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# Targets in International Climate Policy: (Mis)understanding Two Degrees?

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# Targets in International Climate Policy:
# (Mis)understanding Two Degrees?

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**Authors' contributions:** Hermann Held suggested the research question and the dual role of temperature targets as social planner solutions and policy instruments. The article is based on Felix Otto's Master's thesis. Felix Otto wrote the first draft which was edited by Hermann Held. Interviews were designed by Felix Otto and conducted by both. All authors read and approved the final manuscript.

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## Abstract

This article investigates the genesis and role of the 2° target in international climate policy. We identify a dual role played by temperature targets: (i) a social planner's option of decision-making under uncertainty that draws on the precautionary principle, and (ii) a policy instrument to help the social planners' position become reality. Accordingly, the recent debate over the 2° target as found in the literature is actually a mutual misunderstanding: while the opponents mainly focus on the policy instrument function, the proponents focus on the social

planner solution. By publishing this article, we hope to contribute to a more "targeted" dialogue in the future. In order to achieve this, the article analyses the concept of targets and argues that an environmental target always consists of three elements, namely (a) science or system knowledge, (b) norms and values, and (c) an operational perspective. Further, it investigates how targets were defined in international climate policy and how they have evolved over time. In 1997, emission targets were defined in the Kyoto Protocol. In 2015, the 2° target, based on the precautionary principle, was implemented in the Paris Agreement. Learning from the case of sulphur dioxide policy, another example of environmental policy, when considering how the 2° target could be made more effective, one might be tempted to underpin it with impact-related findings that are as concrete as possible – or to replace it with corresponding impact-based targets. However, many actors might contend that the totality of global warming impacts is still hard to judge. Accordingly, the 2° target should also serve as an expression of precaution, as an interim solution of sorts, until we acquired a more comprehensive grasp of climate impacts.

**Key Policy insights:**

1. Differentiating between the 2° target's role as a policy instrument and a decision option fosters a more nuanced discussion on the target and resolves its validity.
2. The Precautionary Principle enabled prudent target setting in climate policy when knowledge on impact was still insufficient and CBA unhelpful.
3. The Precautionary Principle acted as the underlying rationale for the 2° target.
4. With the 2° target, climate policy shifted from a focus on emissions to a focus on impacts that allows for a higher level of ecosystem protection.

## 1. Introduction

The Paris Agreement (2015) represents a cornerstone in international climate policy. For the first time, the UNFCCC's calls for avoiding "dangerous anthropogenic interference with the climate system" (1992) were made concrete, in the form of an operational environmental target within an international treaty. Accordingly, global mean temperature rise must be limited to well below two degrees Celsius compared to its pre-industrial value. This "2° target"

was the product of twenty years of academic debate and successive national and international declarations. However, since being introduced, it has been criticized for producing inefficient policies, i.e., for setting a sub-optimal goal (Tol 2007). Moreover, it has been criticized for its lack of effectiveness in mobilizing the necessary global emissions cuts (Geden 2016). The latter critique culminated in a proposal to replace the 2° target with a zero-emissions target because it is supposed to be more effective (Geden 2016).

In this article, our goal is to put this critique into perspective. We think that we can resolve the disagreement on the target: while the opponents mainly focus on the policy instrument function, the proponents focus on the social planner solution. As a result, a misunderstanding arises that unnecessarily hampers the 2° target's acknowledgement. In order to investigate this, we examine the 2° target's dual role as (i) an expression of a particular normative order under deep uncertainty when assuming a social planner perspective, and (ii) a policy instrument to help the international community comply with precisely this normative order. With regard to (i), we show that the 2° target resonates with a particular strand of existing interpretations of the precautionary principle (PP) in terms of how to address deep uncertainty in decision-making.

When conceptually analysing climate regulation, it is crucial that we address the following question: at which point in the complex environmental cause-and-effect chain between human intervention on one end, and impacts on the other, was the environmental target formulated? While many in the economics research community regard CBA as the benchmark for environmental decision making, we are going to highlight, that a prudent climate target can in fact be determined with the help of a precautionary perspective, that abstains from addressing the economic damages of a decision.

This paper is structured as follows: in the second part we look into the theory of the precautionary principle. This is followed by an investigation of the conceptual foundation of environmental targets in part 3. Part 4 reviews the history of climate targets and critically analyses the justifications for targets. The analysis of the 2° target is intended to facilitate the integrated assessment modelling of climate change and to better differentiate between the target as a policy instrument and a condensation of scientific knowledge on the mechanisms of the climate system. This discussion is further supported by three expert interviews. Hans-Joachim Schellnhuber has been a member of the German Advisory Council on Global Change

(WBGU) ever since it was established in 1992. In 1993, he initiated a debate which tried to identify a "tolerable window" for anthropogenic global warming. The 2° target emerged from that debate due to paleoclimatic and evolutionary arguments. Oliver Geden is an outspoken critic of that target. Both he and Niklas Höhne took part in the international climate negotiations as policy advisors and have influenced the discourse on the 2° target. The interviewees were selected in order to include different views. The semi-structured interviews on the role of the 2° target lasted for about an hour and were conducted between January and April of 2018 by the authors of this paper. They were recorded and later transcribed. We analysed the interviewees' assertions with regards to our framework of the twofold role of the 2° target as i) a social planner's decision option under deep uncertainty and ii) a policy instrument.

## 2. The Precautionary Principle

The precautionary principle is one of several possible approaches to decision-making under uncertainty in national and international law. The PP is intended to guide decisions when a full grasp of the cause-and-effect mechanisms and respective impact chains is difficult to obtain. In technical terms, it addresses situations in which it is impossible to specify the whole state space at stake in conjunction with probabilistic statements linking causes to effects, hence precluding a full-fledged cost-benefit analysis. This makes it particularly suitable for environmental policy, where problems are often abstract, intangible and complex. As summarized by Iverson and Perrings:

> "The PP offers a guide for regulating novel threats under conditions of severe scientific uncertainty. It is argued to have originated in Germany, in the early 1970s, as the concept of 'Vorsorgeprinzip' (Haigh 1993) – 'foresight planning' – which emphasizes avoidance of potentially damaging actions even where there is uncertainty about consequences of those actions" (2012, p. 161).

Iverson and Perrings emphasize a history of alternative interpretations and present a long list of nation-states and international treaties that have adopted the PP in their regulatory statutes for health and the environment. According to Cass Sunstein, the principle was first applied in the 1982 UN World Charter for Nature and then taken up by a number of international declarations und treaties such as the Rio Declaration on Environment and Development or by the European Commission (Sunstein 2005, p. 17).

While it is a commonly held opinion that the PP is "notoriously difficult to define" (Steel 2015, p. 1; Townley 2017, p. 603; Goldstein 2012, p. 5), we believe it is not only the definition that is the cause of difficulties but also the principle's operationalization. Wiener has identified three "archetypal" formulations of the PP, namely: (a) "Uncertainty does not justify inaction", (b) "Uncertainty justifies action", and (c) "Uncertainty requires shifting the burden and standard of proof" (Wiener 2011, p. 528). These formulations are in keeping with the way the PP is incorporated in most international agreements. The philosopher Stephen Gardiner has supplied a more general analysis of the PP's structure, and identified three aspects that the PP always contains: (1) "Threat of harm", (2) "Uncertainty of impact and causality", and (3) "Precautionary response" (2006, p. 36). According to Gardiner, in order to apply the PP, one needs to identify a threat (1) that has uncertain effects, but which (2) can be minimized through the identification and application of appropriate countermeasures (3). These aspects show that it is difficult to achieve a consensus regarding the application of the PP because it is not always clear what should be considered a threat, or what the appropriate measures are to prevent it (Gardiner 2006).

The PP has been applied by various nations and in numerous international agreements over the past several decades. Hence one can see it as an internationally established norm used to apply types of decision-making under deep uncertainty which generally deviate from the prescriptions one would have obtained from corresponding cost-benefit analyses.

For the purpose of this paper we will examine precautionary action in climate regulation: a case that policymakers have identified as involving both (1) "Threat of harm" and (2) "Uncertainty of impact and causality", in keeping with Gardiner's conception. Part 4 of this article analyses the countermeasures, namely, the definition of the appropriate targets. In this case, the PP under Wiener's formulation (a) "Uncertainty does not justify inaction" was invoked. As a conceptual framework for the analysis of action, we will investigate the climate impact chain in both cases; at which point in the chain environmental targets apply; and what this means for the implementation of the PP.

## 3. Setting Environmental Targets

Beat Bächi has argued that the difficulty of finding an exact definition of environmental targets allows the concept to connect various special discourses (Bächi 2012). According to the philosopher Daniel Gruschke, commenting on Bächi, one should consider these targets to be

156 a mix of “scientific insight” and “societal compromise”, which lends them a twofold source of
157 legitimisation through both “scientific objectivity” and “democratic majority decision” (Gru-
158 schke 2012, p. 139). We wish to further clarify this by arguing that targets include three im-
159 portant elements: (a) system knowledge, (b) norms and values, and (c) an operational per-
160 spective.
161 One needs (a) system knowledge to have a general idea of the problem at hand (e.g. that $CO_2$
162 emissions lead to a higher global mean temperature), i.e., knowledge concerning cause-and-
163 effect relations within the system in question (e.g. how the carbon cycle works). This includes
164 awareness of where in the causal web knowledge ends and deep uncertainty begins. This
165 reflects the system perspective on an environmental target. Though targets substantially de-
166 pend on this kind of knowledge, that alone is not sufficient.
167 Why not? Because targets always also imply (b) norms and values that guide the decision on
168 the extent of change one wants to allow within the environmental system in question. This
169 normative perspective allows the “desired endpoint on a relationship curve”, which is what
170 Bertrand et al. (2008, p. 411) consider a target to represent, to be identified. When clear
171 thresholds between the level of emissions and its effects cannot be identified, a theoretical
172 concept of the desired relationship between society and its environment is called for. Alt-
173 hough science and system knowledge are necessary in order to have an idea of the matter at
174 hand, identifying the “problem” presupposes a normative analysis and a concept of how to
175 deal with the environment. Without these aspects, scientific knowledge remains empty, be-
176 cause it is meant to be normatively neutral and cannot identify “problems”.
177 Finally, targets always include (c) an operational perspective. This implies questions like the
178 following: Should an immission target or an emissions target be set? Should a temperature
179 target be used in climate policy instead of a concentration target? The decision regarding (c)
180 will necessarily depend on both (a) and (b).
181 The consequences of society-environment interactions can be conceptualized as an impact
182 chain from the source ($CO_2$), to the environmental effects (crop loss, warming etc.), to the
183 economic assessment of the impacts (see Fig. 1 for a generic conceptual model). Environmen-
184 tal targets can be applied at any point in the impact chain in order to define an appropriate
185 level of emissions or impacts. As a necessary condition for selecting the proper point in the
186 chain, the target variable must be linked to the control variable by sufficient causal knowledge
187 (the emission level). Beyond the target, deep uncertainty may arise along the impact chain.

For the most part, targets that focus on health and the human body are effects-based; consequently, they regulate the immission side of the cause-and-effect relationship, and focus on the amount of a specific substance that a system (e.g. the human body) can tolerate. Setting such immission targets requires an advanced level of knowledge on the system in question and the corresponding impact chain. In the context of environmental policy, targets such as critical loads defining the permitted amount of sulphur intake per hectare per year, or the 2° target in climate policy, are examples of impact-oriented targets that address the level of change within a system. In contrast to immission targets, emissions targets focus on the amount of a substance emitted at the source. One example: the $CO_2$ reduction targets defined in the Kyoto Protocol, which stipulate how much $CO_2$ every country is allowed to emit over a certain period of time.[1] In Germany, for example, emissions targets have historically followed the precautionary principle and been based on the best available technology (BAT) concept. On the one hand, the PP is said to foster stringent regulation even without complete information, thus leading to a higher level of protection than other rationales (Wurzel 2002, p. 19). On the other, emissions targets based on BAT largely focus on feasibility, and less on impacts and damages produced within the affected system. But a focus on emissions targets and BAT can facilitate target setting in cases of unknown dose-response relationships and when the system thresholds are difficult to identify.

As shown in Fig. 1, applying the PP can be seen as terminating the impact chain at a point that corresponds to the current level of knowledge and avoiding the need to cope with an overwhelming amount of complexity. Thus, the first targets were emissions targets that regulated the permitted amount of $CO_2$ emissions; subsequent targets shifted from the emission side of the impact chain toward a focus on the consequences within the system. In similar vein, but focusing on chemicals, Martin Scheringer has proposed assessing a given substance's persistence and spatial range as a proxy for the effects it produces. By pursuing this approach, one can avoid the complexity of damage research, and can apply the PP in order to define targets (Scheringer 2002, pp. 199–200).

One can analytically conceptualize the PP as terminating the impact chain at a point that is appropriate to the level of system knowledge. Regulation according to best available technology focused on the first step of the impact chain (see Fig. 1) and ignores the rest. In contrast,

[1] SRU (1996) and Reinhardt (2008) provide historical perspectives on the development of targets for health and the environment.

cost-benefit analysis (CBA) considers the whole impact chain from emission to an analysis of the lost economic value and seeks to derive an optimal target. In the following, we will examine climate regulation and investigate how regulation has dealt with the impact chain and applied the PP. Once the appropriate extent of the impact chain is identified, the problem of how to set the environmental target arises. We argue, that in climate policy, the 2° target was based on historical information on temperature extremes and thus, as an application of the PP instead of an analysis of the economic damages of climate change.

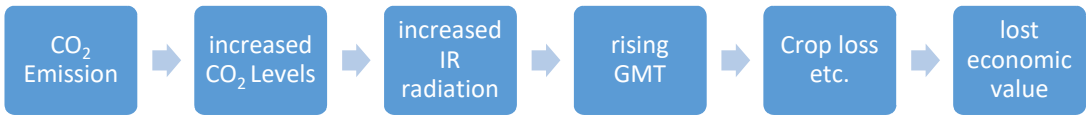


*Figure 1 Conceptual model of impact chain in the climate context based on (Hertwich et al. 2000).*

## 4. Climate Change

The first legally binding international agreement addressing the climate problem was the UNFCCC from 1992, which prescribes to stabilize "greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system" (UNFCCC 1992), Article 2). The problem of how to operationalize "dangerous anthropogenic interference" had to be solved in subsequent international agreements. The first attempt was the Kyoto Protocol (UNFCCC 1997), which defines emission reduction targets for the countries listed in Annex 1 of the UNFCCC (which mainly includes industrialised nations). The emission cuts defined in the Kyoto Protocol are generally not considered to reflect a scientific view on what is required to stabilize the global climate (in fact, it was clear at the time that the defined cuts could not stabilize the climate); rather, they were the result of political negotiations and diplomatic haggling (Liverman 2009; Liberatore 2001).

The 2015 Paris Agreement changed the approach from emissions targets to an impact-focused target on temperature stabilization. Article 2a of the Paris Agreement states that the participating countries agree to hold "the increase in the global average temperature to well below 2 °C above pre-industrial levels" (UNFCCC 2015). In response to pressure from the Small Island States, the article also includes a reference to pursuing "efforts to limit the temperature increase to 1.5 °C above pre-industrial levels, recognizing that this would significantly reduce

247 the risks and impacts of climate change" (Art. 2a). Furthermore, Article 4 calls for achieving
248 "a balance between anthropogenic emissions by sources and removals by sinks of greenhouse
249 gases in the second half of this century" (UNFCCC 2015). While the 2° target had already been
250 adopted by the Council of the European Union in 1996 and gained further international trac-
251 tion in 2009 when it was mentioned in the Copenhagen Accord of COP 15, the formulation in
252 the Paris Agreement was the first within a treaty at the at the UN level[2]. Yet, apart from its
253 legal recognition, the idea of the target dates much earlier. In the following, we want to high-
254 light a number of waypoints of the target's genesis.
255 A very early but less explicit argument for keeping global mean temperature below historic
256 extremes was provided by William Nordhaus, who maintained that: "If there were global tem-
257 peratures more than 2 or 3°C above the current average temperature, this would take the
258 climate outside of the range of observations which have been made over the last several hun-
259 dred thousand years" ((Nordhaus 1975, p. 23)). However, he would later argue that doubling
260 the carbon dioxide concentration represented a more fundamental target and became best
261 known for endorsing CBA as the most apt method for decision making in climate policy. In
262 1987 members of the German Physical Society and the German Meteorological Societies have
263 argued that since the last ice age, variations in GMT have not been higher than 1.5 – 2 °C.
264 Based on this interval, they call for measures to limit warming at no more than 1.5° C
265 (Physikalische Blätter 1987). Both proposals highlighted the role of a historical perspective on
266 temperatures instead of a detailed look into damages. A prominent argument in favour of the
267 2° target and employing the same rationale was made by the German Advisory Council on
268 Global Change (WBGU) in 1995. They argue that global mean temperature rise should be lim-
269 ited to 2 °C compared to pre-industrial levels. According to the WBGU, the geologic period of
270 the younger Quaternary is what "has shaped our present-day environment" (1995, p. 7) and
271 included global mean temperatures as low as 10.4 °C during the last ice age (which ended ca.
272 10,000 years ago) and as high as 16.1 °C during the last interglacial period (which ended ca.
273 115,000 years ago). Adding a margin of 0.5 °C at either end[3] results in a "tolerable climate
274 window" (p. 8) of global mean temperatures between 9.9 °C and 16.6 °C, which human activ-
275 ity should not exceed, according to the WBGU. Taken together with a pre-industrial GMT of

[2] According to Bodansky (2016) the Copenhagen Account was a political agreement while the Paris Agreement is a treaty.
[3] WBGU does not justify the choice of a 0.5 °C margin.

14.6 °C, this corresponds to a maximum allowable warming of 2 °C.

Jaeger and Jaeger have provided an overview of justifications in favour of the target and identified three main perspectives: the catastrophe view, the cost-benefit view and the focal point view (Jaeger and Jaeger 2011). Essentially, the catastrophe view argues that global temperature rise should be capped at 2 °C because a further temperature increase would potentially have catastrophic consequences. Jaeger and Jaeger consider the WBGU's justification to be an example of the catastrophe view. In turn, the cost-benefit view regards the 2° target as the outcome of a cost-benefit analysis. Jaeger and Jaeger quote statements made by the European Commission as examples of the cost-benefit view; however, they claim that it remains quite controversial to what extent the target can be seen as the outcome of cost-benefit analysis (Jaeger and Jaeger 2011). Because of this stance and the lack of consensus regarding the threshold for catastrophic consequences of climate change, Jaeger and Jaeger consider the focal point view to be the best argument for the 2° target. They "propose to use it as a focal point in a coordination game, where a multitude of actors need to find a new coordination equilibrium in the face of climate risks" (Jaeger and Jaeger 2011, p. 25). The focal point perspective on the 2° target has since gained a number of supporters: Knopf et al. refer to the target as a focal point (2012) and Cointe et al., using similar reasoning, refer to it as a "boundary object" (2011, p. 20). Knopf et al. set the limit for temperature rise at 2 °C because of the trade-off between high mitigation costs (which they consider to be a problematic aspect of a 1.5° target) and avoiding tipping points, which can be expected with high probability in a world that is 3 °C warmer. But they also stress that high precision was not their priority, because they do not differentiate between an increase of 1.9 °C and of 2.1 °C (Knopf et al. 2012). Lastly, in a comment on the 2° target, Schellnhuber points out that it "relies on a set of ethical and operational principles (like the precautionary one), and reflects a strategic compromise between desirability and feasibility" (Schellnhuber 2010, p. 231).

That being said, though accepted at the international level, the 2° target has been widely criticized. With regard to its function from a social planner's perspective, Tol (2007) makes it clear that he considers the 2° target to be too costly, and that it might have been a position "too strong for other countries to engage in a dialogue over" (Tol 2007, p. 429). Furthermore, he criticizes the EU for justifying its acceptance of the target by referring to CBA without having actually conducted any CBAs that support the 2° target. In our interview, Schellnhuber objects to applying CBA to the climate problem: "We will not be able to work out a global

utility function that can be optimized in a Ramsey model or any other model. Nobody can work out this function." For him, the PP was important at the beginning of the idea of a 2° target. But he argues that the goal of the PP is to guide decisions for situations with low probability impacts, and that this is not the case in climate policy: "Here, it is different. Here, I can say with high probability that something drastic is going to happen and I want to avoid it. […] We constantly talk about probabilities that lie in the range of 50% or 60% and then shrug our shoulders. This is completely absurd." Further, he argues that the above reconstruction of the original justification along the WBGU's line of reasoning is a rather abstract version of precaution. Instead, given recent advances in impact research, he stresses the above mentioned catastrophe view: the target's role in helping to avoid a series of tipping elements. This rationale is expanded on by Lenton et al. (2019). Yet Schellnhuber concedes that, for those actors for whom "the [natural science-based] data do not speak for themselves", the target could still perform an important precautionary function.

With regard to the target's function as a policy instrument, Shaw finds it poorly suited to conveying the uncertainties and ambiguities of climate change and its impacts, because it implies more accuracy than it can actually provide (Shaw 2013). In our interview with him, Oliver Geden expressed similar issues with the target: "Do people know what the 2° target implies? I don't think so. I would say that this is the price for such a target to work and to be supported by everyone. If only those who truly understood all the implications supported the target, we might only have 5,000 supporters." In the interview, Geden acknowledges that the 2° target has been acting as a focal point for international climate policy and a benchmark to help structure the debate. His critique focuses less on the policy in its social planner function, and more on policymakers and the political debate concerning the target, i.e., on its problematic function as a policy instrument. He argues that the target has successfully structured the debate and political decisions but has not been sufficiently action-guiding due to its inherent ambiguity. According to Geden, a domain like climate policy with its transformative potential runs the risk of an inconsistency between political decisions in favour of a target and subsequent long-term actions that do not support its realization (Geden 2016). Both Geden and Niklas Höhne argue that a zero-emissions target would be preferable. As Höhne argues in our interview: "I prefer it [the zero-emissions target] because the 2° target is not very specific. It was good at the time when it was passed, but it doesn't actually help anyone, because no-one has any idea what they need to do in order to comply with the 2° target. The net-zero

target, phasing out GHG emissions, or whatever you prefer to call it, is a lot more tangible for everyone: I need to get the emissions to zero. And then it doesn't actually matter so much anymore when this happens; the most important thing is that we reach zero. It's not enough to reduce 10% here and 20% there; it has to be zero. And this has an entirely different effect. In my opinion, this is an important and significant step forward." Schellnhuber concedes that today, the 2° target's function as a policy instrument might indeed be performed more effectively by alternatives, e.g. a net-zero target. But he also stresses the risk of inducing underdetermined levels of policy ambition in the process, as the target year might be set rather arbitrarily. He highlights Yamin's "zero emissions for all sectors by 2050" as a potential candidate (Haites et al. 2013), but emphasizes that the systemic justification of any new target must be traced back to the 2° target in its social planner function. Further, he stresses the importance of the 2° target as a policy instrument due to its highly symbolic function. This includes the number "2" as the simplest-possible number, and furthermore, the coincidence with human body temperature, where +2°C corresponds to a serious infection and +4°C signals a life-threatening illness. More generally, he points out the importance of a temperature target which is further underpinned by the IPCC special report on 1.5°C warming (IPCC 2018).

Building on these analyses of the target, we want to highlight two of its functions in particular: firstly, as an expression of a value system, and, as a codification of that, a preference order the "social planner" might assume. Such a social planner position represents one of many academically consolidated options that society may assume with regard to a pending decision. Multiple social planner positions (such as a 2°C target, a 1.5°C target, or no target) represent a prerequisite for society to discursively define its own position when faced with multiple, yet conflicting goals (such as preserving nature or economic growth) it might wish to pursue. Secondly, a target can serve as a policy instrument to make that very social planner's position (e.g. keeping the global mean temperature rise below 2°C) become a reality (by acting as a "focal point").

In the course of reconstructing the foundation of the 2° target as well as the critiques of the target, we found that there are two main lines of argument, tackling the two distinct functions outlined above. One line of criticism, emanating from an economic perspective, argues that the 2° target is not in line with the results of CBAs, making it sub-optimal (and therefore irrational). This critique questions the 2° target as an option for a rational social planner. While this statement holds true for the majority of CBAs published to date, more recent work

demonstrates CBAs as a highly sensitive instrument of analysis with respect to abstract assumptions that are hard to specify for stakeholders (Dennig 2018). Whether PP-based strains can be consistently accommodated in more formalized economic assessment is the subject of on-going research in the area of environmental economics (Held 2019). In that sense, the critique addressing the 2° target's social planner function likewise applies to any PP-based approach as departing from an alternative set of principles. One may or may not subscribe to the latter – this is a fundamental meta-decision on the normative level. Schellnhuber suggested that today, given our advanced understanding of the natural science basis of global warming impacts, the target's PP character should be replaced with a directly impact-based one. For a particular version of decision-making under tipping point position uncertainty, we can follow this argument. However, he also conceded that from an economic point of view, a PP component might still be needed in order to justify the target.

The other line of argument addresses the focal point function of temperature targets. Both in the literature as well as among our interviewees, emission-based targets are preferred over temperature targets, because they are considered to be more actionable. Schellnhuber conceded that this might indeed be the case, while insisting that the authority of emission-based targets must rest on temperature targets as their systemic basis and hence, on the social planner solution. Accordingly, the recent debate over the 2° target as found in the literature is actually a mutual misunderstanding: while the opponents mainly focus on the policy instrument function, the proponents focus on the social planner solution. By publishing this article, we hope to contribute to a more "targeted" dialogue in the future that acknowledges the bridging role of the precautionary principle towards a more nuanced cost-benefit-approach.

## 6. Summary and Conclusions

In this paper, we have analysed the historical genesis and different arguments in favour of the 2° target. Policies started out as emission targets which were considered a first step toward regulation in a situation characterised by uncertainty and political opposition to stringent regulation. This first step meant reducing $CO_2$ emission for industrialized countries in the Kyoto Protocol of 1997. In succeeding policies, a larger extent of the impact chain was considered in order to define the targets. The idea behind the 2° target was to guide prudent decisions in the absence of sufficient information on expected impacts of climate change. That is why the argument relied on the historical variability of temperatures as a theoretical construct for

decision-making and policy makers refrained from making an economic analysis of the damages.

By tackling these questions, we have sought to further clarify the structure and role of targets. We have determined that environmental targets necessarily consist of three elements: a minimum level of system knowledge linking human causes to the target variable; norms for decision-making under deep uncertainty; and, building on the first two, an operational component in terms of the exact target formulation, also factoring in the target's potential role in the political discourse. Our review of the relevant literature, as well as the interviews we conducted, reveals that this "2+1"-type structure may allow targets to play the following dual role in society: (i) as an expression of a particular normative order under deep uncertainty when assuming a social planner's perspective, and (ii) as a policy instrument to help the international community comply with said normative order.

We want to highlight an important comparison for climate policy: the case of the international sulphur dioxide policy regulated by the Convention on Long Range Transboundary Air Pollution (CLRTAP) - widely considered to be one of the major successful examples of international environmental regulation – starting in the 1980. Here, the precautionary principle helped to shape early policies, such as a 30% national emissions target, where emission reductions were prescribed, even though full information on their impacts was not yet available. This was soon replaced by intensive research on impacts, which led to the adoption of the critical loads approach still in use today. While pollution below the critical load is assumed to have no negative impacts on the environment, exceeding the critical load is assumed to harm the ecosystem.[4] A similar trend from emission targets towards a target that is set according to ecosystem requirements can be seen in climate policy; however, it began only recently, which can be explained by the higher complexity of the climate system. The analysis illustrates the bridging function of the precautionary principle. In contexts characterised by deep uncertainty, and for decision-makers who are sceptical about using CBA, it might serve as a substitute, starting with the emissions level as the target variable. As more system-based knowledge becomes available, targets can be formulated further down the impact chain, toward impacts. It was possible up to temperature, and current efforts are seeking to replace the PP by listing more concrete impacts – which is perceived as convincing more stakeholders of the need for

[4] Nilsson and Grennfelt (1988) provide a technical definition of the concept. Patt (1998) and Levy (1993) provide analyses of the political discussions that led to the agreements.

climate action, while completely abandoning the PP does not yet seem feasible. On the policy instrument side, more actionable targets for climate policy are currently being discussed. Future research might reveal how a learning-based phase-out of the PP from decision-making could be formalized, and what actionable targets might be optimally suited for climate policy. What lessons can be learned for climate policy from the effective implementation of sulphur policy? Acquiring more complete information on global warming impacts as soon as possible might accelerate opinion formation and enhance the willingness to act in society, while the PP will likely retain its bridging role for some time to come.

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