that there are reasonable grounds for concern that the potentially dangerous effects on the environment, human, animal or plant health may be inconsistent with the high level of protection chosen for the Community*

And further on.(European Commission, 2000, p8): :

*"The precautionary principle applies where scientific evidence is insufficient, inconclusive or uncertain and preliminary scientific evaluation indicates that there are reasonable grounds for concern that the potentially dangerous effects on the environment, human, animal or plant health may be inconsistent with the chosen level of protection".*

After the adoption of the European Commission's Communication on the precautionary principle, the principle has come to inform much EU policy, including that in areas beyond that of environmental policy. It is implemented, for example, in the EU food law and also affects, among others, policies relating to consumer protection, trade and research, and technological development. While a comprehensive definition of the precautionary principle was never formally adopted by the EU, a working definition and implementation strategy for the EU context has been proposed by Rene von Schomberg in Fisher et al. (2006):

*"Where, following an assessment of available scientific information, there are reasonable grounds for concern for the possibility of adverse effects but scientific uncertainty persists, provisional risk management measures based on a broad cost/benefit analysis whereby priority will be given to human health and the environment, necessary to ensure the chosen high level of protection in the Community and proportionate to this level of protection, may be adopted,*

*pending further scientific information for a more comprehensive risk assessment, without having to wait until the reality and seriousness of those adverse effects become fully apparent".*

Many countries have incorporated the precautionary principle into their laws. As Whiteside (2006, p 119) observes:

*Since Rio, the precautionary principle has been the focus of more and more efforts to give it juridical formulation. It is a rule that is finding its place in a complex legal order. Increasingly, courts are called on to give it greater precision, and to relate it to preexisting rules governing responsibility in case of accidents and the right of citizens to sue public authorities. Judges are likely to take on the tasks of defining thresholds of risk that justify taking precautions.*

By contrasting how the United States and Europe have chosen to regulate transgenic crops, Whiteside shows how the precautionary principle has the capacity to reshape public policy. One interesting example is that France in February 2005 inscribed the precautionary principle in its constitution, alongside the 1789 Declaration of the Rights of Man and the Citizen. As the UN, EU and individual countries have implemented the precautionary principle in various contexts there are many different formulations of the principle. All definitions, however, have two key elements.

- an expression of a need by decision-makers to anticipate harm before it occurs.
- the establishment of an obligation, if the level of harm may be high, for action to prevent or minimise such harm even when the absence of scientific certainty makes it difficult to predict the likelihood of harm occurring, or the level of harm should it occur.

The need for control measures increases with both the level of possible harm and the degree of uncertainty. Some talk about a *strong and a weak version of the precautionary principle*. The strong version can mean that precaution is required whenever there is a possible risk to health, safety, or the environment, even if the supporting evidence is speculative and even if the economic costs of regulation are high. The weak precaution holds that lack of scientific evidence does not preclude action if damage would otherwise be serious and irreversible.

It is important, though, to emphasize that although the precautionary principle operates in the context of scientific uncertainty, it is considered by its proponents to be applicable only when, on the basis of the best scientific advice available, there is good reason to believe that harmful effects might occur.

### ***3. The precautionary principle as an element in risk governance***

The precautionary principle should be considered within a structured approach to risk governance which comprises risk assessment, risk management and risk communication. The precautionary principle is particularly relevant to the management of risk. However, as the CARGO project highlights, the precautionary principle may not be the most relevant risk management approach in all circumstances. In the project we also address risk informed decision making (Serbanescu and Vetere, 2008) and a deliberative approach. (Reynolds et.al. 2008) Risk informed decision making is more based on quantitative assessments than the precautionary principle approach typically in situations where there are relatively small uncertainties in the assessment. The deliberative approach refers to processes aiming to include lay people in discussions over science and technology and risk.

Clearly, it is seldom a question of using only one of the approaches without including elements of the other two. When knowledge is sufficiently good, risk governance turns from precaution to risk-informed decision-making. On the other hand, to put the precautionary principle into action there needs to be some sort of indication of a possible serious risk. There can be cases when science says there is no such indication, but when the public and stakeholders are concerned, for example due to lack of trust in expertise and authorities. In such a situation there needs to be a dialogue that includes both science and the concerned citizens in order to clarify the situation.

Applications of the precautionary principle also need to be considered in risk-informed decision-making so that great and conceptual uncertainties are not downplayed, and clearly the precautionary principle often is a central theme in deliberation. When applying the precautionary principle the question must be posed whether there is enough knowledge for risk-informed decision-making, in which case the precautionary principle might not be needed. The role of deliberation for the application of the precautionary principle is even more obvious as value-laden issues play a key role (see later sections of this report). Furthermore, expert knowledge and therefore elements of risk-informed decision-making should be part of deliberation – otherwise it could be narrowly framed as a purely value-laden and social process and science would be lost.

The emphasis put on the precautionary principle approach in comparison with risk informed or deliberative approaches is not only a matter of the risk characteristics per se. Also traditions and culture play a role. Thus, although there is wide consensus about the limits of acceptable and unacceptable risks, the practical applications of risk management differ significantly between different countries. In particular, the extent to which quantitative risk assessment has gained acceptance in addressing major accident hazards varies between industries. Within Europe, while some regulators are quite enthusiastic requiring quantitative risk assessment studies by law, e.g. the UK and the Netherlands, other countries, e.g. France and Germany, prefer a consequence-based approach. The Netherlands has a clearly defined policy on the maximum levels of risk that are acceptable in land-use decisions (a risk-informed approach). In Germany, deterministic approaches are extensively used in the chemical process industry to demonstrate the quality of measures taken to avoid risk inside and outside the installation.

#### ***4. Issues in the application of the precautionary principle – example areas***

The precautionary principle is not thought to replace risk-informed decision making, but to be used when the latter cannot be applied because of too much scientific uncertainty (provided, that is, that there is a threat of serious or irreversible damage). The European Commission, (2000, p14) has given advice about the stage of deciding whether or not to use the precautionary principle:

*“An assessment of risk should be considered where feasible when deciding whether or not to invoke the precautionary principle. This requires reliable scientific data and logical reasoning, leading to a conclusion which expresses the possibility of occurrence and the severity of a hazard's impact on the environment, or health of a given population including the extent of possible damage, persistency, reversibility and delayed effect.”*

However, when it comes to practical application this first phase of a precautionary approach (to decide if the principle should be applied) is not straight forward. In our analysis we again use the precautionary principle as expressed in Rio:

*Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.*

As the European Commission has done, we extend this version of the precautionary principle also to include human health. Then the case of mobile telephone systems is a challenging example which we first elaborate on. Then we also shortly discuss the case of generically modified organisms (GMO).

##### **The case of mobile telephone systems**

In this area one can identify two major types of research of relevance for possible risks to human health:

- A. Epidemiological studies (on the statistical connection between dose and effect)
- B. Experimental studies on mechanisms (on animals, tissues or human cells)

With respect to this, it is possible to identify different possible degrees of evidence:

1. There are only indications from some experimental studies but no epidemiological evidence of effects on human health. It may be reasonable to say that in such as case there is probably not enough evidence for the precautionary principle to come into action.
2. There is scientific consensus on effects on e.g. the blood - brain barrier in rats but no epidemiological evidence. In this case the evidence is somewhat stronger and some may argue that this is enough for the precautionary principle to be applied e.g. by regulators. This seems

to be a consequence of the position the European Commission took the year 2000 (European Commission, 2000 , p17):

*“The absence of scientific proof of the existence of a cause-effect relationship, a quantifiable dose/response relationship or a quantitative evaluation of the probability of the emergence of adverse effects following exposure should not be used to justify inaction”.*

However, in this case many would still argue against using the precautionary principle. .

3. Some epidemiological studies show a connection between exposure to electromagnetic fields from phones (or from base stations and masts), but there is scientific disagreement about the methods used for the studies. Also in this case some may argue that there is enough evidence for precaution and others can argue against .

4. At the fourth level there is stronger epidemiological evidence but no confirmed mechanism for how harmful effects actually can occur in the human body. Again this may be the case for controversy between different actors.

5. At this level there are both epidemiological evidence and confirmed mechanisms that can explain the effects in human tissue. In this case there certainly seems to be enough evidence for using the precautionary principle. But in such a case there also seems to exist a scientific basis for risk informed decision making, as risks for individuals could be calculated based on exposure. Have we then left the area of application of the precautionary principle at the other end of the scale?

This brief analysis leads us to the question if the precautionary principle is ever applicable for electromagnetic field in connection with mobile phones! In this area the World Health Organization (WHO) has been very active. In February 2003, WHO organized a conference in Luxembourg together with the European Commission on the application of the precautionary principle to electromagnetic fields (EMF). As a result of the meeting the WHO published a draft *Precautionary Framework for Public Health Protection* on its web site (World Health Organization, 2003). The web site paper notes that precautionary decisions have been controversial, and that the principle itself lacks clear definition. Furthermore, “actions by some countries, in the name of the precautionary principle, suggest that there is widespread confusion about what the principle means and how it should be applied”.

The WHO sees two objectives of its Precautionary Framework for public health protection (ibid, p 3). The first objective is *“to anticipate possible threats to health and respond appropriately in order to reduce exposures before introduction of an agent”*. Thinking within the precautionary framework means shifting attention to addressing questions about risks as a priority before deciding on whether to proceed with a new technology. The second objective is *“to address public concerns that a potential or perceived but unproven health problem is taken into account after introduction of an agent”*.

Both these objectives of the precautionary framework are of course controversial. It can be argued that in this form the precautionary principle is no longer action oriented, but can instead be used to prevent the introduction of any new technology without there being any

real factual justification. And can it be justified to use the mere existence of public concern as a reason for precautionary measures when there is no real risk at hand?

The American risk communication specialist Peter Sandman has discussed this in some detail in a paper about the application of the precautionary principle for mobile telephone systems. He opposes the idea that public concern itself should be seen as almost identical to real hazards, and his bottom line is that one should “use hazard mitigation strategies for serious hazards, and outrage mitigation strategies – sharing control, acknowledging mistakes and problems, giving away credit, and the like -for serious outrages” (Sandman, 2004, p 10).

Indeed the WHO says in its official web site fact sheet on mobile telephones and public health (World Health Organization, 2000, Fact sheet N°193):

*If regulatory authorities have adopted health-based guidelines but, because of public concerns, would like to introduce additional precautionary measures to reduce exposure to radiofrequency fields, they should not undermine the science base of the guidelines by incorporating arbitrary additional safety factors into the exposure limits. Precautionary measures should be introduced as a separate policy that encourages, through voluntary means, the reduction of radiofrequency fields by equipment manufacturers and the public.*

Such a distinction between science-based regulatory guidelines on the one hand and encouragement of additional precautionary measures due to public concerns on the other seems to be a double-edged policy that may in fact undermine the scientific approach. We are here on the borderline between a science based approach to precaution and a pure deliberative approach without scientific basis. However, even if such a practice does not seem to have support from any form of the precautionary principle formally expressed by the United Nations or the European Commission, the WHO in this case did not take a unique position.

### **GMO: s - Even more problematic?**

The introduction of generically modified organisms (GMO) and GM foods in particular has involved serious controversies over a broad frame of issues such as food safety, environmental safety, labeling and consumer choice, intellectual property rights, different forms of agriculture and international trade. With respect to the precautionary principle, in this area there are certain questions that need to be raised:

1. What is a serious damage in any of the areas enumerated above and thus what is needed to activate the precautionary principle? In many cases this is a matter of societal values and politics.

2. When can the precautionary principle be replaced by risk informed decision-making? It is not unreasonable to foresee situations that there is enough evidence within some of the areas but not in others – a case which has a high likelihood of being subject for controversy between experts and scientists on one hand and other stakeholders on the other hand.

3. In such a complex situation which GMOs seem to offer a crucial question is who is competent to decide if the precautionary principle is applicable or not. In some areas it would

typically be regulatory agencies, other issues are more purely political. And on the regulatory arena there may be many agencies involved in different parts of the problem – food safety, environmental effects, intellectual property rights, etc.

In this case the need for insight and transparency as a prerequisite for high quality decisions seems crucial. On the factual side, we need to evaluate the scientific status of the area to see if the requirement of scientific uncertainty is fulfilled. On the value-laden side we need to evaluate the nature of the threat and compare it with some sort of standard in order to decide if action shall be taken or not. Such standards have a normative character and cannot be set by science alone. For example, for the GMO case one can identify several possible standards such as food safety, biodiversity, comparison with conventional agricultural practices and compatibility with sustainable agricultural practice. Divergence from any of these standards could set the precautionary principle into action. Which one of them (if any, or which combination of them) to use is, however, a matter of societal values and politics.

## 5. *What makes a risk unacceptable?*

Legislation usually stipulates that measures must be taken to mitigate those risks that are regarded as ‘unacceptable’. Similarly, the presence of trivial risks is accepted as a matter of course. The issue is then what approaches are used in mitigating the non-trivial risks which fall into the “grey area” where a balance needs to be reached between risks, costs and benefits, and other wider decision criteria.

For substances identified as potentially damaging, a range of regulatory controls exists at both national, EU and international levels. The approaches adopted in setting such controls vary across countries and regulatory agencies. In some countries, regulation is based on a precautionary stance, which requires that risks be minimized, even if the causes and mechanisms are unknown, when human health or the environment is under threat. In the extreme, such an approach implies that many hazardous chemicals and activities are considered unacceptable because of the uncertain nature of associated risks. This type of approach to the management of chemical risks may neglect the benefits that the chemicals could confer on society.

A less strict interpretation of the precautionary principle stresses the cost of taking precautionary measures. Other approaches to risk reduction are technology-led. For example, they can be based on the concepts of making emissions ‘as low as reasonably practicable’ or the use of ‘best available techniques not entailing excessive costs’. Both these concepts recognize, at least implicitly, that a balance should be found between the costs involved in reducing risks and the benefits gained from risk reductions. To find the balance point is a matter of values and thus a political task (European Commission, 2000, p4):

*Judging what is an "acceptable" level of risk for society is an eminently political responsibility. Decision-makers faced with an unacceptable risk, scientific uncertainty and public concerns have a duty to find answers. Therefore, all these factors have to be taken into consideration.*

Furthermore, as the European Commission (2000, p4) also points out:.

*Proportionality means tailoring measures to the chosen level of protection. Risk can rarely be reduced to zero, but incomplete risk assessments may greatly reduce the range of options open to risk managers. A total ban may not be a proportional response to a potential risk in all cases. However, in certain cases, it is the sole possible response to a given risk.*

Obviously there are many factors that must be taken into account in risk governance which again raises the question about how decisions can be taken in a transparent way.

## 6. Discussion

Whiteside (2006, p xii) examines the philosophical premises of the precautionary principle. He evaluates two competing theories of precaution:

*“Hans Jonas’s “principle of responsibility” (1984) foreshadows the precautionary principle in arguing that humanity faces new ethical responsibilities toward future generations because modern technologies have the unprecedented potential to destroy life. This philosophy emphasizes the special competence of scientists to manage this situation. Coming from the opposite pole, Bruno Latour (1999) sees precaution as part of a larger project of “bringing the sciences into democracy”. His version highlights social contingencies and factual uncertainties in the development of scientific research”.*

No doubt, there are many angles to the discussion of the legitimacy and relevance of the precautionary principle. As Whiteside illustrates, there can be ethical, moral, democratic and practical arguments for the application of the principle. Before concluding the report we discuss some aspects of the precautionary principle which may be relevant for a comprehensive risk governance approach; critiques against the principle, the role of regulators and politics as well as the capacity or research to decrease the need for the principle by giving better knowledge.

### Critic of the precautionary principle

Critics of the precautionary principle argue that we already have the tools that we need to manage the new risks, often called “science-based risk assessment” or “risk-informed risk assessment”. This framework, it is argued, not the precautionary principle, provides a rational way of coping with the contemporary health and environmental risks.

Opponents of the precautionary principle fear that it will lead to much over-regulation of private enterprise and that it opens the regulatory door to unfounded and even entirely speculative risks. In that way It invites to new levels of politicization into the risk-assessment process, goes the argument.

It can be argued that the precautionary principle is not really action-oriented, but instead can be used to prevent the introduction of any new technology without any real factual reason. And can it be justified, for example, to use the mere existence of public concern as a reason for precautionary measures when there is no real risk at hand? Another problem is that the application of the principle can be taken over by scientists and regulators, and become just another tool in technocratic risk assessment. People with a pure scientific approach want to see that there is a substantial risk before they take action. The probability is high that they will use the mathematical construct of risk, furthermore narrowly defined to a specific type of risk. The dimensions of social values and ethics are then lost.

## The role of regulators

The precautionary principle is the subject of much deliberation and controversy on the philosophical level but also when it comes to practical applications in specific areas. Often the battle goes on between a certain industry wanting to introduce a new technology and opposing groups using the precautionary principle as an argument for a moratorium until more is known about uncertain risks. Typically, regulatory authorities find themselves being on the frontline between these two major stakeholder groups. They have to make decisions based on scientific evidence but they also need to take public values into account as is often argued e.g. in the area of risk management of mobile telephone systems.

Whiteside (2006, p131) argues that there should be a healthy dose of scepticism regarding the regulatory authorities:

*Citizen participation might help prevent some of the safety-reducing dysfunctions of regulatory politics. The challenge is to organize public participation and debate in ways that allow a wider group of stakeholders to interject questions about the quality and scope of scientific studies used in risk assessment (Levidow and Marris 2001, pp 355-356). Citizens might also be brought in to observe the functioning of regulatory bodies.*

When the precautionary approach is used there are questions about the role of authorities in judging value-laden issues:

- Is the area (e.g. GMOs, nanotechnology, electromagnetic fields) a case for precaution, taking uncertainty and potential harm into account?
- Are the value-laden elements in decisions related to precaution explicitly exposed to politicians and the public?
- How do the competent authorities deal with the value-laden elements (purely by experts or with some sort of deliberation)?
- Is there a political interest and responsibility taken for how the precautionary principle is used?
- Do the public and stakeholders have insight into how the precautionary principle is applied?
- If the authorities say that the precautionary principle is not applicable because there are not enough indications of serious harm, are their arguments open for public scrutiny?
- If the authorities say they want to apply the precautionary principle in a certain area, are the links between uncertainty and protective measures transparent?

Regardless of different interpretations of the precautionary principle, a common ground is that the absence of proof of a risk is not reason enough *not* to take precaution. But to trigger the precautionary principle there should be an *indication* for a possible risk. An important issue for discussion is often how strong the indications should need to be for the precautionary principle to be triggered. There is no obvious way to judge whether the authorities apply the precautionary principle in a correct manner. Therefore, there is reason to require that the authorities make transparent on what grounds they apply the principle, scientifically as well as value-based.

## The political responsibility

The politicians need to understand that it is not enough to have established the precautionary principle for environmental protection and public health. They have to take continued responsibility for the application of the principle in all policy areas, for the very simple reason that it is their responsibility to determine what the relevant risks are. The European Commission has made it perfectly clear where the expert role ends and where political responsibility takes over (European Commission, 2000, p 2):

*The precautionary principle should be considered within a structured approach to the analysis of risk which comprises three elements: risk assessment, risk management, risk communication. The precautionary principle is particularly relevant to the management of risk.*

And further on (ibid, p3):

*The implementation of an approach based on the precautionary principle should start with a scientific evaluation, as complete as possible, and where possible, identifying at each stage the degree of scientific uncertainty.*

*Decision-makers need to be aware of the degree of uncertainty attached to the results of the evaluation of the available scientific information. Judging what is an "acceptable" level of risk for society is an eminently **political** responsibility. Decision-makers faced with an unacceptable risk, scientific uncertainty and public concerns have a duty to find answers. Therefore, all these factors have to be taken into consideration.*

The Commission also states that “The decision-making procedure should be transparent and should involve as early as possible and to the extent reasonably possible all interested parties” (ibid, p3).

## The knowledge base

As the precautionary principle plays such an important role in policy making, *the level of uncertainty* is a key factor in risk governance. When there is a possible serious risk with large scientific uncertainty about an activity the principle is supposed to be set in action. When knowledge is sufficiently good, risk governance turns from precaution to risk-informed decision-making. On the other hand, to put the precautionary principle into action there needs to be some sort of indication of a possible serious risk. There can be cases when science says there is no such indication, but when the public and stakeholders are concerned, for example due to lack of trust in expertise and authorities. In such a situation there needs to be a dialogue that includes both science and the concerned citizens in order to clarify the situation.

In the report “Late lessons from early warnings” from the European Environment Agency (EEA) (Harremoës et al. 2001) the authors identify a number of heuristic principles, which can help guide judgement over whether precautionary action is called for in any particular case. The report stresses the need to broaden the sources and forms of knowledge in order to avoid that issues are too narrowly framed so that early warnings of risk are never, or too late, taken seriously. In order to broaden the sources of knowledge and to improve the use of the

precautionary principle, taking public concerns into consideration is only one of several recommendations presented in the report. Other important aspects that are highlighted in the conclusions of the report are (ibid: 193-194): the need for multi-disciplinarity (the inclusion of relevant social issues alongside the physical, chemical, biological and medical aspects of technologies); the need to identify and reduce interdisciplinary obstacles to learning; the need for ongoing scientific monitoring; the need to scrutinise claimed justifications and benefits alongside the potential risks etc.

Thus, most of the recommendations in the EEA report relates to the question of improving the knowledge base. This does not mean that uncertainties or ignorance are eradicated, which the report also stresses. However, the recommendations could increase the chances of anticipating costly impacts and achieve a better balance between the pros and cons of technological innovations (ibid: 194).

## 7. Conclusions

A key element of risk governance is to take all the relevant factors into account so that for each issue being dealt with there is a proper balance between the three approaches treated in the CARGO project; risk-informed decision-making, precaution and deliberation. To find that balance a number of factors should be taken into account in any risk governance process. As Whiteside (2006, p 150) concludes:

*“The precautionary principle is a pragmatically evolving, human principle, born of modern societies’ reflections on the nature of new risks. Any particular formulation of it is an attempt to express both as generally and concisely as possible all the considerations pertinent to an extremely complex risk-management situation.”*

When the precautionary approach is used one must be convinced that the area is really a case for precaution, taking uncertainty and potential harm into account. On one hand, one must ask if there is sufficient knowledge for risk-informed decision-making, on the other hand, if there really are indications strong enough for precaution. Furthermore, one must see to it so that the value-laden elements are taken care of by including lay people and politicians in the decision-making process.

We have seen that the precautionary principle may be difficult to practice even if the principle itself is well expressed. There can be different levels of evidence from different scientific disciplines of relevance. There can also be several relevant areas in which totally different types of expertise are involved, and in addition to that there can be value-laden and political factors outside science that need to be taken into account.

In the case of the precautionary principle, the European Commission (2000, p2) takes side against technocratic risk management and emphasizes the role of politicians not only in the management of risk but also in making it transparent and participatory. In practice, however, the question is whether the political system has really understood what this requires and if it has the muscle to live up to its responsibility. In order to manage risk using the results of risk assessment, politicians need to see if the assessment rests on technocratic assumptions about what is worth assessing, which questions need answers and if scientific controversy has been appropriately included in the assessment. It may well be the case that the risk assessment has excluded research deviating from the mainstream, and has thus outframed uncertainty and by that the precautionary principle from the beginning.

One observation is that regulatory and government agencies have a strong position in all forms of risk governance. They control risk-informed decision-making and use the results of quantitative risk assessment. They often control and conduct the application of the precautionary principle. It can then happen that values enter the scene but decisions are taken by expert bodies without politicians being involved. Finally the agencies can initiate and/or fund, and thus control, deliberative forums. In all this it is important that the competent authorities deal with the value-laden elements in a transparent way and that their considerations are open for public scrutiny for example with regard to how the precautionary principle is applied.

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