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Global Warming and Human Survival: A Mathematical Philosophy Approach to Environmental Sustainability

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Abstract: This thesis builds an interdisciplinary paradigm of how global warming needs to be considered as a crisis for the very existence of humankind and not just as a problem related to environmental studies and policies. A crucial limitation of the research is found between empirical climatology and normative ethics, and both are inadequate to analyze the issues associated with the risk of climate change. To fill in this gap, the thesis employs mathematical philosophy, applying the instruments of Bayesian epistemology, decision, game, and moral philosophies. Epistemically, what is shown is that while climate uncertainty may feature non-linearity, feedback mechanisms, and tipping points, it should not act as an excuse for not taking action. Rather, when viewed using the tools of Bayesian logic, fat tail risks, and Pascal's wager approach, uncertainty acts as a strong rationale for preemptive action to be taken. From a strategic point of view, the research paper considers climate change as a game of asymmetric players with multiple agents and multiple generations. The analysis demonstrates that the traditional models of collective action cannot capture the differences in the degree of responsibility, vulnerability, and institutional capability among the parties. In applying the concept of game theory to the long-term decision-making process, the paper reveals the asymmetry between the two generations – present and future – from the ethical perspective, which states that any choice made by one generation will irrevocably alter the opportunity set for the other generation. Moreover, the paper examines flaws in traditional economic approaches to climate change valuation, such as the discounting of future well-being using positive pure time preference. It is shown that such an approach undermines the value of future generations and is inherently biased towards procrastination. On the contrary, the combination of almost zero interest rates and the priority-based welfare principle can provide a more logically consistent approach to environmental management, maintaining temporal impartiality and giving priority to disadvantaged groups in the current and future generations. The main conclusion of this research is that sustainability in terms of environmental protection must be considered as a basic axiom of rational and ethical choice when making decisions in the context of existential threats. Taking into account the uncertainty factor, catastrophic risks, dependency and justice, the paper provides a new definition of environmental sustainability, which is an important prerequisite for ensuring the survival of humanity. The conclusions made have practical implications related to the need for effective global climate.

Keywords: Climate Change, Global Warming, Existential Risk, Bayesian Epistemology, Decision Theory, Game Theory.

I. INTRODUCTION

The Context of Existential Risk

The phenomenon of global warming is not only being viewed as an environmental disturbance and political issue but also as an existential risk to the sustained existence of the ecological conditions necessary for sustaining human life, civilization, and societal organization. Global warming, in addition to increasing temperatures, rising sea levels, mass extinctions, and other consequences, poses a serious challenge to the interdependent system of food production, water availability, epidemiology, infrastructural integrity, economic systems, and world peace. In this respect, global warming can only be addressed as an existential risk, in the sense that its effects

pose a threat to the flourishing of future generations, rather than in the more limited sense of species extinction.

The existential aspect of global warming arises out of the intersection of scale, irreversibility, uncertainty, and systematic interdependence. Where pollution affects localized areas, global warming spans the bounds of the planet over temporal scales that transcend traditional policy and intuitive morality. The results are unpredictable and subject to positive feedback loops that may magnify disruption above and beyond expectations. Thus, for the earth to be warmer means for it to become a place where there is less certainty about the stability of the environment, in its capacity as the background condition for civilized life. If human existence means anything, it implies not only physical existence but also the continuation of the social institutions, the ecological systems, and the processes which provide for a person's dignity and well-being.

The description of climate change as an existential threat is no hyperbole but, rather, a reasonable claim concerning the sheer extent of cumulative risk. It is not that the complete elimination of humanity from the face of the earth is likely, but rather the possibility of civilizational breakdown and massive ecological damage is enough of a threat to warrant philosophical re-examination of what constitutes climate change risk. The difficulty lies not in measuring physical losses but in considering how we must think and behave when faced with the destruction of our moral and political capacities.

The Gap in Current Literature

There has been abundant literature on climate change; however, much of it tends to be disjointed. For instance, climate science has evolved into a highly advanced field that employs empirical and computational tools to model the course of emissions, temperatures, tipping points, and regional impacts. Such modeling is fundamental in understanding atmospheric phenomena, carbon flows, and the probability distribution of climate states. In contrast, moral and political philosophy has produced extensive discussions on environmental ethics, accountability, distributional justice, legacy emissions, and intergenerational responsibilities. However, despite the advancements made by both disciplines, there exists a crucial conceptual link that needs bridging.

Many areas of climate science, however, must by necessity continue to be cantered on the probable events that will occur under certain conditions, as opposed to integrating uncertainty, ethical loss, and existential peril into the process of rational action. In parallel, many debates in ethics and philosophy, although increasingly quantitative, still do not formally model risk, belief, and obligations under conditions of deep uncertainty. Thus, crucial questions may be under-explored: How should highly unlikely but extremely catastrophic scenarios be weighted in ethical reasoning? How should individuals act rationally in cases of scientific uncertainty coupled with irreversible loss? What formal model would incorporate the obligations of individuals toward unknown future beings who cannot be precisely determined? And finally, how might sustainability be redefined in light of the need for long-term viability, not of resources alone, but of humanity and civilization itself?

The significance of this gap cannot be overemphasized as climate change is a case where scientific prediction alone will not solve the issue and where moral intuitions alone will not provide the necessary guidance to act. The issue of climate change involves taking actions in conditions of uncertainty, over very long periods, in cases of asymmetry

of vulnerabilities, and with potential irreversibility. Traditional approaches may regard scientific uncertainty as a hindrance to take action while considering moral obligation as insufficiently attuned to probabilities. The requirement then is for a framework to combine scientific understanding of the risks into a formally defined moral-political rationale for action.

The Mathematical Philosophy Approach

The present study seeks to adopt a philosophy of mathematics perspective toward environmental sustainability as an attempt at reconciling empirically based climate science with normative assessment. By adopting a philosophy of mathematics perspective, this study aims at using formal devices such as axiomatic systems, decision theory, Bayesian epistemology, and modal-deontic logic as ways of making explicit the principles upon which individuals should think rationally about the risk posed by climate change, their obligations with regard to moral responsibility, and their very survival. Neither should the application of a philosophy of mathematics perspective be understood as a way of turning ethics into arithmetic, nor should it entail that all values are commensurable quantitatively.

Consistency requirements regarding propositions of obligation, harm, and responsibility can be formulated within formal logic. The use of decision theory provides the means of assessing courses of action when decisions need to be made under uncertainty and there are policy choices that depend upon probabilities, asymmetric costs, and temporal considerations. Bayesian epistemology becomes particularly pertinent since climate action is not founded on certainty but rather on rational adjustment of beliefs under conditions of ignorance. In the realm of climate change, the agent is not expected to act only when catastrophes are certain. Rather, he or she is supposed to act when there is sufficient evidence but still uncertainty, and there would be a loss of future options due to delay.

Such a mathematical-philosophical approach can also be applied to the issue of intergenerational justice. Future people cannot take part in decisions being made right now, but they will suffer from our failure to act today in an extremely unfair manner. This approach could help us understand how our obligations toward future people cannot be considered just an emotional extension of our concerns regarding the people alive today; rather, such obligations should be viewed as rational restrictions on what we can do within the environment. Furthermore, through such thresholds as risk dominance and catastrophe decision rules, this approach can assist us in viewing sustainability not only as an ideal that should be achieved, but also as a necessity.

Thus, the proposed mathematical philosophy approach to climate risk can be both explanatory and normative. On the one hand, it helps explain the nature of climate risk, taking into account its uncertain, complex, and nonlinear nature. On the other hand, this philosophical approach is also normative, since it indicates the criteria for behavior of societies confronted with irreversible damage to present and future life systems.

Thesis Statement and Objectives

Global warming is seen as a crisis not only because of its magnitude and potential consequences but also for the way it challenges both empirical and qualitative approaches of assessing its ethical implications. In this work, the link between uncertainty, catastrophism, and duties to future generations is formalized through an axiomatic model showing how environmental sustainability becomes a

rational and moral duty in response to such problems. In particular, it is argued that where the probability-weighted impacts of climate inaction include threats to the viability of life and wellbeing on a global scale, rational actors must take responsibility for developing a sustainable course of action that addresses these risks.

The main idea behind this analysis is that there is an ethical theory of mathematics, which can serve as a basis for better reasoning in environmental decision-making by combining the following three components: first, formal understanding of beliefs and uncertainties; second, decision-theoretic approach to assessing high-stake decisions in group actions; and finally, moral consideration about intergenerational justice with the focus on the maintenance of the enabling environment for human life and flourishing. Sustainability here means something more than an economic or ecological policy instrument, but rather a manifestation of a more profound obligation.

In order to prove this claim, four tasks will be pursued in the following discussion. Firstly, a reconstruction of the existential importance of climate change through an embedding of global warming in a wider theory of systemic risk and civilizational vulnerability will be undertaken. Secondly, the constraints in the current approach in climate science and in moral philosophy, viewed separately from one another, will be established. Thirdly, a framework, based upon logic, Bayesian theory and decision theory, will be elaborated, according to which rational agents should act vis-à-vis risks of climate changes that are uncertain and catastrophic in nature. Finally, the application of this framework to environmental sustainability will reveal how it may be seen as more than a mere policy choice.

Here is the outline of the rest of the essay. The following section addresses the scientific and philosophical justification for considering global warming an existential threat. The next section provides an overview of the philosophical literature pertaining to environmental ethics, intergenerational justice, and moral agency in times of uncertainty. This will be followed by the presentation of our formal framework, which includes the necessary logical and decision-theoretic considerations for drawing ethical conclusions from climate science. It will be shown that this framework leads to a clear concept of environmental sustainability and its significance for climate politics and human survival.

II. THEORETICAL FRAMEWORK: EPISTEMOLOGY AND CLIMATE UNCERTAINTY:

In this section, the paper establishes its theoretical perspective in which the problem of climate knowledge in an environment of deep uncertainty is considered. Specifically, it begins with the assertion that any form of climate risk assessment should not rely solely on deterministic predictions and expected utility theory. Climate change is a knowledge domain with incomplete information, non-linearity, feedback loops, uncertainty of models, and the potential for catastrophic outcomes despite low probabilities. In this context, a mathematics-based philosophy cannot be considered unnecessary – it is essential for establishing a relationship between science and sound ethics.

Bayesian Epistemology and Climate Tipping Points

The application of Bayesian epistemology as a framework for reasoning about climate change is especially powerful since it gives an account of belief updating as the rational

agent receives new evidence. As its name suggests, the simplest form of Bayes' theorem involves the probability of a particular hypothesis after the receipt of certain evidence in terms of the prior probability of the hypothesis and the probability of observing the evidence under the hypothesis. In the case of climate reasoning, the hypotheses involve the degree of warming expected under particular emissions scenarios, and the probability of hitting certain thresholds in the earth's natural systems. These thresholds include major events like the breaking down of permafrost, changes to the functioning of the ocean currents, and other kinds of tipping points that have irreversible implications for global environmental conditions. This raises an epistemological issue, since these events cannot be predicted with absolute certainty, yet the mere fact that their timing or scale is unknown does not mean that we should suspend judgment.

It is important because of the refusal of Bayesianism to an overly black-and-white criterion for knowledge. Climate policy tends to be affected by the unarticulated criterion of justification, which demands absolute certainty for taking any measures. It is impossible from the point of view of epistemology. Neither science nor public policy is guided by the certainty but by the ability to adjust the beliefs rationally in light of the uncertainties. In the case when several observations demonstrate an increase in the rate of cryospheric retreat, the increase in heat waves, the deterioration of ecosystems' resistance, and the growth of climate sensitivity, rational agents should update their understanding of the system's danger in such a way.

This approach becomes particularly relevant in connection with tipping points due to the inherent problem that threshold events tend not to be amenable to linear extrapolation. Prior to crossing the threshold point, the available information might seem insufficient or confusing. But after passing this critical point, the resulting effects might prove to be sudden, reinforcing, and partially irreversible. A Bayesian theory of knowledge provides much insight into this scenario in the sense that the theory promotes interpreting partial knowledge as part of an overall body of rational belief. Rather than trying to wait for enough information to pinpoint the location of every possible threshold, a Bayesian would ask whether all of the existing information warrants believing that potentially harmful scenarios have a high probability of coming true and thus acting preemptively.

Bayesian reasoning about the climate also has an additional implication that goes beyond the field of formal statistics. It changes the responsibility of proof for moral reasons. Since the consequences of tipping points could be dire and irreversible, with an impact stretching into multiple future generations, any position calling for delay cannot rest on the idea that some residual uncertainty is neutral. On the contrary, they need to explain why uncertainty counts as reason for inactivity and does not count as reason for prevention. The epistemological takeaway is that responsible judgment about climate change will not be able to rely on an impossible criterion of absolute certainty, but rather on assessing how evidence changes the likelihood of the worst possible outcomes.

The Philosophy of "Fat Tails"

While Bayesian epistemology deals with the process of updating belief when faced with uncertainty, fat tails theory offers insight into why some kinds of uncertainties about climate change defy normal economic logic. A distribution is considered fat-tailed if there are extreme events that, despite their low probability of occurrence, carry substantial weight of probability mass. Regarding climate change, this implies that, despite being a low-probability

event, an extreme high impact event such as civilizational collapse or even an existential catastrophe cannot simply be discounted as having no bearing on the decision making process.

Indeed, it forms the very basis of Martin Weitzman's "Dismal Theorem," where, based on some reasonable assumptions, the author demonstrates how the traditional cost-benefit approach that uses the concept of expected utility fails for climate scenarios that have catastrophic risks characterized by a fat-tailed distribution. Logically, this is quite understandable: should there be a significant enough risk of an event involving unbounded or near-unbounded losses, then the total disutility of this event would simply overshadow any other considerations. Hence, the cost-benefit approach becomes inappropriate in this case, since no longer can one discount climate risk along with other variables, considering consumption as well.

The relevance of the above argument to a sustainable development theory is substantial. Standard cost-benefit analyses assume that the damages caused by climate change are, in principle, comparable to the economic costs and that the uncertainty can seamlessly be accommodated into welfare accounting. However, if the risk associated with climate change has catastrophic and/or existential implications, then such an assumption becomes untenable. The problem is not only that the standard model fails to quantify adequately the costs but also that it might be unable to measure at all the value of the destruction of the conditions on which future welfare depends. The end of humanity, the collapse of civilization, or the degeneration of the biosphere's habitability is neither more severe nor extreme forms of normal cost of policies.

In terms of the philosophical significance of fat tails, the issue concerns the way that fat tails present a challenge to conventional models of rational decision-making under conditions of risk. Conventional risk entails a scenario where expected value logic is sufficient, as negative events can only go so far in their damage and can be undone in one manner or another. In situations of deep climate risk, there is a tail end of possibilities which have such dire implications that they confer an ethical seriousness upon decisions. The very possibility of a pathway leading to irremediable disaster means that inaction becomes the normatively significant alternative to action.

This does not imply that every scenario of catastrophe is necessarily equally likely, nor that policy reasoning can be reduced to a logic of worst-case possibilities. On the contrary, a mature fat-tail ethic will resist both simplistic catastrophism and complacent optimism. What it implies is more specific: in cases where the distribution of outcomes displays fat tails and costs display non-linearities, a rational ethics will require that more weight be assigned to protecting against the worst scenarios. For in such cases, the concept of sustainability cannot be adequately understood as one that maximizes expected utility; it also needs to serve as a limiting principle on paths that threaten humankind with the possibility of tail-end destruction.

Pascal's Wager for the Anthropocene

Where Bayesian uncertainty meets fat tails, another layer of philosophy comes into play: the modern form of Pascal's Wager in the Anthropocene epoch. In the original form, Pascal considered rational faith under uncertainty regarding eternity either in heaven or hell. The logical framework was based on game theory: if the reward from acting rationally is infinite, while risks are finite, it is rational to do so. Even though one cannot transfer the original theological

premises of Pascal's Wager into the realm of climate policy, the underlying logic applies well enough. Herein, climate change mitigation could be seen as betting on the ability to live in favorable conditions, whereas inaction would be equivalent to betting against catastrophes.

A rational gamble with climate change does not assert that extinction is guaranteed or that any failure of mitigation necessarily means doom for civilization. Instead, it is predicated upon a relative decision framework. Assume that there are two primary political strategies: one involving significant mitigation and adaptation measures, and another where such efforts have been postponed or are inadequate. Assume, moreover, that the probability of disastrous climate scenarios cannot be calculated with certainty but that their consequences are catastrophic and irreversible, and that these effects endure across generations. In light of these assumptions, the relevant question to ask is not whether such calamity can be proved to occur, but which strategy is more justifiable considering the asymmetrical nature of the stakes involved.

What distinguishes the version of Pascal's Wager for the Anthropocene is that it goes beyond a merely prudent consideration. The argument encapsulates the requirement of rational moral agency in the face of existential uncertainty. If there is even a non-trivial probability that one's policies will cause irreversible harm to future generations and that one can avoid these harms at acceptable cost, then it is morally required to take the path that avoids the harm. There is nothing in the argument that requires the use of infinite utilities in a mathematical sense. What makes it compelling is overwhelming asymmetry.

On the other hand, the idea of a climate wager must be contrasted against irrational fear and doomsday talk. It is not about panic but rather a recognition that decisions made under conditions of uncertainty must take into account the magnitude and irreversibility of potential losses. Waiting for certainty of disaster before acting might mean that the opportunity to do so has passed. The climate wager therefore implies a form of anticipatory ethics. Rather than acting based on knowledge of what lies ahead, the wager is taken on the grounds of uncertainty about the future. Given the current age of Anthropocene-induced changes to Earth's natural systems, not acting on climate is a wager too—one whose consequences are not equally shared.

The Pascalian approach thus elevates the ethical dimension of sustainability. Sustainability is more than an administrative goal of resource allocation or a political slogan for reconciling environmental and economic concerns. It is the concrete embodiment of a rational bet on the ongoing existence of valuable human and ecological possibilities. Opting for sustainability means endorsing the notion that when faced with vague yet possibly catastrophic risks to the foundations of human existence, reason and ethics coincide in advocating prudence, adaptability, and forward-thinking stewardship.

Concluding Synthesis:

In sum, Bayesian epistemology, fat-tail theory, and a new Pascalian wager constitute a logically consistent body of theory to make sense of climate uncertainty. Bayes' theorem models rational beliefs under conditions of incomplete yet growing information. Fat-tail theory accounts for the reason why rare climate events can never be dismissed in terms of conventional cost-benefit analysis. And Pascalian decision theory proves that uncertainty regarding potentially disastrous outcomes makes procrastination irrational and unethical. The message here is unambiguous: Climate uncertainty is no grounds for

epistemic or political caution. On the contrary, by taking climate uncertainty seriously as an epistemological and philosophical issue, it is possible to conclude that sustainability emerges as a rational response to the nature of uncertainty per se.

III. THE GAME THEORY OF SURVIVAL AND ENVIRONMENTAL ETHICS

Whereas climate uncertainty poses the challenge of determining how rational actors should act in the presence of limited information, climate politics presents the related question of how rational actors should act when they face situations characterized by strategic interaction, temporal extension, and unequal ethical impact. Climate change cannot be explained merely as an issue involving prediction. Rather, it must be understood as one of coordination, burden sharing, and institutional choice. Climate emissions result from many parties whose interests are not inherently aligned with collective benefit, whereas their negative consequences will affect different actors in a disproportionate fashion. In light of this, global warming can be studied as a classic case for game-theoretical modeling. However, it is important to emphasize that strategic considerations alone are inadequate when they are not combined with ethical criteria to determine which equilibrium results can be considered justifiable. It is for this reason that the following analysis seeks to develop a game-theoretic approach to climate survival through a direct engagement with environmental ethics.

The N-Player Prisoner's Dilemma and the Tragedy of the Commons

The well-known Prisoner's Dilemma has been used historically as an environmental cooperation metaphor due to its capture of the crucial element of climate policy: all actors are individually rewarded for their defection, as long as other actors act cooperatively, although all become worse off if all defect. In the case of climate change policy, cooperation involves expensive measures, such as mitigation, emissions reduction, technologically transitioning, and being an environmental steward, whereas defection involves not taking on mitigation responsibilities and continuing carbon-intense growth. On an aggregated scale, the Prisoner's Dilemma becomes something akin to a tragedy of the commons, where the atmosphere is a common pool resource that suffers from pollution due to the lack of incentives to take care of it.

But in the case of global warming, the standard two-player game falls short of reflecting the complex ethics and politics involved. Global warming can be more realistically modeled as an N-player Prisoner's Dilemma, where players – states, corporations, organizations, and populations – find themselves in different positions relative to their emissions and susceptibility. It is an asymmetric game; players have contributed unequally to the buildup of carbon dioxide in the atmosphere, have unequal ability to adapt, and face very different timelines when it comes to suffering negative consequences. While the high-emitting industrialized countries have reaped substantial gains from economic growth powered by carbon emissions, countries in the Global South with smaller carbon footprints now stand exposed to greater risks from higher temperatures, food shortages, rising water levels, and climate-linked diseases.

The difference creates shifts both in how we describe the game and how we evaluate it. When both players in the Prisoner's Dilemma are structurally similar, defection is the rational choice because they consider themselves to be in the same situation. But when applied to the case of the climate, such a game is skewed by differences in historical

accountability, current capability, and future risk. Thus, the climate game is not only an exercise in collective irrationality but also one of structural inequity. Neither the Global North nor the Global South enters into the game at the same starting point. While one side has defined the rules of the game and benefited from the development opportunities provided by their use, the other is expected to play along in a set of terms that were not of its own devising.

The issue of asymmetric information adds another layer to the structure. The willingness of states to cooperate and how constrained they are domestically is uncertain, while at the same time there is also uncertainty about what kind of harm each state will suffer from climate change. This creates an environment where mistrust, procrastination, and under commitment are likely outcomes. Actors can be afraid to make concessions without any certainty that the other party will follow suit, or that they have the ability to switch and still remain competitive. Furthermore, certain aspects of climate change operate on a longer timeframe, which makes them less relevant than political ones in decision-making.

But when these imbalances are acknowledged, the tragedy of the commons cannot be understood as an ethically neutral statement of the problem. It is a historically contingent institutional phenomenon. Rather than a situation in which everyone fails to cooperate, it is a situation in which the game has been rigged in a manner favoring the appropriation of ecological commons by some actors at the expense of others. Consequently, an ethically appropriate response cannot be simply the demand for cooperation, but must take into account the redesign of the game itself according to principles of justice. This means sharing the burdens in relation to capability, historicity, and vulnerability. In game theory terms, sustainability is not only a condition in which the sum total of emissions is reduced, but also a condition in which cooperation is made sustainable by virtue of being a just arrangement among different players.

The wider philosophical conclusion is that climate change demonstrates the limitations of rational choice theories, which focus on achieving equilibrium alone as a criterion for success. There can be stable equilibriums that are unjust, and there can be efficient equilibriums whose distributional implications are unacceptable. In such a case, a game theoretic approach to survival should evaluate the effectiveness of climate change strategies based on whether they achieve a solution to the collective action problem without creating dominance, abandonment, or sacrifice of the disadvantaged parties.

Intergenerational Game Theory

The strategic dimension of climate change gets further complicated when time is introduced into the equation. While conventional models of climate change consider collective action to be carried out by contemporary players, the true moral implications of climate change come in light of the fact that actions undertaken by people today will affect future people, who cannot currently do anything in response. Hence, climate change is not merely a game for N-number of players, it is also a game between different generations. What this means is that the present generation takes decisions that will impact the conditions under which future generations will live, while these future generations cannot do anything strategically in response right now.

This pattern of intergenerational relations produces an ethically exceptional situation for strategic interaction. With normal iterative games, both reciprocity and

reputation can facilitate cooperation since the defecting generation faces possible punishment from others in the future. However, future generations are not capable of punishing current generations in advance; their defense is one-sided. The current generations play first with immense influence over the game tree – they have the ability to either preserve choices, weaken them, or make them unavailable.

A sequential game-theoretical depiction explains the nature of this imbalance. Imagine that the current generation selects at an initial stage between a scenario of high emissions and another one that is geared towards sustainable development. In the former case, there will be better payoffs now in terms of consumption and political expediency, while in the latter, a great deal of sacrifices must be made now but more possibilities will emerge for a stable and habitable future for the next generations. After this move by the current generation, however, future generations are faced with a restricted game. If certain dangerous temperature benchmarks have been surpassed, the next generation does not pick between the best possible states of affairs, but only among the methods of adaptation in a ruined environment.

It is crucial from a philosophical point of view that this aspect signifies that the impact of global warming goes beyond the mere sum total of welfare reduction suffered by people. It extends to a situation where there is a lack of freedom, opportunity, and institutional ability for those people that have not yet been born. This is in the sense that such people may face problems of forced migration, instability, poor health, and conditions under which they cannot thrive at all. Game theory terms it a case where the latter group is left with a dominated strategy when compared with what the former group faced.

Intergenerational game theory hence provides a richer basis for the idea of an environmental obligation than contemporary reciprocity would provide. Contemporary individuals have to be viewed not simply as utility-maximizing agents, but also as preservers of the future framework of the game. The obligation involved pertains to the maintenance of option values for people who cannot engage in the game at present. This can be formulated in the following manner: A generation is behaving unjustly if the strategy adopted by it leads, by all indications, to serious restrictions on the freedoms of future generations, without their consent, for relatively trivial gains in the present situation.

This approach also highlights the fundamental flaw in the political arrangements where there is an election cycle that is relatively short, along with economic logic based on discounting. In such systems, approaches that seek to achieve the maximum gain in the short run even when it leads to path dependency with devastating consequences in the long run are usually rewarded. However, discounting future survival considerations on the sole basis of their occurring in the future is morally untenable under the criterion of sequential justice. The temporal positioning of future survival considerations cannot lessen their moral importance.

Formalizing Rawlsian Justice

In the case that climate change is indeed a problem of the N-player commons as well as an intergenerational sequential game, the only thing left to do is to determine which result would have greater ethical merit. In this regard, Rawlsian justice emerges as an effective ethical standard. The method that John Rawls designed, called the "veil of ignorance," allows individuals to make decisions concerning principles of societal arrangement without

being aware of their own position in the allocation of gains and losses. In the context of climate change, the veil can apply in both geographic and temporal dimensions. One has to select institutions and paths of development for the climate without knowledge of being born in a society that emits heavily or lightly, in a robust nation or a vulnerable country, in the current generation or in the future, amid serious environmental degradation.

This is where the Rawlsian maximin rule – select the configuration that maximizes the situation of the least advantaged – takes on a special relevance. For if one thinks about global warming from behind a climate veil of ignorance, it would be self-defeating to favor a scenario in which certain groups thrive at the expense of making life unsustainable for other groups. This is because one could very well be situated among those whose fate is determined by such a choice. Maximin need not entail complete equality of outcomes; however, it entails establishing social structures in such a way that minimizes the risk of sustaining an existence that is conducive to human flourishing.

This can be expressed formally as follows. Assign a distribution of payoffs over generations associated with every potential climate policy. In doing so, we have to consider broad definitions of welfare, encompassing not only monetary income or fulfillment of preferences but also access to the necessary preconditions for exercising agency such as physical well-being, environmental security, social stability, and basic material necessities. The maximin criterion involves the comparison of policies based on their minimal generational payoff. Ethically speaking, the optimal climate policy corresponds to maximizing welfare levels among the most disadvantaged generation, conditional on sustaining just institutions throughout generations. If the set of possible policies includes such options which cause inevitable, permanent, and preventable loss to future generations, such policies cannot pass the maximin threshold despite providing higher average welfare currently.

When applied to survival of the human race, this concept results in a rigorous yet sensible conclusion. The best course of action from an ethical standpoint, according to mathematics, is neither the one that ensures the highest growth rate for a new generation nor the policy that trades the possibility of catastrophic outcomes for practicality during the transition. Rather, it is the policy that will ensure the maximum security of the lowest threshold of viable and decent existence in potential birth locations. In other words, a person behind the veil of ignorance would rationally choose an approach to sustainability based on minimizing the likelihood of any generation falling below the minimum threshold of survival.

This kind of formalization of Rawls' theory is particularly critical because it provides a way to express a widely held ethical notion in the language of decision theory. Intergenerational justice can be rhetorically potent but conceptually fuzzy when put into practice. Through the framing of climate decision-making as a veil-of-ignorance decision over time for the survival of humanity, the argument gains clarity. One can articulate not only that future generations have significance but that a decision under uncertainty about the fair allocation of risks and benefits should support resilient, precautionary policy choices and the preservation of the worst future position.

However, it must be understood that the Rawlsian model is not meant to provide a mechanistic solution to every single problem encountered in policy. Maximin may be too cautious when used without any limitation in every

situation. Yet, when it comes to situations wherein the minimally possible gain refers to the basic requirements for sustaining life and liberty, maximin is indeed sensible and reasonable. This is because climate change ethics presents a case where there will be irreparable harm in the form of loss of livelihood, loss of health, and even the collapse of institutions.

Concluding Synthesis:

According to game theory, global warming is not simply a case of collective action problem. Instead, it represents an interaction of structural inequality, temporal asymmetry, and moral significance between current and future individuals. Although the n-person prisoner's dilemma illustrates the temptation to free-ride in relation to the commons (the atmosphere), only an advanced version of game theory can take into consideration inequality both in responsibility and vulnerability between Global North and Global South. With intergenerational game theory, we learn that the current generation of humanity functions as a first mover, capable of limiting or expanding the strategic options available for future generations. With maximin analysis, we then have the necessary standard of ethical assessment.

The core conclusion, then, is that the mathematically most ethical reaction to global warming is not one of laissez-faire adaptation to whichever equilibrium happens to result, but rather the creation of a fair order of cooperation that ensures the basic requirements for human life are maintained over time. Sustainability is thus the equilibrium chosen by rational and ethically neutral agents who lack knowledge of their place in time. Consequently, sustainability cannot be considered simply politically advantageous; it is mathematically just.

IV. THE MATHEMATICS OF VALUE: DISCOUNTING HUMAN LIVES

The problem of climate change cannot be reduced to a problem of physics and strategic interaction alone; it is also a problem of valuation. In other words, as soon as the impacts of climate change are quantified over a prolonged period of time into the future, we have to ask ourselves: how do current social arrangements weigh the well-being of living persons against the well-being of people who are yet unborn? The prevailing answer to this question within climate economics consists in the method of discounting, which is basically an algorithm for reducing future gains and losses to their present value. While discounting may seem to be nothing more than an unavoidable exercise of economic rationality, its application in the case of climate change takes on a profound ethical dimension, because it involves decisions regarding the amount of weight we give to suffering, mortality, and stability in the future.

This section presents a case against the way that discounting is currently used in economics, claiming that its use hides a core ethical dilemma, which is that a positive pure time preference can effectively be used as a device to undermine the worth of people existing in the future solely by virtue of being in the future. This is particularly problematic within the context of climate change, where the impacts of current emissions are postponed, compounded, and often irreversible. In order to address this matter, this section begins with an analysis of the Ramsey equation, along with the ethical implications inherent within the discount rate. The section proceeds to establish that a near-zero pure rate of time preference represents the best ethical foundation for climate assessment.

The Ramsey Equation and the Ethics of the Discount Rate

In climate economics, the discounting framework usually stems from the Ramsey model, where the social discount rate is split into two different parts: the normative component and the descriptive component. The standard form of the consumption discount rate is given by where r is the social discount rate, δ is the pure rate of time preference, η is the elasticity of marginal utility of consumption, and g is the expected growth rate of per capita consumption. Every single one of these elements has ethical dimensions. The value of δ indicates the degree of discounting of welfare based solely on the fact that it happens in the future. The element η g represents the consideration that if future generations will be richer, a certain level of consumption will matter less for them than for individuals today. Despite the mathematical simplicity of this formula, its philosophical meaning is deep: it regulates the process of conversion of future climate impacts into current decision-making priorities.

The ethical issue relates fundamentally to δ, which refers to the pure rate of time preference. Where δ>0, any harm experienced by a future individual has less moral weight than an otherwise identical harm caused to a current individual based on the fact that it happens at a later time point. This is not a case of uncertainty, opportunity costs, or inequalities in economic status. This practice might be relatively acceptable in personal finance due to the impact of factors like impatience, rates of return, and market preferences. However, when used in social ethics and particularly cases involving death, relocation, environmental degradation, and intergenerational sustainability, it turns into an ethically questionable issue.

This characteristic bears significant implications for climate policy decisions. Inasmuch as much of the worst effects of climate change take place over long periods, a small positive figure for δ is enough to heavily discount the current weight accorded to the future damage done. The math speaks volumes. If future utility is discounted at an exponential rate, a harm taking place a hundred years from now might be considered minimally consequential in a cost-benefit evaluation today, even if that harm involves large-scale displacement or catastrophic risks.

Sometimes defenders of discounting have tried to justify the practice on the grounds that some positive rate is simply necessary due to the uncertainties surrounding the future, the productivity of capital, or the need to align public policy with the revealed preferences of society. But these defenses need to be sorted out. The uncertainty regarding whether there will even be people around in the future is a different matter from discounting the existence of those who are here already. The concept of opportunity cost does not in and of itself constitute a moral justification for discounting. And the fact of impatience in markets cannot provide much guidance when considering what is right with regard to future persons unable to consent.

In this regard, the climate policy discussion concerning the discount rate must not be considered just a debate on parameter estimation. It is an argument regarding the ethical foundations of intergenerational decision-making. Upon recognizing that the discount rate is a normative theory rather than a value-free parameter, then there may be reasonable grounds for questioning the validity of standard climate-economics models.

The Zero-Discount Argument

Any reasonable philosophy of climate value will have to assume that future persons are as morally valuable as present persons, at least with regard to such basic concerns as life, well-being, safety, and the environment needed for agency. Such an assumption implies that the pure time-discount rate ought to be zero or close to it. Not that all future welfare is equivalent in practical terms to present welfare, or that factors such as risk, economic growth, and marginal utilities do not play roles. The point is that temporally when something happens cannot affect its moral value. It cannot give license to treat some humans as less valuable simply because they are born at a particular point in time.

The philosophical rationale for zero pure time preference is thus an obvious antidiscrimination argument. To accord less importance to future people simply because they have not yet been born is to discriminate against them in precisely the same way that discriminating against people based on their race, national origin, or class would. The absence of future individuals from today's decision-making institutions only increases our obligation to speak up for their welfare in terms of ethical principles. As such, those who wish to discount future harms must bear the burden of proving why this is permissible.

The math also bears importance. For a positive pure rate of time preference $\delta > 0$, the present value of future catastrophes decreases very quickly over time, thereby introducing a natural tendency towards delay. However, for $\delta \approx 0$ the future is heavily weighted, and mitigation is no longer a sacrifice made for far-off unknowns, but rather an intelligent reaction to a growing threat. The difference is particularly important when dealing with tipping points, path dependency, and irreversibility. In a tipping point system, the cost of waiting is not linear. Early pollution sets the stage for future catastrophes, shrinks the adaptation range, and makes it likely that future populations will find themselves with a destabilized environment and political order. Positive δ does more than devalue the future; it may systematically create decision-making rules that lead to system breakdown.

In other words, one could formulate this concept using probabilistic language. Specifically, let us assume that the period of postponed mitigation increases the chance that the threshold of irreversible damage will be passed after which climate change damages become reinforcing and cannot be reversed anymore. Under conditions when future impacts are heavily discounted, public policies will inevitably invest less than optimally into prevention, thus accumulating risks over time. This not only means that losses increase but also that risks move towards an environment of cascade failures – food scarcity, immigration stresses, problems with infrastructure and institutions, etc. From this point of view, it becomes clear how discounting is used as a method of transferring risks from today's winners to tomorrow's losers. For this reason, one can easily see why arguments against high δ values are both normative and pragmatic.

An objection might be raised against the zero-discount principle because it would put an undue burden on the present, particularly on those poor individuals who have immediate demands that need to be met. However, this kind of argument fails to distinguish between a purely time preference approach and one that considers distribution concerns when formulating policies. A low δ need not mean being indifferent toward the poor in the present but rather that poverty alleviation in the present and climate

change mitigation in the future need to be addressed concurrently without any temporal bias.

Utilitarianism vs. Prioritarianism

Ethics of discounting can only be fully comprehended when it is considered in a wider social welfare framework. Traditionally, climate economics has depended on utilitarian aggregation to measure welfare. Policies are assessed based on the net welfare gains they generate. Mathematically speaking, this process could be summarized as maximizing the aggregate welfare function like

$$W = \sum_{t-0}^{T} \beta^t \sum_{i-1}^{N_t} u(c_{it}),$$

where denotes the utility of person i at time t, and β is the discount factor. This framework has undeniable strengths. It is tractable, general, and sensitive to aggregate consequences. However, its moral weakness becomes evident in high-stakes climate contexts. Because utilitarianism aggregates across persons, severe suffering experienced by a minority may be treated as acceptable if it is offset by sufficiently large benefits to others. In principle, a policy that leaves some communities exposed to devastating climate impacts could still be judged optimal if overall welfare is higher.

The significance of this point becomes particularly disturbing when one considers the nature of global warming, since the suffering caused by its effects is not random but rather disproportionately affects the most vulnerable sectors of the world's population: impoverished people, climate-vulnerable areas, island nations, future individuals, and those least responsible for past emissions. A purely aggregate approach could mean that the very victims that have the best claim to protection are being subjected to a system that sacrifices their interests. While discounting may be limited, even a utilitarian aggregation could lead to outcomes whereby the slight inconvenience of rich people equals the misery of poor people.

Prioritarianism represents a more morally sensitive approach. What underlies prioritarianism is that there is greater moral importance attached to gains in well-being made by individuals who have a lower well-being to begin with. In the mathematical formula of social welfare functions, increasing importance would be assigned to gains in well-being at lower levels of well-being. Prioritarianism does not mean merely diminishing marginal utility from an economics perspective, but assigning greater moral significance to gains made by disadvantaged persons. With regard to the issue of global warming, prioritarianism is a more morally appropriate way of looking at the imbalance between small inconveniences suffered by rich emitters and severe damage to poor nations.

It would, then, be fair to say that the climate welfare function under prioritarianism is one where the welfare losses or gains experienced by individuals at the bottom of society hold greater normative value than the losses or gains suffered by those at the top end. Such a perspective makes a great deal of difference for policymaking, since measures such as adaptation funds for highly susceptible areas, aggressive mitigation measures for future low-capacity societies, and loss and damage schemes for highly susceptible societies can be justified not as a charitable act but as a necessity based on weighted justice.

As an ethical doctrine, prioritarianism is better suited to the existential nature of climate damage. The worst consequences of climate change are not simply detrimental to average well-being; they pose a danger of dropping individuals and populations below levels needed to have a decent quality of existence. Once the issue of threshold vulnerability becomes salient, the idea of maximizing welfare becomes less satisfactory from an ethical point of view. It does not suffice to ask about the size of the total amount of well-being but whether there are vulnerable individuals who are made worse off so that others might be a little bit better off.

That being said, it does not imply that there is no space for utilitarian thinking. Indeed, aggregate welfare considerations still have their relevance, especially when a certain shift will allow for a wide range of positive side-effects. However, within the realm of climate ethics, the priority should be given to prioritarian constraints upon utilitarianism. Rather than attempting to create a formula that maximizes aggregate welfare irrespective of distributional considerations, what needs to be developed is a system where the safeguarding of the vulnerable will become an inherently important part.

Concluding Synthesis:

Discounted math is always more than math itself. When applied to climate policy, it embodies assumptions about equality in time, moral value, and acceptable risks. The Ramsey formula shows us that the discount rate is not an impartial variable but rather a concise articulation of ethical values between generations. A positive pure rate of time preference will consistently reduce the importance of future pain and thus accept delays when the situation grows increasingly urgent. Conversely, a close-to-zero pure rate of time preference is more consistent with the moral equality of current and future people and reduces the institutional tendency towards policies that increase risks of collapse.

In addition, however, the ethical soundness of climate valuation is not only dependent on the discounting of welfare over time, but also on its aggregation between individuals. Utilitarian approaches offer methodological rigor but risk making the suffering of the most vulnerable acceptable for the sake of increased welfare overall. On the other hand, priority-based frameworks, which place higher moral value on the interests of those worst-off in the face of climate-related damage, present a much more compelling basis for sustainability in the presence of extreme inequality and vulnerability. It follows from this that sustainability cannot be achieved unless it is based on a morally justifiable model of value that takes both temporal and distributive considerations into account.

V. CONCLUSION

The current research endeavor has proposed a comprehensive approach towards explaining the nature of climate change as a multidimensional problem concerning its existential, generational, and structural dimensions, which necessitates a comprehensive and coherent framework for understanding rather than fragmentary approaches based on disciplines. It is shown that environmental sustainability is not an arbitrary preference or ideal but a logical and moral obligation stemming from its inherent structure.

Epistemically speaking, one learns from the analysis that the existence of uncertainty in the science of climate change cannot be used to make a case against acting. Rather, the fact is that uncertainty makes the case for taking action

more urgent than before. This happens in the light of the Bayesian interpretation of uncertainty along with the presence of fat tail risks and Pascalian rationality. The reality of having low probability but high catastrophe scenarios, irreversibility, and the interconnectedness of the systems involved makes delaying action not an idle option, but a dangerous choice.

With respect to strategy, it is apparent from the above discussion that climate change is a profoundly unbalanced and dependent game between players both contemporary and future. The N-player aspect of emissions, coupled with unequal distribution of responsibility and vulnerability, means that climate change is a problem of ethics as much as coordination. From the perspective of intergenerational game theory, it becomes clear that the current generation enjoys a dominant position over future generations' opportunity sets, and thus creates duties which cannot be derived merely from reciprocal self-interest. With sustainability as the sole ethical equilibrium that respects the minimum standards of humanity regardless of where an individual is situated within the temporal and geographic distribution, as per the Rawlsian veil of ignorance, it appears clear what the solution is.

Moreover, the paper has critically assessed the mathematical underpinning of climate valuation, focusing on the concept of discounting. It has been claimed that there is no moral reason to assign a positive pure rate of time preference since it would unjustly diminish the worth of future people. The combination of the near-zero discount scheme with the prioritization of welfare can serve as an alternative that combines impartiality in time with the prioritization of the worst-off. In this way, the shortcomings of the utilitarian approach to climate valuation could be overcome.

Overall, these considerations provide substantial justification for the thesis, which maintains that a mathematical philosophy of climate ethics may close the chasm between factual knowledge and moral responsibility. Through a rigorous articulation of the interconnections between uncertainty, disaster, interconnectedness, and ethical justice, this study offers a conceptual framework within which sustainability can be interpreted as an axiomatic precondition for collective survival. Ultimately, sustainability is not merely a matter of resource preservation and balancing competing concerns; it is a means of safeguarding the very possibility of future moral existence.

The larger implication from a policy perspective and governance perspective becomes obvious. The approach towards climate change needs to be driven by principles of precautionary nature, justice and long-term perspectives. The institutions have to be framed in such a way that they take into account the risks involved, overcome the strategic asymmetry and reflect the interests of future generations who are yet not able to speak for themselves.

To conclude, the problem of global warming is not just about predicting environmental change but about defining a new concept of rationality and responsibility in the face of deep uncertainties and existential concerns. Through the mathematical philosophy perspective presented in this essay, it can be shown that the dilemma posed by global warming is a normative one, choosing between pursuing a course of action that jeopardizes the very existence of future generations or following a moral commitment to sustainability, which ensures the viability of future life for all generations.

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