

The Precautionary Principle (with Application to the Genetic Modification of Organisms)

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Abstract—The precautionary principle (PP) states that if an action or policy has a suspected risk of causing severe harm to the public domain (affecting general health or the environment globally), the action should not be taken in the absence of scientific near-certainty about its safety. Under these conditions, the burden of proof about absence of harm falls on those proposing an action, not those opposing it. PP is intended to deal with uncertainty and risk in cases where the absence of evidence and the incompleteness of scientific knowledge carries profound implications and in the presence of risks of "black swans", unforeseen and unforeseeable events of extreme consequence.

This non-naïve version of the PP allows us to avoid paranoia and paralysis by confining precaution to specific domains and problems. Here we formalize PP, placing it within the statistical and probabilistic structure of "ruin" problems, in which a system is at risk of total failure, and in place of risk we use a formal "fragility" based approach. In these problems, what appear to be small and reasonable risks accumulate inevitably to certain irreversible harm. Traditional cost-benefit analyses, which seek to quantitatively weigh outcomes to determine the best policy option, do not apply, as outcomes may have infinite costs. Even high-benefit, high-probability outcomes do not outweigh the existence of low probability, infinite cost options—i.e. ruin. Uncertainties result in sensitivity analyses that are not mathematically well behaved. The PP is increasingly relevant due to man-made dependencies that propagate impacts of policies across the globe. In contrast, absent humanity the biosphere engages in natural experiments due to random variations with only local impacts.

Our analysis makes clear that the PP is essential for a limited set of contexts and can be used to justify only a limited set of actions. We discuss the implications for nuclear energy and GMOs. GMOs represent a public risk of global harm, while harm from nuclear energy is comparatively limited and better characterized. PP should be used to prescribe severe limits on GMOs.

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1 INTRODUCTION

The aim of the precautionary principle (PP) is to prevent decision makers from putting society as a whole—or a significant segment of it—at risk from the unexpected side effects of a certain type of decision. The

PP states that if an action or policy has a suspected risk of causing severe harm to the public domain (such as general health or the environment), and in the absence of scientific near-certainty about the safety of the action, the burden of proof about absence of harm falls on those proposing the action. It is meant to deal with effects of absence of evidence and the incompleteness of scientific knowledge in some risky domains.¹

We believe that the PP should be evoked only in extreme situations: when the potential harm is systemic (rather than localized) and the consequences can involve total irreversible ruin, such as the extinction of human beings or all life on the planet.

The aim of this paper is to place the concept of precaution within a formal statistical and risk-analysis structure, grounding it in probability theory and the properties of complex systems. Our aim is to allow decision makers to discern which circumstances require the use of the PP and in which cases evoking the PP is inappropriate.

2 DECISION MAKING AND TYPES OF RISK

Taking risks is necessary for individuals as well as for decision makers affecting the functioning and advancement of society. Decision and policy makers tend to assume all risks are created equal. This is not the case. Taking into account the structure of randomness in a given system can have a dramatic effect on which kinds of actions are, or are not, justified. Two kinds of potential harm must be considered when determining an appropriate approach to the role of risk in decision-making: 1) localized non-spreading impacts and 2) propagating impacts resulting in irreversible and widespread damage.

1. The Rio Declaration on Environment and Development presents it as follows: "In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation."