The Pursuit of Sustainable Development as a Duty of States under International Law

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ABSTRACT

This dissertation analyzes the existence of a duty of states to pursue sustainable development. First, it discusses previous concepts of sustainable development. Systems and social choice theory are then used to define the consistency of a proposed set of policies with sustainable development, relative to the current world system, a given time horizon, and a legitimate social preference relation.

A duty of states to pursue sustainable development is demonstrated: States have a duty to advance the right of peoples to self-determination; self-determination, the right of peoples to determine their future, encompasses sustainable development as a possible objective; peoples have freely expressed their will for sustainable development; therefore states have a legal duty to pursue sustainable development. The international law of self-determination can also be characterized as an international trust, imposing on states as trustees the duty to pursue sustainable development on behalf of peoples as beneficiaries. Furthermore, the duty is reinforced by an emerging human right to sustainable development, either as a synthesis of rights to development and environment, or rooted directly in the United Nations Charter.

A series of case studies amplifies on these concepts, and shows how different policy issues can be integrated when evaluating the consistency of an overall policy set with sustainable development. Case studies on threats of unrecoverable catastrophes include a large comet, a viral mutation, and a large-scale nuclear attack. The threat of a large-scale nuclear attack is shown to plausibly forestall sustainable development by itself, underscoring the deep connection between sustainable development and national security. An analytical approach to evaluate global climate change policies is set out: creating linked models with modular interfaces, executing the models for alternative policy strategies, and evaluating the model projections, inclusively of expert and public opinion.

The net result is that pursuit of sustainable development is accomplished by: learning about the world, searching for promising policy strategies, projecting the consequences, and evaluating whether those projections meet the standard of sustainable development:

"ongoing improvement of the world system according to a legitimately constructed social preference relation".

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"The fiftieth anniversary of the United Nations is therefore not only a time to review the Organization’s first half-century and prepare it for its second, it is also an occasion to address ways to regain the momentum in world affairs that appeared so dramatically at the outset of the decade."

"The days, weeks and months covered in this report have been filled with discouraging developments. But from a larger, longer-term point of view, there are many signs that progress is being made, giving cause for confidence that, over time, success is entirely possible. Never before have so many courageous and committed people been involved in world betterment. Never before have nations recognized so clearly that their fate is bound up with each other. And never before has it been so undeniable that mutually beneficial international institutions of cooperation - with the United Nations foremost among them - are a vital global necessity.

It is therefore imperative to remain focused on the reality of movement towards long-term achievement and not to permit dismay over immediate difficulties to weaken the positive momentum that has been achieved."

"The divine spark of creative power is instinct in ourselves; and if we have the grace to kindle it into flame, then stars in their course cannot deflect our efforts to attain the goal of human endeavours."

"The Indigenous people, our people, were aware of their responsibility, not just in terms of balance for the immediate life; they were also aware of the need to maintain this balance for the seventh generation to come. The prophecy given to us, tells us that what we do today will affect the seventh generation and because of this we must bear in mind our responsibility to them today and always."

"We cannot simply think of ourselves and our survival; each generation has a responsibility to ‘ensure the survival for the seventh generation’."

"In fact, our concept of time forces us to think hundreds of years into the future. The investment we make is not measured in dollars or in material wealth, it is measured in terms of our ability to ensure that what is here for us today is here for our children and our childrens' children tomorrow."

"To prepare for one year, plant rice; to prepare for ten years, set trees; but to prepare for a hundred years, educate people!"

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**Arnold Toynbee, 4 A Study of History 39 (1939), as quoted in Burns Weston, Richard Falk, Anthony D'Amato, "International Law and World Order" xvii (1980).


****Ancient Chinese proverb.
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I. INTRODUCTION

Sustainable development is a critical issue in today's world. However, a formidable array of challenges must be overcome to implement it. The objective of this dissertation is to: 1) analyze the existence of a duty of states under international law to pursue sustainable development, 2) formulate a conceptual definition of sustainable development which can form the basis of this legal duty, and 3) analyze a series of case studies to develop insight into how to evaluate the consistency of a government policy set with sustainable development.

The analysis demonstrating a duty of states under international law to pursue sustainable development is based upon the right of peoples to self-determination. Self-determination is first placed in historical context. Then the United Nations Charter and relevant General Assembly Resolutions and International Court of Justice decisions are presented. The argument about the existence of a binding norm of self-determination is patterned after the sources of international law contained in the Statute of the International Court of Justice: international conventions or treaties, customary international law, general principles of international law, court decisions and teachings of publicists. With respect to the issue of whether self-determination constitutes a norm of customary international law, the troublesome existence of state practice in violation of the norm is addressed specifically.

As will be seen, the international community, including the International Court of Justice, the United Nations General Assembly, and a strong consensus of international legal scholars, have concluded that the right of peoples to self-determination has attained the status of a binding norm under international law. Self-determination is then shown to be a flexible and dynamic right, to which all peoples are entitled and which all states are obliged to respect and advance.
This right of peoples to self-determination is, fundamentally, the right of peoples to determine their future. The pursuit of sustainable development is shown to be one possible choice in exercising this right. In fact, the peoples of the world have freely expressed their will for that choice, in a series of solemn convocations culminating in the United Nations Conference on the Environment and Development in 1992. The resulting duty of states to pursue sustainable development is also shown to be reinforced by additional foundation in human rights.

A threshold issue concerning a duty to pursue sustainable development is whether there is a suitable conceptual foundation for sustainable development itself. Therefore, at the outset, a conceptual definition of sustainable development which is able to serve as the basis of a duty is developed. This systems/social choice definition of sustainable development is characterized as ongoing improvement of the world system according to a legitimately constructed social preference relation. However, any "Holy Grail" of a selection mechanism to solve the difficult issue of ultimately choosing among policy alternatives is expressly disclaimed. Rather, the systems/social choice definition is designed as a "litmus test", to help evaluate whether a proposed policy set is consistent with sustainable development.

This definition of sustainable development is characterized over a range of information regimes, including complete information, probabilistic uncertainty and nonprobabilistic uncertainty. A necessary condition for the achievement of sustainable development in the context of an ongoing threat of unrecoverable catastrophe is derived, and then applied in selected case studies.

The series of case studies is used: 1) to amplify on the conceptual substance of sustainable development (e.g., the treatment of minimum thresholds of ongoing improvement and the explicit characterization of information sets in the large-scale nuclear attack scenario, or the contingent but incomplete nature of policy strategies in the viral mutation scenario), and 2) to illustrate how specific policy issues can be incorporated into an evaluation of the consistency of an overall policy set with sustainable development.
Several brief case studies on the threat of an unrecoverable catastrophe are used to explore different informational regimes such as probabilistic or non-probabilistic uncertainty (e.g., large comet or viral mutation) and to characterize the relative priority of different policy issues (e.g., large comet vs. large-scale nuclear attack). These case studies of catastrophes also demonstrate that strong assumptions, which have in the past been directly embedded within definitions of sustainable development, can still be incorporated for analytical tractability and heuristic clarity. Such assumptions are just incorporated later, during the analysis phase, rather than in the conceptual definition of sustainable development itself. For example, a rationalizable social preference relation and a corresponding utility function are assumed in the analysis of the threats of a large comet and a large-scale nuclear attack. Likewise, probabilistic uncertainty is assumed for the case of a large comet, while it is used to generate heuristic benchmarks in the case of a large-scale nuclear attack. The calculations demonstrate that a large comet does not currently appear to be a major issue in the pursuit of sustainable development. On the other hand, the threat of a large-scale nuclear attack plausibly appears by itself to have jeopardized sustainable development.

A global climate change case study is then used as a framework to discuss how to apply the systems/social choice definition of sustainable development in the context of large, complex and uncertain issues with many strong interconnections with the rest of the world system. This process involves: creating linked models, executing them for alternative policy strategies, and evaluating those projections. Some difficult issues relating to the actual implementation of coordinated policy strategies in the context of a global commons are discussed, including the problem of ensuring compliance with politically negotiated agreements.

In the final analysis, sustainable development can be pursued by learning about the world, searching for promising policy strategies, projecting their consequences, and evaluating those projections relative to the sustainable development criterion of ongoing improvement.
II. THE CONCEPT OF SUSTAINABLE DEVELOPMENT

1. PREVIOUS ATTEMPTS TO DEFINE SUSTAINABLE DEVELOPMENT

The concept of sustainable development can be traced from its articulation by the World Commission on Environment and Development in 1987, through numerous interim attempts at definitions, to the current economic paradigm of maintenance of capital. However, it will be seen that there is no truly clear definition of sustainable development even today.¹

a) Classic Definition

According to the World Commission on the Environment and Development:

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."²

This aspiration struck a resonant chord around the world and helped mobilize a global political discourse of immense importance. Even today it is used as a working definition of sustainable development.³

If sustainable development is a legitimate legal duty or policy objective, the terms in its definition must themselves be sufficiently well-defined. The central constraints in this classic definition of sustainable development revolve around the term "needs". But where should the line be drawn between "needs" and "wants"? Subsistence? Some minimum standard of


³Private communication, European Community Forward Studies Unit, which also expressed a lack of confidence that the conceptual difficulties concerning sustainable development would ever be resolved.
living? An official poverty line? The Commission may have implied the last interpretation, but provided in turn a circular definition for it: "The poverty line is that level of income below which an individual or household cannot afford on a regular basis the necessities of life." This circular definition did not reflect naivety on the part of the Commission, but difficulty at the root of the concept of a poverty line itself. The basis for calculating the poverty level in the United States goes back three decades, when Mollie Orshansky used the fact that people "spent about one-third of their income for food", and so defined the poverty line at "three times the dollar amount needed to buy a nutritious but low-cost diet."\(^4\)

However, Orshansky herself has criticized the continued reliance on her methodology, as the percentage which people spend on food has halved. A second approach is to poll consumers for their opinion of what level of income constitutes poverty. Finally, the poverty line can be defined as some percentage of the median income, varying between 40 and 60 percent in different European countries. If, instead of some poverty line, the Commission instead intended "needs" to connote some equitable redistribution of income or growth in income, the same absence of a standard remains.\(^5\)

The ambiguous term "needs" is in turn used to formulate a dual constraint - on behalf of "the present" and on behalf of "future generations". This temporal dichotomization of society is central to the definition. But while a traditional family might reasonably be parsed into generations, the artificiality of dividing up a society into generations is only highlighted by elaborate overlapping generations models.\(^6\) Further, when this dual constraint is interpreted as a balance test, the artificial division unhelpfully characterizes the issue of sustainable


\(^5\)Of course, besides the objection on the grounds of ambiguity, another objection is the questionable wisdom of a policy prescription which focuses solely on the maintenance of some minimum standard of welfare.

\(^6\)See, e.g., Jerome Rothenberg, "Time Comparisons in Public Policy Analysis of Global Climate Change: An Economic Exploration" (mimeo 1993), with a novel duty of "backward indebtedness" arising due to predecessors' bequests.
development as a competition between "the present" and "future generations".

The dominant variation on the classic definition is a heightened focus on the welfare of the world's poor. Gro Harlem Brundtland, Edward Barbier and Mustafa Tolba have each emphasized the elimination of poverty as the first priority of sustainability.\(^7\) The same ambiguity as in the term "needs" remains, unless a strict, but politically infeasible, maximin standard is used.

b) Utility and Social Welfare Function Approaches

The conceptual taxonomy of sustainable development continues with definitions reciting a non-declining or increasing social welfare time series.\(^8\) Next are concepts which call for maximizing current welfare subject to some sustainability constraint. In the next section, that sustainability constraint will be expressed as some version of a capital maintenance constraint.

Another approach seeks to identify a social welfare proxy whose time path determines whether sustainable development is achieved. John Pezzey has defined sustainable development as non-declining utility of a representative member of society.\(^9\) This suffers from questions about the existence of "utility functions" for a given individual,\(^{10}\) the general

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\(^8\)Many of these alternative definitions are recounted in David Pearce, Anil Markandya, Edward Barbier, "Blueprint for a Green Economy" (1989).


\(^{10}\)There are experiments which find persistent inconsistencies between individual behavior and the axioms underlying von Neumann-Morgenstern utility functions.
difficulty in eliciting such a utility if it did exist for an individual, the inherent inability to perform interpersonal utility comparisons needed to designate a "representative" member of society, and the impossibility in performing the intertemporal utility comparisons which are needed to conclude that utility is non-declining. David Pearce, Edward Barbier and Anil Markandya have generalized this approach by positing a social welfare vector (including real income, health, education, access to resources, among others) whose monotonic increase is associated with sustainable development. The key problem with this approach is that inclusion of a component in the social welfare vector signifies a requirement to preserve its magnitude irrespective of tradeoffs with other components, foreshadowing the substitutability issues underlying the capital maintenance paradigm.

Sustainable development has also been viewed as a requirement to maximize current welfare, subject to some sustainability constraint. This appealing formulation suffers from Arrow's

11"Mechanism design" addresses the issue of "incentive compatibility", or truthful revelation of preferences. It is typically necessary to induce individuals to refrain from misrepresentation designed to manipulate outcomes. Therefore, "first best" solutions are generally unavailable.

12John C. Harsanyi, "Cardinal Welfare, Individualistic Ethics, and Intertemporal Comparisons of Utility".

13Preferences vary over time. Since a utility function only reflects preference orderings of a given preference structure, it is conceptually unjustified to make intertemporal comparisons of utility.


15"...[S]ustainable development ... requires maximizing the net benefits of economic development, subject to maintaining the services and quality of natural resources". Edward Barbier, "Economics, Natural Resources, Scarcity and Development" (1989). This has been adopted as the working definition of sustainable development by the staff of the European Commission. "Environment and Development: Towards a European Model of Sustainable Development" (undated seminar paper received September 1994). "Sustainable development ... optimizes the economic and societal benefits available in the present, without jeopardizing the likely (emphasis added) potential for similar benefits in the future." Robert Goodland, G. Ledoc, "Neoclassical Economics and Principles of Sustainable Development", 38 Ecological
Theorem's limitations on the existence of an acceptable social welfare function.\textsuperscript{15} It also fails to spell out the sustainability constraint. Finally, if current and future welfare are at each other's expense, it prescribes a constant social welfare, which seems to be a rather unappealing scenario which is fundamentally inconsistent with development.

c) Current Economic Paradigm: Maintenance of Capital

According to the current economic paradigm, the sustainability constraint should be interpreted as the maintenance of capital. In a general sense, this means equal access to the resource base for each generation.\textsuperscript{17} This concept will be subdivided into four variations of increasing strictness, after which the conceptual ambiguities of the approach will be discussed.

i) Very Weak Sustainability: Complete Substitutability

Very weak sustainability, also known as "Solow sustainability", presupposes complete substitutability among alternative forms of capital, and therefore demands only that the total capital base be maintained.\textsuperscript{18} The corresponding policy prescription is to maintain

\begin{quote}
\textit{Modelling} (1987). (Note the intimation of a probabilistic element in the future scenarios.) "We might choose to maximize present value subject to the constraint that future generations are not made worse off." Tom Tietenberg, "Environmental and Natural Resource Economics" (1984).
\end{quote}

\textsuperscript{16}There is no social welfare function which maps individual preferences onto a social preference weak order (i.e., reflexive, complete and transitive) which satisfies the conditions of universal domain, independence of irrelevant alternatives, pareto optimality and non-dictatorship. See the discussion of Arrow's impossibility theorem in Amartya K. Sen, "Collective Choice and Social Welfare" 33-46 (1970).

\textsuperscript{17}David Pearce, "Foundations of an Ecological Economics", 38 Ecological Modelling (1987).

consumption below an adjusted Net National Product, equalling Gross National Product less conventional depreciation and further reduced by the amount of depletion of natural resources. This is equivalent to keeping consumption below "Hicksian income", defined as the maximum level of consumption which leaves society as well off at the end of the period as at the beginning.

ii) Weak Sustainability: Preserve Critical Natural Capital

Weak sustainability, also known as "modified Solow sustainability", allows for the non-substitutability of critical natural capital, such as would be required for ecosystem stability. The sustainability constraint then prescribes maintenance of total capital, further subject to conservation of critical natural capital.

With regard to "Solow sustainability", see also Robert M. Solow, "Sustainability: An Economist's Perspective" (Woods Hole Oceanographic Institute lecture of June 14, 1991), and Robert M. Solow, "An Almost Practical Step Toward Sustainability" (Resources for the Future lecture of October 8, 1992). Solow carefully credits Hartwick for early thinking on the subject; see John M. Hartwick, "Intergenerational Equity and the Investing of Rents from Exhaustible Resources", 67(5) American Economic Review 972-74 (1977). Solow also explicitly characterizes the capital maintenance paradigm as a rule of thumb, foreshadowing the nature of its invaluable role in the generalized systems/social choice definition of sustainable development in the context of bounded rationality, which will be discussed later.

The further adjustment to conventional Net National Product which Solow advocates is variously referred to as rents from non-renewable resources or net depletion of exhaustible resources (i.e., Hotelling rent or shadow cost, equal to real value less marginal cost of extraction). As an aside, typically it is renewable resources (e.g., fisheries) that are exhaustible and non-renewable resources that are not exhaustible (e.g., increasingly inaccessible mineral deposits). More to the central point, presumably it is any drawdown of natural capital which should be reflected in an adjusted Net National Product. Still more generally, any drawdown (or increase!) of any form of capital not currently reflected in conventional Net National Product (e.g., human capital as reflected in education) should presumably be reflected in an adjusted Net National Product.

See Herman E. Daly, John B. Cobb, Jr., "For the Common Good: Redirecting the Economy Toward Community, the Environment, and a Sustainable Future", 70-71 (1989), quoting Sir John Hicks, "Value and Capital", 172 (1948). Daly and Cobb also identify "defensive expenditures" such as pollution abatement costs as intermediate goods which should also be subtracted to calculate an adjusted Net National Product.

20
iii) Strong Sustainability: Preserve Aggregate Natural Capital

Strong sustainability adopts the perspective that there is no true substitute for natural capital, because it enhances human welfare in many different ways and its degradation can be effectively irreversible. Therefore, strong sustainability calls for maintenance of total capital, further subject to the independent conservation of aggregate natural capital.

iv) Very Strong Sustainability: Preserve All Natural Capital

Very strong sustainability poses the strictest requirements of all, short of the non-anthropocentric preservationism of deep ecology. It calls for the scale and character of human activity to adjust to a steady state within the world system, with zero economic growth and zero population growth. Thermodynamically intensive "development" would be allowed, while thermodynamically extensive "growth" would be precluded.21 This interpretation of the sustainability constraint requires the separate maintenance of each individual component of natural capital. However, that is largely a translation into the economic paradigm of what is essentially a systems-oriented constraint. While it might be characterized as infeasible, at least in the near term, it is largely free from ambiguity.

With an exception for very strong sustainability, which is actually a steady-state systems constraint, the modern economic paradigm of sustainability as maintenance of capital is inherently ambiguous. This paradigm only addresses the sustainability constraint, and is silent about "development".22 In addition, the most fundamental concepts of economics cannot be taken for granted in this context. What is the definition of capital? Something able to provide future utility to people? Then all assets are capital, and intertemporal aggregation is

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21See, for example, Herman E. Daly, "Steady-State Economics" (1991), where a "steady state economy" is defined as "an economy with constant stocks of people and artifacts, maintained at some desired, sufficient levels by low rates of maintenance 'throughput'".

22One might be tempted to claim that merely modifying the requirements slightly to call for ongoing growth, rather than maintenance, of total capital would result in "development". However, if growth in total capital were achieved by means of reductions in "consumption", the result might not be viewed as "development" at all. Rather, the inclusion of a condition such as a monotonic increase in (per capita?) consumption would seem to be necessary.
necessary to calculate a capital aggregate in the context of incomplete markets. But intertemporal aggregation requires that putative utility at different points in time be assigned relative weights, typically associated with discount rates. How are discount rates identified? Must they be invariant over time? If the discount rates rise, has capital decreased even in the absence of physical changes?

How can we know whether capital is being maintained? This requires the relative valuation of different forms of capital. If there is a market, how are market imperfections such as monopoly, monopsony or externalities handled? In the absence of markets, how do we calculate relative values, even accepting the conventional taxonomy of use value (direct, indirect and option) and non-use value (existence and bequest)?

How severe should the constraints on substitutability be? Is strong sustainability too strong (claiming that a fishery is a better substitute for copper than improved technology would be), and weak sustainability too weak (claiming that we can continue to substitute manufactured goods for a dwindling natural resource base)? Can our past measurements of substitutability, including market pricing, adequately reflect future prospects?

Is equity denied a role? If we rely on markets, will preferences be weighted by a person's expenditures?

What about human capital? Despite its central prominence in any meaningful discussion of sustainable development, the modern economic paradigm either assumes a constant population, or merely calculates capital per capita. If people themselves embody a critical component of total capital, then should "consumption" be considered a form of capital maintenance or even capital formation?

It is true that each of these questions can be operationally answered in order to calculate a scalar which we designate as "capital". The problem is that each assumption we pick up along the way becomes attached to the conceptual definition of aggregate capital. If we were
to dissolve each assumption in turn, perhaps we would share the fate of the raccoon who found a sugar cube, and washed it in the stream once too often.

In this sense, characterizing the sustainability constraint as maintenance of capital is inherently vague, since any calculation of capital is only the product of a series of assumptions. While a set of conventions like "generally accepted accounting principles" may be an appropriate way to construct financial statements for comparative evaluations of commercial organizations, such an approach hardly amounts to an assurance of sustainable development in the sense of continuing improvements in human welfare as the world system changes over time.

d) Evaluation of Previous Definitions
These previous attempts to define sustainable development will next be shown to suffer from a combination of: 1) unattainability due to vagueness or infeasibility, 2) lack of realism in the formulation of substitutability constraints, or 3) the disturbing implications of Arrow's Theorem. 23

In fact, there is widespread recognition that none of the previous definitions of sustainable development is satisfactory:

"From a theoretical point of view, the concept of sustainable development suffers from some serious flaws. While there is now a large consensus on the utility of the concept of sustainable development as such, its precise meaning has remained obscure. It has been described as a 'nearly magic word', as 'the latest development catchphrase', and as a 'buzz word'. There is no agreement on its substance and the discussion has produced quite a variety of often conflicting definitions.

The discussion of the meaning of sustainable development in the international legal discourse is also still in a state of infancy. . . . Attempts by various authors to draw inferences in international law from the concept of sustainable development . . . .

development have been useful in seeking more clarification, but have failed to recognize or to adequately address the underlying theoretical problems. \(^{24}\)

i) Unattainability due to Vagueness or Infeasibility

The classic "needs" based definition, the "representative utility" based definition, and the very strong sustainability version of the capital maintenance paradigm can be characterized as currently unattainable. The classic "needs" based definition is inherently vague, unless an interpersonal standard such as the politically infeasible maximin criterion is used. Further, the definition based on non-declining utility of a representative member of society is infeasible to implement, due to problems with determining a representative utility and due to the conceptual impossibility of performing intertemporal utility comparisons in the face of evolving preferences.

The very strong sustainability version of the capital maintenance paradigm calls for the independent preservation of each component of natural capital, or a steady state system in the strict thermodynamic sense. As long as human population continues to grow in numbers and develop in material well-being, the resulting burden on natural systems will render infeasible the preservation of each component of natural capital called for in this approach.

ii) Unrealism of Substitutability Constraints

Previous attempts to define sustainable development using what amount to social welfare functions suffer from the presence of unrealistic substitutability constraints (except for Solow sustainability, which suffers from the unrealistic absence of any substitutability constraints) and the disturbing implications of Arrow's Theorem. The two main social welfare approaches call for the monotonic increase of a social welfare vector and the maintenance of capital. \(^{25}\)


\(^{25}\)In fact, it could be argued that scalar capital must be some function of the social welfare vector which is nondecreasing in each of the vector components which reflect "stock" assets, and independent of those components which reflect consumption or "flow". For example,
The substitutability constraints, which are inherent in these approaches except for Solow sustainability, are unrealistic because they exclude as inferior those outcomes which negligibly impair a specially designated asset category even if the resulting gain in all other assets is arbitrarily great. This can be illustrated by example: If food production and housing are the two components of a simplified social welfare vector, then tripling total food production at the net expense of a single hut would violate the monotonic increase required of each vector component and be inconsistent with sustainable development. In the weak sustainability version of the capital maintenance paradigm, assume that wildlife habitat is one component of the critical natural capital which must be maintained in the aggregate. If new technology which delivered fusion energy with orders of magnitude less burden on the future environment were obtainable at the net expense of a single acre of wildlife habitat, then investing in that new technology would violate the critical natural capital constraint and be inconsistent with sustainable development. In the strong and very strong sustainability versions of the capital maintenance paradigm, this would be true even if wildlife habitat were not even considered part of critical natural capital.

suppose that a simplified social welfare vector were comprised solely of three components: healthfulness of diet, food-production assets and housing. Then capital would be some function of food-production assets and housing, perhaps the sum of their quantities multiplied by their respective prices.

It is significant that there are severe conceptual problems in this transformation from a social welfare vector to a capital scalar. If market prices are used, they reflect only the marginal utility of marginal traders, and need not even be a component of a Pareto efficient allocation if there are violations of the restrictive conditions of the First Welfare Theorem of economics (complete markets, convex preferences and competitive behavior). Who decides upon the capital components? Should diet be considered maintenance of (human) capital? These conceptual problems underscore the element of choice in the very definition of capital.
iii) Implications of Arrow's Theorem

The maintenance of total capital envisioned by the economic paradigm of sustainability is subject to disturbing implications from Arrow's Theorem in social choice theory. Consider all possible future paths of the world system. At any point in time, total capital is meant to represent the capacity for future welfare. This is equivalent to the continuation value of a node in a game, and amounts to a social welfare function which encodes preferences over future prospects. But a dictatorship is the only possible way to map individual preferences onto any conceptual definition of capital while satisfying Arrow's conditions.\textsuperscript{26}

It is helpful to begin the discussion of the implications of Arrow's Theorem by distinguishing between two common meanings of the term social welfare function.\textsuperscript{27} Consider a society which must choose among possible alternative outcomes. A Bergson-Samuelson social welfare function for the society specifies some preference ordering over the alternative outcomes by assigning a real number to the value of each outcome. Now suppose that the individuals which comprise the society have their own preference orderings over the alternative outcomes. An Arrow social welfare function is a collective choice rule which determines the preference ordering for the society as a function of the individual preference orderings. In other words, given the individual preference orderings, an Arrow social welfare function is a rule to calculate the preference ordering for society. The two concepts are related, in that the preference ordering for society determined by an Arrow social welfare function on the basis of individual preference orderings corresponds to a Bergson-Samuelson social welfare function.

\textsuperscript{26}Assuming universal domain, independence of irrelevant alternatives and Pareto optimality, any such preference relation (i.e., any quantitative or even non-quantitative definition of "capital") which is reflexive, complete and transitive must result from a social choice function which is a dictatorship.

\textsuperscript{27}This discussion follows the presentation in Amartya K. Sen, "Collective Choice and Social Welfare" (1970).
Arrow's Theorem makes some seemingly reasonable assumptions and then draws a disturbing conclusion. The assumption that the collective choice rule which determines the preference ordering for the society must work for any possible combination of individual preference orderings and any possible subset of outcomes is called the condition of unrestricted domain. The assumption that if every individual prefers one alternative outcome to another then society will also is called the weak Pareto principle. The assumption that individual preferences about unavailable outcomes cannot affect the preference ordering of society over available outcomes is called the condition of independence of irrelevant alternatives. The assumption that there is a preference ordering for society is equivalent to a requirement that preferences be reflexive (each outcome is at least as good as itself), complete (for any two alternative outcomes, one of them is at least as good as the other) and transitive (if one outcome is at least as good as a second, and the second is at least as good as a third, then the first is also at least as good as the third). According to Arrow's Theorem, if there are at least three alternative outcomes, then the only collective choice rule which is consistent with these four seemingly reasonable assumptions is a dictatorship.

This discussion relates directly to capital. At any point in time, society is faced with a real choice concerning production, consumption and capital. The claim that the capacity for future welfare can be represented by some scalar number is equivalent to the claim that given a choice between two alternative initial conditions with different amounts of capital, society would prefer the initial condition with greater capital. In other words, capital represents a preference ordering for society over the capacity for future welfare. Of course, preference orderings of individuals will in general vary depending on the specific composition of the capital, for instance based on different opinions about the relative value of a trout stream versus a Broadway theater. Preference orderings will also vary based on the distribution of ownership rights for a given composition. However, a dictatorship is the only collective choice rule consistent with Arrow's assumptions which is able to generate the societal preference ordering over future welfare which is referred to by the term capital.

Systems theory and social choice theory combined can provide a rigorous definition of sustainable development in a way able to provide concrete policy guidance. In capsule form, sustainable development is "an ongoing improvement of the world system according to a legitimately constructed social preference relation". The social preference relation is constructed, rather than being a prescribed function of fully developed underlying preferences of individuals, and must satisfy a legitimacy constraint comprised of procedural rationality (such as considering relevant and appropriate information) and equity (such as representation for the interests of affected persons). This capsule definition of sustainable development will be explained more fully in the context of three information regimes: complete information, probabilistic uncertainty and non-probabilistic uncertainty.

Throughout this analysis, the focus will be on the consistency of a proposed government policy with sustainable development, because:

1. governments have a critical role in the pursuit of sustainable development;
2. as will be seen, states have a binding legal duty under international law to pursue sustainable development;
3. the existence of this legal duty, and the capacity for its effective enforcement through international and domestic pressure, depends on sufficient conceptual clarity about the nature of the duty of states to pursue sustainable development.

a) Consistency of a Proposed Policy Set with Sustainable Development

i) Basic Analysis
A given state of the world system (system,) reflects some quality of human life (Q,) of which future prospects (F,) are one aspect and current conditions (C,) are another aspect. Sustainable
development over one time increment could be taken to mean:

\[ F_{t+1} \geq F_t \quad \text{(sustainability), and} \]
\[ Q_{t+1} > Q_t \quad \text{(development)}, \]

where the preference relation ("\(\geq\)"") is a legitimately constructed social preference relation.\(^{28}\) The first relationship embodies the sustainability constraint, in that future prospects are being maintained. The second relationship embodies the development constraint, in that the quality of life is improving. Note that in the limit, if the quality of life assigns weight exclusively to future prospects, these conditions reduce to a monotonic increase in those future prospects. Alternatively, if the quality of life assigns weight exclusively to current conditions, then the "development" constraint reduces to monotonic improvement of current conditions. Future prospects can be evaluated by explicitly considering each stage in the future path of the world system, so that sustainable development over time interval \([0, T]\) can be defined as:

**Definition of Sustainable Development**

\[ \text{system}_{t+1} > \text{system}_t, \quad \forall \ t \in [0, T-1]; \]

where "system," is the state of the world system at time "t," including both quality of life and future prospects. Indeed, quality of life and future prospects can be simultaneously functions of each other, since future prospects can be an important part of, and also significantly affected by, quality of life.

Note that while the time horizon \(T\) is taken to be a parameter in this analysis, its choice could dramatically affect the meaning of sustainable development. (E.g., contrast a time horizon corresponding to a 2 or 4 year election cycle to an indefinitely long time horizon.) If arbitrariness is to be avoided, any explicit decision on a planning horizon must be subject to a

\(^{28}\) Preferences are denoted by the symbol "\(\geq\)", so that "\(x \geq y\)" means that \(x\) is at least as good as \(y\). The strict component of the preference relation is denoted by the symbol "\(>\)", so that "\(x > y\)" means that \(x\) is strictly better than \(y\).
legitimacy constraint of rationality and equity just like the social preference relation. In the context of significant uncertainty which increases into the planning future, a planning horizon which in relevant aspects extends to the order of a century may capture about as much value as possible in evaluating proposed policy sets. In addition, it is appropriate to consider an implied "terminal constraint" of $F_T \succeq F_0$, i.e. future prospects at the end of the planning horizon being preferred to present-day future prospects, perhaps operationalized in appropriate part by the capital maintenance paradigm of economics.

In terms of actors, governments have a vital role to play in the pursuit of sustainable development. Individual government policies designed to address the same issue can be considered to be part of the same policy subset. The aggregate of all government policies for a given time period is called a "policy set". This hierarchical nature of policy subsets is illustrated in Figure 1.

It should be emphasized that the focus of this analysis is on the consistency of an overall policy set with sustainable development, as opposed to the consistency of individual policies with sustainable development. This is because the effect that any individual policy has on the achievement of sustainable development in general depends on the rest of the policy set and its evolution over time (see Appendix 1).

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29Peoples, in the sense of the beneficiaries of what will be shown to be the duty of states to pursue sustainable development, can be expected to survive "indefinitely long". Therefore, there is a strong case for the time horizon implicit in that duty correspondingly to be indefinitely long.

30The author is indebted to Mary Pat Williams Silveira for having focused his attention on this issue.
Figure 1: Policy Hierarchy - From Individual Policies to Complete Policy Set

Notes:
1. Policies can be hierarchically organized into different policy subsets, for instance by type of policy instrument (e.g. taxation) rather than application subject area.

2. Some policies may belong to more than one logical policy subset, for instance the policies in the figure relevant to both global warming and stratospheric ozone depletion (e.g., CFC emission reductions).

3. The only policies not included in the complete policy set are those which do not affect human welfare either positively or negatively (e.g., not using or generating resources), which is presumably the null set.
In the context of complete information, a *policy strategy* \( P \) is a temporal sequence of policy sets. In the context of uncertainty, a *policy strategy* is a temporal sequence of policy set functions \( P_t : \text{system}_t^{\text{obs}} \rightarrow \text{"policy set space"}, \) where \( \text{system}_t^{\text{obs}} \) is the observed component of the world system (including previous but still accessible observations) at time "\( t \)." A "policy strategy" in the context of uncertainty can be thought of as a plan of how to react to observations of future events. It is therefore very similar to the usage of the term "strategy" in game theory.\(^{31}\) However, game theory generally: 1) focuses on the interactions of (a constant set of) multiple players, whereas the focus in this stage of the analysis is on a proposed policy set of a particular state; and 2) assumes the existence of rationalizable preferences and payoff functions in the form of von Neumann-Morgenstern utility functions, whereas this research does not assume at the outset a rationalizable social preference relation.

In order to defend a proposed policy set as consistent with sustainable development, a government must demonstrate the existence of an eligible policy strategy which results in an ongoing improvement of the world system according to a legitimate social preference relation. The possibility of projecting improvements in the world system by relying on future policy set functions which are more difficult to adopt than the current proposed policy set is avoided by restricting the eligibility of policy sets and policy strategies, as seen in Figure 2.

Figure 2: Eligible Policy Sets

Reliance on future policy sets which would be harder to agree on than the proposed current policy set

Eligible Policy Sets $P_t^E (\text{system}_t ; P_0)$.

Example of eligible policy strategy

$t \rightarrow$

Notes:
1. "Difficulty to adopt" refers to how hard it is to reach agreement to implement a policy set, rather than the cost or unpleasantness of carrying it out. However, one could expect a connection between the two, influenced in part by the perception of necessity. It is unrealistic to precisely quantify the difficulty to adopt a policy set; rather, this is a qualitative evaluation.

2. The difficulty in adopting a policy set is a function of $\text{system}_t$, the state of the world system at that time. For instance, a larger endowment could make it easier to carry out a particular policy set, and therefore presumably easier to agree upon as well.

3. In the context of complete information, an eligible policy strategy $P \in P^E$ is a temporal sequence of eligible policy sets $P_t \in P_t^E$, such as the example in the figure. In the context of uncertainty, a strict definition for an eligible policy strategy would be that all possible future policy sets contemplated by the strategy (based on different possible observed components of the world system) must be in the eligible policy set region; a more appropriate definition is that a credibly binding commitment to the policy set functions $P_t$ which comprise an eligible policy strategy $P \in P^E$ must be no more difficult than adopting the proposed current policy set $P_0$. 

33
Similar to the eligibility constraint on policy strategies, the social preference relation by which the future projected path of the world system is evaluated must satisfy an eligibility criterion comprised of feasibility and legitimacy. The legitimacy constraint in turn consists of rationality and equity.

The evaluation process must attain the threshold of procedural rationality, for example taking into account relevant information. In the unrealistic limit, this would result in neoclassical optimization. However, in the world of bounded rationality, procedural rationality results in realistic "satisficing".

The evaluation process must also satisfy an equity constraint, involving access to information and an opportunity for participation by those affected. Of course, the limit of complete participation by everyone all the time is once again unrealistic.

These dimensions of an eligible (i.e., feasible and legitimate) social preference relation ($\triangleright^E$) are illustrated below in Figure 3. Implicit in this illustration is the assumption that the set of eligible social preference relations is nonempty. This assumption makes sense considering that: 1) procedural rationality connotes an appropriate investment of resources in decision-making, taking into account what resources are actually available; and 2) modern technology is rapidly enhancing opportunities for distribution of information to, and meaningful participation in decision-making by, larger segments of a population. However, this assumption of the availability of feasible and legitimate social preference relations is questionable where the fabric of a society is too weak or too strained, as could result from destitution or war.
Figure 3: Eligible Social Preference Relations (\( \succ^e \)) in Rationality - Equity Space

Optimization

↑

Impractical, e.g. 
unaffordable

RATIONALITY

Inequitable

Feasible & 
Legitimate

Inequitable & 
Irrational

Irrational

Insufficient 
Participation

Insufficient 
for

Procedural 
Rationality

Impractical, e.g. 
logistically

EQUITY →

Note: This diagram should be interpreted as a conceptual framework illustrating the component dimensions of an eligible social preference relation \( \succ^e \). It is unrealistic to precisely quantify the rationality or equity of a given social preference relation. Rather, a social preference relation is subjected to a qualitative evaluation of its legitimacy.
In the context of complete information, a policy strategy is a known sequence of policy sets, each of which affects the path of the world system (see Figure 4).

Figure 4: World System and Policy Strategy in the Context of Complete Information

<table>
<thead>
<tr>
<th>Time</th>
<th>World System</th>
<th>Policy Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>system₀</td>
<td>P₀: Proposed Policy Set</td>
</tr>
<tr>
<td>1</td>
<td>system₁ ←</td>
<td>P₁</td>
</tr>
<tr>
<td>2</td>
<td>system₂ ←</td>
<td>P₂</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Future Policy Sets</td>
</tr>
<tr>
<td>T-1</td>
<td>systemᵣ₋₁ ←</td>
<td>Pₚ₋₁</td>
</tr>
<tr>
<td>T</td>
<td>system₁ ←</td>
<td>Pₚ</td>
</tr>
</tbody>
</table>
More generally, in the context of uncertainty, a policy strategy is a sequence of policy set functions which map the observed component of the world system onto the set of feasible policy sets. Once again, the policy sets which are actually adopted (based on observations of the world system up to the present) in turn affect the future path of the world system (see Figure 5).

**Figure 5: World System and Policy Strategy in the Context of Uncertainty**

Note: In this diagram, \( P_0 \) denotes the proposed current policy set; \( P_t \) in bold denotes the set of feasible policy sets at time "t"; and \( P_t \) in script denotes a function mapping the observed state of the world system (including prior and still accessible observations) onto the set of feasible policy sets.
These concepts can be combined to form a set of definitions for the consistency of a proposed policy set with sustainable development under different information regimes (see Figure 6). In this context, information regimes are taken to mean the nature of the information about the current and future states of the world system, including complete information, probabilistic uncertainty and non-probabilistic uncertainty.

Figure 6: Definition - Consistency of Proposed Policy Set with Sustainable Development

<table>
<thead>
<tr>
<th>Complete Information</th>
</tr>
</thead>
</table>
| In the context of complete information, a proposed policy set \( P_0 \) is consistent with sustainable development, with respect to \( \{ \text{system}_0, \succ^E, T \} \), if and only if there exists an eligible policy strategy \( P \in P^E \) such that:
| \( \text{system}_T \succ^E \text{system}_{T-1} \succ^E \ldots \succ^E \text{system}_1 \succ^E \text{system}_0 \). |

<table>
<thead>
<tr>
<th>Probabilistic Uncertainty</th>
</tr>
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</table>
| In the context of probabilistic uncertainty, a proposed policy set \( P_0 \) is consistent with sustainable development, with respect to \( \{ \text{system}_0, \succ^E, T \} \), if and only if there exists an eligible policy strategy \( P \in P^E \) such that:
| \( f_t(\text{system}_T) \succ^E f_{T-1}(\text{system}_{T-1}) \succ^E \ldots \succ^E f_1(\text{system}_1) \succ^E f_0(\text{system}_0) \); |
| where \( f_i \) is the joint probability distribution function over possible states of the world, conditioned on \( f_0 \) and the policy strategy \( P \). |

<table>
<thead>
<tr>
<th>Non-probabilistic Uncertainty</th>
</tr>
</thead>
</table>
| In the context of non-probabilistic uncertainty, a proposed policy set \( P_0 \) is consistent with sustainable development, with respect to \( \{ \text{system}_0, \succ^E, T \} \), if and only if there exists an eligible policy strategy \( P \in P^E \) such that:
| \( \phi_T(\text{system}_T) \succ^E \phi_{T-1}(\text{system}_{T-1}) \succ^E \ldots \succ^E \phi_1(\text{system}_1) \succ^E \phi_0(\text{system}_0) \); |
| where \( \phi_i \), which can include non-probabilistic information, expresses what is known about the possible states of the world at time "t", conditioned on \( \phi_0 \) and policy strategy \( P \). |
This set of definitions can be restated as:

"A proposed policy set is consistent with sustainable development iff there exists an eligible policy strategy resulting in ongoing improvement of the world system according to an eligible social preference relation."

In this definition, an "eligible policy strategy" is one whose components would be no more difficult to adopt than the proposed policy set, and an "eligible social preference relation" is both legitimate (i.e., rational and equitable) and feasible. Building on this conceptual foundation, the process of evaluating the consistency of a proposed policy set with sustainable development is portrayed below in Figure 7.
Figure 7: Evaluation of Consistency of Proposed Policy Set with Sustainable Development

1. Eounded rationality implies that: a) the loop which develops eligible policy strategies and projects the corresponding paths of the world system cannot be infinite; and b) policy strategies cannot attain the ideal of including plans for how to react to all possible future observed components of states of the world system.
2. Other proposed policy sets may be evaluated, whether or not $P_0$ is found to be consistent with sustainable development. If $P_0$ is found to be consistent with sustainable development, this process is still not a policy prescription to adopt it, but only a diagnostic "litmus test".
3. Even adoption of a policy set inconsistent with sustainable development in the sense of ongoing improvement may be politically defensible (see, e.g., path (a) in Figure 11). One threshold filter to constrain such defensibility could be that the projected terminal state of the world, $\text{system}_1$, must be preferred to the current state of the world, $\text{system}_0$. 

$P_0$ consistent with sustainable development.
In Figure 7, the development of an eligible policy strategy and the projection of the path of the world system are both combined. This is because the world system which is projected for a given period determines the eligible policy set functions, and the adopted policy set function in turn affects the future path of the world system.

Designate by \( P^*_0(\text{system}_0, >^E, T) \) the set of all policy sets which are consistent with sustainable development with respect to the current state of the world system (system_0), an eligible social preference relation (\( >^E \)), and time horizon (\( T \)).

There are three possible alternatives: the set \( P^*_0(\text{system}_0, >^E, T) \) may be empty, a singleton, or have multiple elements. It is readily apparent that if sustainable development is possible over time horizon \( T \), then it is also possible over all shorter time horizons; i.e.:
\[
\{|P^*_0(\text{system}_0, >^E, T)| > 0\} \rightarrow \{|P^*_0(\text{system}_0, >^E, T^*)| > 0 \ \forall \ T^* < T\}.
\]
In addition, if sustainable development is not possible over time horizon \( T \), it is also not possible over all longer time horizons:
\[
\{|P^*_0(\text{system}_0, >^E, T)| = 0\} \rightarrow \{|P^*_0(\text{system}_0, >^E, T^*)| = 0 \ \forall \ T^* > T\}.
\]
If \( P^*_0 \) is a singleton, then by definition there is a unique policy set which is consistent with sustainable development over time horizon \( T \).

If \( P^*_0(\text{system}_0, >^E, T) \) is empty, then there is no current policy set which is rigorously consistent with sustainable development. In this case, the "pursuit of sustainable development" could be further interpreted by the social choice mechanism, still subject to the legitimacy constraints of rationality and equity. One possible interpretation would be to find the maximum time horizon \( T_{\text{max}} \) for which sustainable development is possible, i.e.:

\[
T_{\text{max}} = \text{MAX}(T : |P^*_0(\text{system}_0, >^E, T)| > 0).
\]

Adopting a policy set from the set \( P^*_0(\text{system}_0, >^E, T_{\text{max}}) \) could be called the "prolongation of improvement" criterion. Or a policy set could be adopted consistent with minimizing the time interval before sustainable development could be achieved, if ever. Alternatively, with additional restrictions on the social preference relation such as rationalizability, objectives
such as maximin, maximax or maximization of expected utility could be adopted.

If $P_0^*(\text{system}_0, \times^E, T)$ has multiple elements, then the social choice mechanism has the luxury of selecting from multiple policy sets consistent with sustainable development. In this case once again, with additional restrictions on the social preference relation, objectives such as maximin, maximax or maximization of expected utility could be adopted.

It should be emphasized that this analysis is intended to provide a conceptual "litmus test" by which the consistency of proposed government policy sets with sustainable development can be evaluated. Conversely, this analysis is not intended to provide a selection mechanism to determine the optimum choice from among alternative government policy sets, policy strategies or social preference relations. Rather, such choices are the province of the political process, although the results of the conceptual "litmus test" are able to provide useful guidance.

ii) Extension to Collection of States

So far, we have not focused on the precise actor(s) responsible for the proposed policy set $P_0$. The proposed policy set could be interpreted as an aggregated proposed policy set for the entire world, in which case the social preference relation would presumably be based on an hierarchical aggregation of social preference relations of all states. Alternatively, the proposed policy set $k_0$ could be interpreted as that of a single state, where that state's projection of the world system incorporates its expectation of other states' conduct given its own policy strategy. This approach makes most sense if a state were largely insulated from other states' conduct, or could accurately predict other states' policies given its own strategy (e.g., if it happened to be the influential world leader).

It is straightforward to generalize the analysis to explicitly take into consideration the demarcation of the world community into states. This is appropriate since governments are uniquely significant in the pursuit of sustainable development, which will be seen to be their duty under international law. Assume that there are $N$ states, designated by the superscript
i ∈ \{1 \ldots N\}, where the aggregate of all states is denoted by the superscript \( \forall = \{1 \ldots N\} \), and the complement to state "i" is denoted by superscript \( -i = \{\forall \setminus i\} = \{1 \ldots -1, i+1 \ldots N\} \).

We then define the consistency with sustainable development of a proposed policy set of an individual state \( P_0^i \) as follows.\(^ {32}\)

**Consistency with Sustainable Development of Proposed Policy Set for Single State**

In the context of non-probabilistic uncertainty, a proposed policy set \( P_0^i \) of state "i" is consistent with sustainable development with respect to \{ system, \( \succ^E_i \), \( T \), \( P_0^{-i} \) \}, iff there exists a composite policy strategy \( P^v \in P^E \) such that:

\[
\phi_T(\text{system}_T) \succ^E_i \phi_{T-1}(\text{system}_{T-1}) \succ^E_i \ldots \succ^E_i \phi_1(\text{system}_1) \succ^E_i \phi_0(\text{system}_0);
\]

where \( \succ^E_i \) is an eligible social preference relation of state "i", and \( \phi_0 \) expresses what is known about the possible states of the world at time "t", conditioned on \( \phi_0 \) and the composite policy strategy \( P^v \), where \( P^v = \{ P^1, \ldots P^N \} \) is a composite of eligible policy strategies for each of the states. If a state is a member of a coalition which has potential gains from trade such as cost-effective reciprocal source reductions in transfrontier pollution, its set of eligible policy strategies can be larger than if it did not participate in such bargaining.\(^ {33}\)

It is then natural to define the consistency with sustainable development of a composite proposed policy set \( P_0^v \) of all states as consistency with sustainable development of the proposed policy set of each state, as follows:

\[^{32}\text{The following definition assumes non-probabilistic uncertainty; the corresponding definitions for probabilistic uncertainty or complete information are clear.}\]

\[^{33}\text{An alternative definition might consider not just the initial policy set of the rest of the world \( P_0^{-i} \) as a parameter, but also the future policy strategy \( P^i \), presumably a member of the eligible policy strategy set \( P^E^{-i} \), as projected by state "i". This alternative definition filters out unrealistic scenarios such as extreme beneficence on the part of successful economies, but suffers from the unpredictability of policy strategies of other states (which could be reduced by negotiating coordinated policy strategies). The alternative possibilities for how to incorporate other states' policy strategies into the definition of the consistency with sustainable development of a proposed policy set for a given state are analogous to the alternative specifications for non-coalitional behavior in cooperative game theory.}\]
Consistency with Sustainable Development of Composite Policy Set for All States

A composite proposed policy set \( P_0^V = \{ P_0^1, \ldots, P_0^N \} \) of all states is consistent with sustainable development, with respect to \( \{ \text{system}_0, \succ^{EV}, T \} \), iff the proposed policy set \( P_0^i \) of each state is consistent with sustainable development with respect to \( \{ \text{system}_0, \succ^{EI}, T, P_0^i \} \), where \( \succ^{EV} = \{ \succ^{EI} \ldots \succ^{EN} \} \) is a composite of eligible social preference relations for each state.\(^{34}\)

It is interesting and significant to note that for this formulation of global sustainable development, we obtain a "greatest common denominator syndrome", in that we must achieve ongoing improvement of the world system from the perspective of each state - including the state with the strictest standards - in order to claim that a composite proposed policy set is consistent with sustainable development.

Of course, it is ultimately for the realm of political discourse to judge the relative fairness and propriety of different combinations of policy sets of individual states. Presumably, fairness of proposed policy sets for states would be a function of: difficulty to adopt - so that something which is relatively more difficult for a state could be less strict for it; which in the limit amounts to feasibility - so that states cannot be expected to do something which is impossible for them; previous conduct - for example, a state which has made more use of the atmosphere as a sink for chlorofluorocarbons or greenhouse gases could have a larger responsibility concerning stratospheric ozone depletion or global warming; and individual states' social preference relations - so that a state whose citizenry has higher environmental standards could incur a larger portion of the expense to meet those standards. However, it seems clear that there may be a range of composite policy sets which are considered fair or appropriate within the realm of political discourse, rather than a single "answer".\(^{35}\)

\(^{34}\)If the alternative definition (for the consistency with sustainable development of a proposed policy set for a single state) of the previous footnote is used, it can be extended to all states by constraining different states' projections of policy strategies to be the same.

\(^{35}\)See below, at pp. 270ff, for a discussion of some of the issues concerning the implementation of coordinated policy sets.
iii) Unrecovered Catastrophe Analyzed with Utility Functions

Of course, more stringent assumptions can make it possible to obtain additional results. To demonstrate the power of the underlying conceptual framework, consider a situation in which there is an ongoing threat of an unrecoverable catastrophe. Assume that the probability of the catastrophe is a constant, statistically independent $P_c$ per period. Assume further that the social preference relation is rationalizable by a von Neumann-Morgenstern utility function, so that outcomes with higher expected utility are preferred. While this is an idealized framework with strong assumptions, it will nevertheless make possible heuristically valuable analyses capable of providing meaningful policy guidance.

Consider the case where, before taking into account the threat of catastrophe, society is indifferent among successive states of the world system, which therefore have equal utility denoted by $U_{ok}$. Normalize to zero the utility of the world system if the catastrophe occurs, and assume that the catastrophe is nonrecoverable, so that afterwards the utility would remain at zero forever.

The expected utility at a time "t" periods in the future, designated as $EU_t$, taking the possibility of catastrophe into account, is then:

$$EU_t = Pr(cat) U_c + Pr(ok) U_{ok},$$

where $Pr(cat)$ is the probability of a catastrophe up to that time period,
$Pr(ok) = 1 - Pr(cat)$,
$U_c = 0$, and
$U_{ok}$ is normalized to 1.

The expected utility can then be calculated as:

$$EU_t = [1 - (1 - P_c)^t] (0) + (1 - P_c)^t (1) = (1 - P_c)^t.$$

In particular, for positive $P_c$ the expected utility will decline with time, so that successive
states of the world system will be strictly inferior and sustainable development will not be achieved. Clearly, if sustainable development is to be achieved in the context of this ongoing threat of a nonrecoverable catastrophe, then the expected utility of the non-catastrophic state of the world must increase with time.

Let us calculate the increase in the non-catastrophic utility which is necessary to offset the threat of catastrophe and achieve sustainable development. The systems / social choice definition of sustainable development requires an ongoing improvement of the world system:

\[
\text{system}_{t+1} > \text{system}_t \quad \forall \ t \in [0, T-1].
\]

Our assumption of rationalizability means that this is equivalent to the condition that the expected utility increase over time:

\[
\text{EU( system}_{t+1} ) > \text{EU( system}_t ) \quad \forall \ t \in [0, T-1].
\]

Substituting for the expected utility, the condition for sustainable development then becomes:

\[
[1- (1 - P_c)^{t+1}] (0) + (1 - P_c)^t U_{t+1} > [1 - (1 - P_c)^t] (0) + (1 - P_c)^t U_t,
\]

\[
(1 - P_c)^{t+1} U_{t+1} > (1 - P_c)^t U_t, \text{ or finally:}
\]

\[
U_{t+1} / U_t > 1 / (1 - P_c),
\]

where \( U_t, U_{t+1} \) are the non-catastrophic utilities for times "t" and "t+1" respectively, and are either known with complete information or are expected values (conditional upon the catastrophe not occurring) themselves.

According to this condition, the growth in utility needed to achieve sustainable development is higher for a higher probability of catastrophe \( P_c \), as would be expected. For a zero probability of catastrophe (\( P_c = 0 \)) even infinitesimal growth is adequate (if the required
threshold of improvement each period is zero), whereas for a certain catastrophe \( P_c = 1 \) the required one period growth is unbounded.

This condition will be used later to analyze brief case studies of threats of a large comet in the context of probabilistic uncertainty, and a large-scale nuclear attack in the context of non-probabilistic uncertainty but using probabilistic analysis to develop heuristic benchmarks.

Finally, it should be noted that this utility-based analysis is fundamentally different from previous definitions of sustainable development which revolve around an increase in utility. The full range of additional assumptions, including rationalizability, can be dealt with by the systems / social choice approach, but in an adaptive fashion rather than being "hard-wired" into the conceptual definition itself.

**b) Conceptualizing Paths of the World System**

The most general definition of sustainable development can be abbreviated as:

\[
\phi_{t+1}(\text{system}_{t+1}) > \phi_t(\text{system}_t), \quad 0 \leq t \leq T-1,
\]

where \( \phi \) represents knowledge about the world system, some of which may be subject to non-probabilistic uncertainty, and is defined in Figure 6. In order to explore what this expression means, the "world system" and its change over time will be discussed in this section, while the social preference relation "\( > \)" will be discussed in section (c).
i) Components of the World System

The meaning of system, the state of the world system, can be explored by conceptually organizing our knowledge of the world. For example, consider a representation of the earth along a time axis extending from the historic past to the future horizon.\textsuperscript{36}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure8.png}
\caption{Space-Time Region of the World System}
\end{figure}

Consider the space-time region designated by "R" in the diagram. It is possible to archive knowledge which relates to such a space-time region, according to its associated discipline and indexed by relevant space and time scales:

\begin{flushright}
\textsuperscript{36}In this diagram, the single arrows of the past are meant to indicate a functional (single-valued) mapping from a state of the world to the state which followed, while the double-barbed arrows of the future signify a multiple-valued correspondence which maps one state of the world to a distribution of subsequent states, according in part to future policy sets selected by governments.
\end{flushright}

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Knowledge within such a conceptual archive can be associated with a series of keywords for logical access. The contents of the archive to be accessed in this way can be any information, including data, issues, models and analyses. Linkages between entries in this conceptual archive can take a variety of forms, including equivalence, membership, or participation in a feedback loop. The net result is a reasonably comprehensive conceptual archive. Making increasingly sophisticated projections will depend on modularity of a hierarchy of models, standardized interfaces so that models can use other models' output as input, information modulation so that interpolation or aggregation to adjust for different scales is largely transparent, and explicit characterization of the propagation of uncertainty.

Our characterization of the world system can take place in the context of three different information regimes: complete information, probabilistic uncertainty, and non-probabilistic uncertainty. Complete information connotes the absence of uncertainty of any material information, both present and future. Probabilistic uncertainty means that the different possible states of the world system can be characterized by a probability distribution function. However, an inability to describe the world by a probability distribution function of alternative possible states leads to non-probabilistic uncertainty.

In the case of non-probabilistic uncertainty, there are deep forms of uncertainty that cannot be
expressed as probability distribution functions. One alternative is to be aware of different possible states of the world, but have only a qualitative understanding of their relative likelihood. A stronger form of uncertainty is to be aware of different possible states of the world, but have no idea of their relative likelihood. Perhaps the strongest form of uncertainty is the case where we don't even know what all the possible states of the world are. But an even more dangerous condition is arguably the case where we have misplaced confidence in what we think we know. These distinctions can be illustrated by a series of examples relating to stratospheric ozone depletion.

\[\text{\footnotesize\textsuperscript{37}}\] The seminal reference for this topic is Frank Knight, "Risk, Uncertainty and Profit" (1921). Knight used the term "risk" for the case of objective probabilities with known parameters and functional forms, "uncertainty" for the case where parameters or functional forms are unknown and there is no past data from which to estimate them, and "statistical probability" for the intermediate case where some data does exist to estimate unknown parameters or functional forms. See the discussion in A. Norman, D. Shimer, "Risk, Uncertainty and Complexity", 18 Journal of Economic Dynamics and Control 231-49 (1994). See also L. Hoogduin, "On the Difference Between the Keynesian, Knightian and the 'Classical' Analysis of Uncertainty and the Development of a More General Monetary Theory", 135(1) De Economist 42-65 (1987), where Keynes' view of changing uncertainty foreshadows bounded rationality.

There is also a case of non-probabilistic uncertainty which semantically appears to belong in probabilistic uncertainty, where people act as if they had a combination of a utility function and a "non-additive" subjective probability distribution function for which: \(\Pr(A) + \Pr(B) \leq \Pr(A \And B) + \Pr(A \Or B)\), and in particular \(\Pr(A) + \Pr(\text{not-}A)\) could be less than 1. See, e.g., James Dow, Sergio Ribeiro Da Costa Werlang, "Nash Equilibrium under Knightian Uncertainty: Breaking Down Backward Induction", 64 Journal of Economic Theory 305-24 (1994).

\[\text{\footnotesize\textsuperscript{38}}\] "There are more things in heaven and earth, Horatio, Than are dreamt of in your philosophy." William Shakespeare, "Hamlet" Act I, Scene V.
Suppose we know that chlorine atoms which result from photodecomposition of chlorofluorocarbons destroy ozone according to the following reaction:

\[ \text{Cl} + \text{O}_3 \rightarrow \text{ClO} + \text{O}_2, \]

with some rate constant theoretically equal to the product of the frequency of collision of the reactants multiplied by the probability of reaction for each collision. This rate constant is approximately proportional to the product of the reactant concentrations as follows:

\[ \kappa \propto [\text{Cl}] \times [\text{O}_3]. \]

Laboratory measurements of the rate constant may be highly precise (i.e., reproducible) and even highly accurate (i.e., close to the true rate constant) but are not exact. However, by analyzing the sources of experimental uncertainty, it may be possible to probabilistically characterize the uncertainty of our estimate of the rate constant.

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40For a discussion of chemical kinetics and photochemistry, see e.g., Peter V. Hobbs, "Basic Physical Chemistry for the Atmospheric Sciences" 43-61, 137-154 (1995).
Now consider the two-reaction "cycle" of chlorine's destruction of ozone:
\[ \text{Cl} + \text{O}_3 \rightarrow \text{ClO} + \text{O}_2 \]
\[ \text{ClO} + \text{O} \rightarrow \text{Cl} + \text{O}_2 \]
In this case, the ClO molecule is repeatedly recycled back to the element Cl, in which form it can destroy additional ozone molecules.

A different two-reaction cycle based on nitrogen oxides is:
\[ \text{NO} + \text{O}_3 \rightarrow \text{NO}_2 + \text{O}_2 \]
\[ \text{NO}_2 + \text{O} \rightarrow \text{NO} + \text{O}_2 \]
In this case, it is a molecule of NO which destroys an ozone molecule, and the resulting NO\(_2\) molecule is repeatedly recycled back to the original form.

The net ozone-destroying reaction in both the chlorine and nitrogen oxide cycles is the same:
\[ \text{O} + \text{O}_3 \rightarrow \text{O}_2 + \text{O}_2 \]

Suppose we know, at the level of quantitative probabilistic uncertainty, the rates of the net reaction for each of the two different underlying cycles as a function of concentrations, temperature and pressure. Even so, it could be that we have only qualitative information on the relevant concentrations in the stratosphere (e.g., perhaps "in the few parts per billion range") or no observational data at all (e.g., before in situ measurements were first made). In this case, there is non-probabilistic uncertainty about the effect of the two known cycles on ozone destruction. Even worse, there could be important reaction paths of which we are unaware. For example, the release of chlorine molecules from inert reservoir species as mediated by polar stratospheric clouds, leading to the Antarctic "ozone hole", was unknown before the 1980's.

Finally, the particularly dangerous case of misplaced confidence can be exemplified by the former belief that the non-reactivity of chlorofluorocarbons with biological organisms meant they were harmless. Actually, their chemical stability is what enables them to survive the trip to the stratosphere, where they can trigger ozone depletion.
Even in the case of non-probabilistic uncertainty, people can make preference choices. Indeed, decisions are routinely made in situations where uncertainty cannot be quantified. In such situations, people seem to behave less as utility maximizers than as "satisficers". Satisficing can take the form of "minimal rationality", such as when people draw inferences and make decisions based upon cues (e.g., go along with respected opinions or defer to authority). Another form of satisficing occurs in the context of bounded rationality.

According to bounded rationality, as pioneered by Herbert Simon, decision-making is a limited resource. According to Simon, people are limited in their access to information about the present and the future. Sometimes this is a limitation in principle based on the chaotic nature of real systems, and sometimes additional information can be generated by appropriate investment. People are also limited by a serial ability to process information at a finite rate. In effect, the world system is sufficiently complex relative to the capacity of human cognition that true optimization, such as by exhaustively comparing the outcomes of all alternative strategies, is not possible.

Simon models real behavior with a series of steps. At first, aspiration levels are established. If results fall short of the aspiration levels, then two things occur: heuristic, adaptive search behavior is initiated to regain satisfactory results, and the aspiration levels begin to adjust downward. If these two reactions fail to reestablish satisfactory results sufficiently quickly, then emotional behavior such as aggression or apathy will replace rational adaptive behavior. In essence, the unrealistic substantive rationality of neoclassical optimization is replaced by feasible procedural rationality of satisficing or even "optimal satisficing".

Many of these concepts are applicable, with some modifications, to sustainable development. It is apparent that the world system and its projection over time are quite impossible to

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41See his collected works on the subject in Herbert Simon, "Models of Bounded Rationality" (1982) divided into two volumes: "Economic Analysis and Public Policy" (vol.1) and "Behavioral Economics and Business Organizations" (vol. 2).
analyze with a precision sufficient to select an "optimal" policy set. Rather, we first establish an aspiration level, e.g., ongoing improvement of the world system over some time horizon. Next, we project how alternative promising policy strategies would affect the path of the world system, using tractable and adaptive models which become progressively more realistic with learning over time. Finally, we evaluate whether successive states of the world constitute ongoing improvement over the selected time horizon.

There are two important differences between the definitions of sustainable development under probabilistic and non-probabilistic uncertainty. First, the inability to quantify all uncertainty as a joint probability distribution function is explicitly recognized in the non-probabilistic definition. Second, the rationality constraint on the social preference relation explicitly incorporates the concept of procedural rationality, or rational adaptive behavior. This can be characterized as investing in and processing information by means of heuristic rules of thumb which adaptively change based on ongoing feedback.

It is helpful to summarize the connection between bounded rationality and sustainable development. To do so, Wall's eight-statement synthesis of Herbert Simon's ideas will be used, grouped according to their applicability and inapplicability respectively.42 The first four statements about bounded rationality are directly applicable to sustainable development:

1) "Goals are stated as aspirations, and are adaptive." A good example of an adaptive goal in the context of sustainable development would be the magnitude of any minimum threshold of improvement.

2) "Complexity dominates decision-making, which must rely on rules of thumb." One classic rule of thumb for sustainable development is the capital maintenance paradigm.

3) "Formulation of candidate strategies is adaptive." If one aspect of a strategy to achieve sustainable development is to maintain capital, then the formulation of the definition of capital

should be adaptive.

4) "The focus of attention is adaptive." An example of an issue directly affecting sustainable development which achieved the stature of focused policy attention, with highly encouraging results, is stratospheric ozone depletion.

The other four statements about bounded rationality should, ideally, be substantially inapplicable to sustainable development:

1) "Alternative strategies are evaluated by serial processing." This constraint need not apply to the pursuit of sustainable development, which should explicitly encourage parallel processing and presentation of alternative syntheses by diverse constituencies, in order to improve processing capacity and robustness of conclusions (in accordance with the rationality constraint of the social preference relation) and to incorporate the interests of those affected (in accordance with the equity constraint).43

2) "Candidate strategies are synthesized by incremental modifications to the current strategy." This constraint should also be jettisoned, and a more "global" search for new strategies initiated, exploring bold new ideas and divergent viewpoints.

3) "Candidate strategies are only sought when aspirations are unmet." This constraint potentially abandons important improvements. Rather, there should be ongoing review and evaluation to formulate strategies with better prospects.

4) "The first strategy 'satisficing' the aspiration is adopted." Again, in the case where multiple policies could be consistent with sustainable development, it will typically be appropriate to make some further investment in deciding among them. In the limit, this would return us to the unrealism of neoclassical optimization and the disturbing implications of an Arrow social welfare function. However, procedural rationality in the context of decision-making as a scarce resource will keep "optimal satisficing" well short of those lofty, disturbing and unrealistic ideals.

43See Michael D. Cohen, "The Power of Parallel Thinking", 2 Journal of Economic Behavior and Organization 285-306 (1981), in which organizational structures are shown to be capable of powerful heuristic search strategies which are strongly parallel.
iv. Change over Time

If we explicitly consider the time operator, we can write:

\[ \text{system}_{t+1} = \tau \circ \text{system}_t, \]

where the time operator \( \tau \) is actually a component of the world system. That is, symbolically we can write:

\[
\begin{align*}
\tau(t) &= \text{system}_t', \\
\tau'(t) &= \text{system}_t'',
\end{align*}
\]

which makes explicit the fact that change is itself a function of time. The process of projecting future states of the world can then be thought of as projecting the consequences of current processes into the future, while taking into account projected changes in the processes themselves.

The focus of this paper is on the policy sets and policy strategies available to governments to pursue sustainable development. A policy strategy is taken to mean a temporal sequence of policy set functions. The consistency of a proposed current policy set with sustainable development can be evaluated by considering various eligible policy strategies, with correspondingly different projected paths of the world system.

It is possible to illustrate the desirability of alternative paths of the world system in comparison to each other over time, if we assume that the social preference relation is rationalizable by a utility function (see Figure 11 below). Of course, given the rest of Arrow's assumptions, this would imply that the Arrowian social welfare function is a dictatorship. Nevertheless, the exercise remains heuristically valuable.
In Figure 11, the utility of the world system over time, $U(\text{system}_t)$, is plotted for different alternative paths. Path (e), with the lowest terminal point, reflects an overshoot and collapse scenario. Path (d) represents steady erosion. The only path in this figure which is consistent with sustainable development in the sense of ongoing improvement is path (c). The utility of path (b) is always above the sustainable development path (c), however it has a dramatic downward spike which could make it a worse alternative under reasonable preferences.

Alternatively, if the interval over which periodic comparisons are made is sufficiently wide, the downward spike of path (b) could be smoothed out and the path would then be consistent with sustainable development.

The most interesting comparison is between path (a) and path (c). Path (a) is everywhere significantly above path (c), but is inconsistent with the "ongoing improvement" requirement of sustainable development due to an extended but rather mild downslope. This highlights the fact that when using a "satisficing" criterion, not only is there no guarantee that an optimal
outcome will be selected, but an optimum may not even be consistent with the satisficing criterion itself. Realistically speaking, this situation might be avoided in several ways:
1) The width of the periodic comparison interval is endogenous to the evaluation process, and could be broadened to encompass the downturn. 2) The uncertainty inherent in the projections could fail to capture such temporary future reversals in the secular trend.
3) If a government were after all to adopt a policy set validated by a policy strategy resulting in the projection of path (a), with such a large improvement over time extending all the way to the time horizon "T", there would be no strong political or legal argument against the decision.\textsuperscript{44}

At any rate, the complete comparison over alternative paths of the world system implicit in the figure is unrealistic to the extent that Arrow's other assumptions also hold true, since it leads to the existence of a rationalizable social preference relation and the Arrowian social welfare function as a dictatorship. The classic approach to compare the social welfare of two alternative paths goes even further, by calculating a scalar number equal to the present discounted value of a weighted sum of individual utilities. This metric entails unrealistic assumptions about the existence of individual utility functions, an ability to elicit or compare them, and an ability to intertemporally aggregate utilities by means of discoverable discount rates.\textsuperscript{45}

\textsuperscript{44}Even binding duties can countenance appropriate deviations. Franck gives as an example the appropriate violation of an injunction "Don't Run in the Hall" if there is a fire. Franck, infra note 142 at 68.

\textsuperscript{45}Even a far less ambitious attempt to merely create a partial order of alternative paths encounters difficulties. For example, suppose a given path is inconsistent with sustainable development according to the systems / social choice definition. Consider the set of all temporal sequences of perturbations, i.e. windfall gains or losses, which would result in the path becoming consistent with sustainable development. Suppose we define an alternative path as weakly preferred to, or at least as good as, the given path if it would also be consistent with sustainable development if it were subjected to any member of that set of perturbations. This relation is not necessarily complete, e.g. if there are two alternative paths inconsistent with sustainable development due to downturns at different times, which are made consistent with sustainable development by windfall gains at different times.
As can be seen from this Figure 11, the "litmus test" for the consistency of a policy set with sustainable development does not constitute a mechanism to select an "optimal" policy set. However, in the context of today's struggle to adequately incorporate longer-term consequences into policy formulation, such a litmus test would enhance the leverage of international and domestic political constituencies for sustainable development, by providing a conceptual standard suitable for a binding legal duty. Such a legal duty would be an example of how international law can serve as a constructive and progressive influence.

c) Social Preference Relation

A social choice mechanism selects a strategy from available alternatives, such as a policy set from some feasible set. As will be seen, states have a duty under international law to pursue sustainable development which imposes constraints on the selection mechanism, based in part on a social preference relation.

The social preference relation is constructed during the decision process, and is not simply a function of pre-existing individual preferences. In fact, individual preferences are best viewed as endogenous variables which adapt to changing world circumstances, rather than exogenous constants. The social preference relation needed to evaluate the consistency of a policy set with sustainable development will be seen to be sufficiently spartan that Arrow's classic impossibility theorem becomes inapplicable. This is possible because sustainable development is a satisficing constraint, and therefore avoids the problem of maximizing some social welfare function based on a rationalizable social preference relation.

i) Legitimacy Constraint on the Social Preference Relation: Rationality and Equity

For states to fulfill their duty to pursue sustainable development with respect to some social preference relation, that relation must be legitimately constructed. This legitimacy constraint includes duties of rationality and equity.46

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46These duties parallel management's duties of competence and loyalty in corporation law.
The *rationality* constraint on the construction of a social preference relation includes several dimensions. In the context of non-probabilistic uncertainty, it can be characterized as "procedural rationality". It is necessary for the decisionmakers to consider relevant information, at least in the sense of making a reasonable investment decision about generating knowledge. There should be reasonable consistency among different policies, adaptability based on observed feedback, and suitable diversification in the interest of robustness.

The *equity* constraint means that those affected must have access to information and an opportunity to participate. Therefore, policies must not cause transboundary pollution of neighbors who are unrepresented in the decision process, or pollution of the global common without taking into account the interests of the international community.

Redistribution issues are often considered to impose equitable or moral duties. However, any positive rights of recipients must be balanced against rights of property owners which can also be important both for equity and for efficiency. Since there seems to be no objective standard concerning how much distribution should occur and to whom, it may be more useful to view a redistribution policy as one of the defining choices of a society.

In like fashion, the notion of "intergenerational equity" can usefully be seen as a defining choice of a society. It should be noted that the social preference relation used throughout this analysis reflects preferences and decisions of today's society. Of course, today's society incorporates into its preferences and decisions the well-being of its progeny, at least to some degree. However, to the extent that the interests and preferences of today's society and future generations were truly opposed, future generations would have no viable means of recourse. Rather than invoke a conceptual framework which focuses on putatively opposing interests of current and future generations, it may be realistic and helpful to view society as an organic, evolving entity with a genuine interest in its future.
ii) Construction of the Social Preference Relation

The central principles in the construction of the preference relation are: develop useful information, make it accessible, support alternative interpretations, and evaluate promising policy strategies. The first steps are to identify the systems to be compared and characterize their differences. In the context of the conceptual archive discussed earlier, the projection of a state of the world into the future will result in changes to the system. Some of those changes can be separably valued, such as commodities with efficient futures markets, or even consumer goods with efficient markets.

For changes in the system whose value can be approximated separably, there are powerful techniques to estimate their relative value, which can be characterized as "use value", which includes direct, indirect and option, and "non-use value", which includes existence and bequest. Markets can be an efficient mechanism for pricing and allocation, assuming they are complete, convex and competitive. Incomplete markets can be augmented, as in the case of tradeable pollution rights. Market prices can be used even in the context of market failure such as externalities, by estimating adjustments. Even absent explicit market prices, travel cost or hedonic pricing data can be used, or contingent valuations elicited. After estimating valuations separably, adjustments must be introduced for non-additivities in the aggregation process. The result is an estimate of net monetary impacts by category and period.

To compare the system and its changed version, the results of this monetized analysis and all non-monetizable impacts are inventoried. A comparison can be performed directly on the impact of the changes, netted out by category and period as appropriate. Alternatively, impacts during different time periods can be aggregated, using discount rates appropriate to each category. For example, market goods could be discounted by corresponding market interest rates, goods of uncertain availability could be discounted using relevant probability weights, while some categories, e.g., critical natural capital, should perhaps not be discounted.

47This contrasts with the economic paradigm of calculating a measure of capital based on a series of assumptions and conventions.
The main idea is to defer as long as possible the introduction of assumptions and non-consensus values into the information structure used for the construction of preferences, in order to avoid inflexible conventions and to promote alternative approaches. In this way, different individuals and organizations, including responsible government agencies, could perform analyses independent to varying degrees, resulting in differing perspectives on the consistency of proposed government policy sets with sustainable development. These differing perspectives would in turn be incorporated into the political process.

Whether there will be ongoing improvement of the world system is subject to a variety of complexities. There will be probabilistic uncertainties and non-probabilistic uncertainties including eventualities of which we will not be aware. In this case, the degree of insurance incorporated in a policy set in accordance with the precautionary principle will be one of the factors considered in the process of evaluation. In addition, preferences may involve "fat indifference curves" which do not discriminate among sufficiently close alternatives, or an "endowment effect" which accords special significance to the actual or expected endowment. This may necessitate ongoing achievement beyond some minimum threshold, in order to constitute the improvement required by sustainable development. 48

As has been seen, representation of future preferences is an issue which is often considered to be a source of difficulty, but need pose no conceptual problem. The process of evaluating

48For example, one of the "outstanding features of post-war politico-economic conditions" is that 'It has now come to be taken for granted, both by governments and by the average person in the Western capitalist countries, that each year should bring a noticeable increase in the real income per head of population' (emphasis added). Michael Brenner, "Fundamental Representation and Interest Group Theory: Some Notes on British Practice", in Gary Byrne, Kenneth Pedersen, "Politics in Western European Democracies: Patterns and Problems" 45 (1971), characterizing the seminal book, Andrew Shonfield, "Modern Capitalism: The Changing Balance of Public and Private Power". This argument would seem to be even stronger in the case of developing countries. See pp. 159ff.

For a case study which incorporates such a minimum threshold of improvement, see the discussion on the threat of large-scale nuclear attack (below at pp. 224ff.)
projections, even about the distant future, is based on current preferences. It is true that some will incorporate into their own preferences their beliefs about future preferences, whether on moral or other grounds. It is also true that there is even more uncertainty about future preferences than there is about current preferences, just as there is significant uncertainty about all other aspects of the future projections. But there would be no mechanism by which putative future preferences could override current preferences. Furthermore, the evidence for a secular increase in human welfare over historical time scales, at least up to the point where distributional equity is considered, supports the proposition that future interests tend to be effectively taken into account.

d) Advantages of Systems/Social Choice Definition

The systems / social choice approach presents several advantages over previous attempts to define sustainable development. The classic definition revolves around an undefined level of "needs". In contrast, the proposed formulation is conceptually well-defined. Its two components are: 1) an ongoing improvement of the world system, 2) evaluated according to a legitimately constructed social preference relation. The first component of ongoing improvement has been formally and explicitly presented for different information regimes. With the second component, the construction of the social preference relation must satisfy a dual legitimacy constraint of rationality and equity. It is of course inappropriate to try to evaluate the rationality or equity of a given constructed social preference relation by means of some precise quantitative standard. Rather, compliance with the legitimacy constraint must in the final analysis be qualitatively judged by political or judicial processes. The classic definition also pits "future generations" against present society, whereas the current approach adopts the perspective that peoples of the world, with their future in mind, have wisely invoked their right to impose on states a duty to pursue sustainable development.

Unlike the definition which calls for non-declining utility of a representative member of society, the new definition relies only on concepts which can in principle be implemented - such as the construction of a social preference relation, which occurs as a matter of course on
a routine basis. A series of earlier definitions, including those calling for an increase in all components of a social welfare vector and those calling for the maintenance of capital subject to constraints on favored categories, inject substitutability assumptions directly into the definition. In contrast, the systems/social choice formulation avoids prematurely fixing such factual issues in the conceptual definition, but rather defers them to the evaluation stage where they can be progressively investigated from multiple perspectives and subjected to the crucibles of scientific and political discourse.

One of the assumptions implicit in most of the previous definitions is an exclusive focus on particular dimensions of human welfare, such as environmental or economic. On the other hand, the proposed formulation encompasses anything which could affect a preference comparison. As just one example of the generality of the systems/social choice definition relative to earlier definitions, a policy strategy which strongly advanced human rights by devoting the growth in real income over some transition interval to the subsidization of the retirement of abusive government leaders and functionaries could hypothetically result in an improvement of the world system, although it would not be reflected in the environment or economics.

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49 The feasibility of sustainable development using the systems/social choice approach should not be prejudged. The consistency of a government policy set with sustainable development can only be judged relative to a particular initial world system and a particular legitimately constructed social preference relation. It may turn out that no feasible government policy set can result in sustainable development. For example, if we had learned that Schoemaker-Levy was going to impact Earth instead of Jupiter, and had no means to prevent it, then ongoing improvement of the world system over a time horizon beyond the time of impact would have been infeasible. However, there is no justification in presuming infeasibility in advance, and the pursuit of sustainable development is fully appropriate as a policy objective of governments and, as we shall see, a legal duty upon states.

50 "As the International Commision of Jurists has urged, development is not a purely economic matter. Rather, development should be seen as: 'a global concept, including with equal emphasis, civil and political rights and economic, social and cultural rights..." William Andrew Shutkin, "International Human Rights and the Earth: The Protection of Indigenous Peoples and the Environment", 31 Virginia Journal of International Law 479, 507 (1991).
Indeed, the central values in a preference structure outlined by Richard Falk are:

1) minimization of large-scale collective violence,
2) maximization of social and economic well-being,
3) realization of fundamental human rights and conditions of political justice, and
4) rehabilitation and maintenance of environmental quality.\(^{51}\)

It is noteworthy, for example, that economics represents only a portion of one out of the four central values in this framework, and is also the only component which Falk seems to expect to improve over the coming decades.\(^{52}\) The International Conference on Human Rights adopted a perhaps still broader perspective of human welfare as affected by government policies, when it urged "all peoples and governments . . . to redouble their efforts to provide for all human beings a life consonant with freedom and dignity and conducive to physical, mental, social and spiritual welfare."\(^{53}\)

The "Solow" or "very weak sustainability" version of the capital maintenance paradigm relies in principle on the representation of the capacity for future welfare by a single scalar number designated as "capital". This leads in principle to the disturbing concentration of power implied by Arrow's Theorem, if the rather basic assumptions of that theorem are satisfied. In contrast, Arrow's Theorem is inapplicable to the proposed formulation of sustainable development, since it does not constitute a selection mechanism which purports to prescribe an optimum policy set. Rather, the systems / social choice definition embodies a satisficing constraint derived from bounded rationality which stops short of neoclassical optimization. It thus provides a "litmus test" for policy sets which is intended as a constructive contribution to the political process ultimately responsible for the hard choices facing society.


For insight into the inapplicability of Arrow's Theorem to the social preference relation embedded in the systems/social choice concept of sustainable development, it is helpful to contrast the current approach with the "very weak sustainability" version of the capital maintenance paradigm by means of a diagram. In Figure 12(a), a society at time $t_0$ is faced with choices from the set $\{x, y, z\}$, and has an Arrow social welfare function which defines capital as a societal preference ordering over future outcomes as a function of individual preference orderings. Given a choice among different initial conditions, society would choose the one with the greatest capital. However, such a choice would fall squarely within the framework of Arrow's Theorem with its disturbing implication that a few reasonable assumptions imply that the collective choice rule must be a dictatorship.\(^{54}\)

Now consider the social preference relation embedded in the systems/social choice concept of sustainable development. The question is whether a particular policy set is consistent with sustainable development. To answer this question, a promising policy strategy (i.e., a sequence of functions mapping observed states of the world onto sets of feasible policy sets) is identified and the corresponding path of the world system is projected. Assume that in Figure 12(b), the path outlined in bold ($t_0 - t_1 - t_2$) represents just such a projection of the path of the world system based on some promising policy strategy. To evaluate whether this path represents ongoing improvement, a legitimate social preference relation must make a series of hypothetical choices: first, between system$_{1}$ and system$_{0}$; next, between system$_{2}$ and system$_{1}$; next, between system$_{3}$ and system$_{2}$, etc. Note that if even a single policy strategy results in a projected path which represents ongoing improvement, then the proposed policy set is

\[^{54}\text{This is a formulation of a hypothetical choice among alternative initial conditions with different capital, and it abstracts away the consumption component of the societal choice. To explicitly consider the consumption component, assume that the Arrow social welfare function which results in a Bergson-Samuelson social welfare function representing a societal preference ordering over future outcomes as a function of individual preference orderings over both capital and consumption, is determined by scalar representations of consumption and capital. The main additional assumption here is that if the contribution of capital to social welfare can be specified by a scalar number, so too can the contribution of consumption. In this case, Arrow's Theorem, along with its disturbing implication, would apply to the social welfare function subsuming both consumption and capital.}\]
consistent with sustainable development. If multiple paths satisfy the ongoing improvement criterion, then the consistency of the proposed current policy set with sustainable development is correspondingly reinforced. However, if there are multiple policy sets which are consistent with sustainable development, the systems/social choice satisfying criterion does not constitute a selection mechanism which prescribes which policy set to adopt.

This process is immediately removed from the domain of Arrow's Theorem, since the sequence of hypothetical choice sets is each comprised of only two elements. Alternatively, if the hypothetical choice set is taken to be all states along one path, or even along all possible paths, then Arrow's Theorem is still inapplicable because the preference relation does not satisfy the "completeness" component of rationalizability (since it only compares potentially successive states).\(^{55}\)

\(^{55}\)There is another fundamental reason for the inapplicability of Arrow's Theorem. That theorem presupposes existing underlying individual preference orderings which form the grist for the mill of the collective choice rule. In contrast, in this case the social preference relation recognizes that few if any individuals may be sufficiently informed to effectively make comparative evaluations of potentially successive world systems. This may obtain both in principle due to bounded individual rationality, and in practice due to unwillingness of an
Still another component of rationalizability which can reasonably be violated in this context is the assumption of transitivity. Since each comparison involves two temporally distinct states of the world, it is not a choice set in the sense of selecting which of the two states to bring about. In this context, seeming intransitivities or cycles could be natural, and arbitrage to eliminate them might be impossible or inappropriate. As an "anti-endowment effect" example, consider a family which spends a year at the beach and then chooses between the beach, desert, and mountains. It might prefer the desert as a change of pace. But after a year in the desert, it might prefer the mountains, and after a year in the mountains it might prefer the beach again. As another example, a macroeconomic "cycle" of increasing inflation which deflates back to a low value prior to the onset of hyperinflation might lead to more cumulative growth than a steadier alternative. In both these examples, it is not possible to eliminate these seeming intransitivities by means of arbitrage.

To summarize, the primary advantage of the systems / social choice perspective of sustainable development is its distillation of the essence of previous definitions - ongoing improvement of human welfare - into a conceptually clear standard, while deferring assumptions about either rationalizability of the social preference relation or observable inferences such as substitutability between various resources.

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individual to invest in such competence in the face of an informational commons context. Therefore, the social preference relation is constructed, making use of a collective process which is subject to a legitimacy constraint which includes taking into account the interests of those affected. Since the Arrow conditions of universal domain, independence of irrelevant alternatives and Pareto optimality are premised on the existence of individual preference orderings, which will not generally be available, Arrow's Theorem is again inapplicable. However, while Arrow's Theorem is itself inapplicable to a constructed social preference relation in the nature of a decision mechanism, similar logic to Arrow's can be used to infer analogously disturbing concentrations of power when attempting to optimize. Amartya Sen, "Rationality and Social Choice", 85(1) American Economic Review 1, 5-7 (March 1995).
III. Pursuit of Sustainable Development as a Duty of States under International Law

This section makes the case that the pursuit of sustainable development is a duty of states under international law. The main analysis is based upon the principle of self-determination, and is presented in three parts: First, the existence in international law of the right of peoples to self-determination is demonstrated, based on the sources of international law set out in the Statute of the International Court of Justice. Second, the nature of the right of peoples to self-determination is discussed, referring in particular to two reports on the subject commissioned by the United Nations. Third, the right of peoples to self-determination is shown to be the source of a duty of states to pursue sustainable development. This is because sustainable development is one possible objective to pursue by virtue of the right to self-determination, and peoples of the world have freely expressed their choice for it.

An auxiliary analysis is based upon the international law of human rights. After discussing the relationship between self-determination and human rights, and outlining the structure of the international law of human rights, we will explore the status of human rights to development, environment, and, ultimately, sustainable development as emerging norms.

In addition, the existing matrix of international conventions is discussed, in order to explore whether it already embodies a duty to pursue sustainable development.

Finally, selected issues in the application of the duty of states to pursue sustainable development are analyzed, including the legal merits of the systems/social choice definition, selected hypothetical situations, and the feasibility of and political prospects for the pursuit of sustainable development.
At the outset, however, it is important to address a threshold issue: the reality of international law itself. According to the Restatement of the Foreign Relations Law of the United States:

"International law has the character and qualities of law, and serves the functions and purposes of law, providing restraints against arbitrary state action and guidance in international relations."\(^{56}\)

The Restatement of the Law duly notes the arguments that international law is generally hortatory, or amounts to hypocritical lip-service:

"The absence of central legislative and executive institutions had led to skepticism about the legal quality of international law. Many observers consider international law to be only a series of precepts of morality or etiquette, of cautions and admonitions lacking in both specificity and binding quality. Governments, it is sometimes assumed, commonly disregard international law and observe it only when they deem it to be in their interest to do so."\(^{57}\)

However, the Restatement of the Law goes on to emphasize that despite the non-existence of a police authority capable of coercing states into compliance with international law, a matrix of alternative motivations serves to induce legitimate behavior:

"A principal weakness perceived in international law is the lack of effective police authority to enforce it. That is indeed a weakness, but the criticism reflects misplaced emphasis. Effective police authority deters violations of law, but there are other inducements to compliance. In the international system, law is observed because of a combination of forces, including the unarticulated recognition by states generally of the need for order, and of their common interest in maintaining particular norms and standards (emphasis added), as well as every state's desire to avoid the consequences of violation, including damage to its "credit" and the particular reactions by the victim of a violation. There are occasional, sometimes flagrant, violations, but all nations generally observe their obligations under international law, and an international legal system exists and functions as a working reality. ... See generally, Henkin, How Nations Behave: Law and Foreign Policy, Chapter 3 (2d ed. 1979)."\(^{58}\)


\(^{57}\) Id.

\(^{58}\) Id. at 19.
In particular, states' "common interest in maintaining particular norms and standards" will be seen as a powerful inducement to comply with a duty to pursue sustainable development, because the global challenges to human civilization necessitate effective coordination of long-term policies by the community of nations.

The idea that binding norms, enforced at least in part by social and political pressure, can mold the behavior of even the most powerful actors, also underlies Henkin's analysis of international law:

"Much is made of the fact that, in international society, there is no one to compel nations to obey the law. But physical coercion is not the sole or even principal force ensuring compliance with law. Important law is observed by the most powerful, even in domestic societies, although there is no one to compel them. In the United States, the President, Congress, and the mighty armed forces obey orders of a Supreme Court whose single marshal is unarmed."  

Henkin amplifies on this perspective with characteristic insight and articulateness:

"[International] law works. Although there is no one to determine and adjudge the law with authoritative infallibility, there is wide agreement on the content and meaning of law and agreements, even in a world variously divided. Although there is little that is comparable to executive law enforcement in a domestic society, there are effective forces, internal and external, to induce general compliance. Nations recognize that the observance of law is in their interest, and that every violation may also bring particular undesirable consequences."  

"If international law is difficult to make, yet it is made; if its growth is slow, yet it grows. If there is no judiciary as effective as in some developed national systems, there is an International Court of Justice whose judgments and opinions, while few, are respected."  

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60 Id. at 320 in the original and at 24 in the quoting authority.

61 Id at 25 in the original and at 23 in the quoting authority.
Perhaps the author of this dissertation may be forgiven for echoing Henkin's optimistic answer to the tough question he poses at the conclusion to his classic treatise "How Nations Behave":

"[T]he question is whether, admitting the inadequacies of international society, law really matters - whether it makes sense for nations to bother with law, to depend on it, to uphold it, to seek its extension.

To me, the answer is clear. In the society we have, international law sustains what order we have and promises better. There is bound to be controversy about its application and interpretation, but that does not vitiate its significance or effectiveness. . . .

[Progress] depends on nations paying more, not less, attention to law, extending its domain, and sacrificing some often superficial, immediate interest for law's longer, deeper promises."  

One of the longest and deepest promises which international law has to offer may be a norm to pursue sustainable development, rooted in the right of peoples to self-determination - the right to determine their future - which they have exercised in a series of solemn global convocations culminating in the United Nations Conference on Environment and Development.  

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63 The nature of international law as "really law" is further discussed in the context of enforcing a possible duty to effectively participate in the formulation and implementation of coordinated policy sets concerning global climate change in order to pursue sustainable development, infra pp. 276ff.
1. Existence of the Right of Peoples to Self-Determination

a) Pre-1945 History

i) Early History and Woodrow Wilson

The principle of self determination has deep historical roots. In the words of Vice-President Ammoun of the International Court of Justice,

"[T]he path whereby this right of peoples has made its entry into positive international law... [has been] the fight of the peoples for freedom and independence, which has been going on ever since there have been conquering and dominating peoples and subject but unsubjegated peoples."\(^{64}\)

The norms of freedom and equality that underlay the American and French revolutions are frequently cited as progenitors of the modern concept of self-determination.\(^{65}\) Perhaps ironically, the term derives from the German *selbstbestimmungsrecht* used by nineteenth century radical philosophers.\(^{66}\)

Woodrow Wilson placed self-determination on the international agenda after World War I, and met with widespread public support.\(^{67}\) His "Fourteen Points" speech outlining the United States position for the Versailles peace conference was permeated with the concept, if not the terminology, of self-determination.\(^{68}\) The following month, Wilson forcefully emphasized self-determination in a speech to Congress:

"People are not to be handed about from one sovereignty to another by an international conference or an undertaking between rivals and antagonists. National aspirations must be respected; peoples may now be dominated and

\(^{64}\)Vice President Ammoun, *Namibia*, ICJ Reports 62 (1971) (separate concurring opinion).


\(^{67}\)Arthur S. Link, "Woodrow Wilson: Revolution, War, and Peace" 84 (1929).

\(^{68}\)William J. Hartnett, "The Right of Peoples to Self-Determination" 3, manuscript for New World Order Seminar, St. Louis University School of Law (December 9, 1991).
governed only by their own consent.

'Self-determination' is not a mere phrase. It is an imperative principle of action which statesmen will henceforth ignore at their peril."\(^69\)

Wilson proceeded to enumerate the principle that:

"[E]very territorial settlement involved in this war must be made in the interest and for the benefit of the populations concerned, and not as a part of any mere adjustment or compromise of claims amongst rival states."\(^70\)

ii) Inter-War Period and Atlantic Charter

The Wilsonian ideal atrophied in the inter-war period.\(^71\) The classic example of inter-war failure to support self-determination is the Aaland Islands dispute. The Aaland Islands were part of Finland, but the representatives of its inhabitants formally requested annexation to Sweden. The League of Nations appointed an International Committee of Jurists, which concluded:

"Although the principle of self-determination of peoples plays an important part in modern political thought... there is no mention of it in the covenant of the League of Nations. The recognition of this principle in a certain number of international treaties cannot be considered as sufficient to put it on the same footing as a positive rule of the Law of Nations."\(^72\)

American isolationism and the impotence of the League of Nations in the face of German militarism and the Italian invasion of Ethiopia further underscored the inter-war vulnerability of self-determination.\(^73\)

\(^69\)"The Four Principles of Peace", Address to Congress of February 11, 1918, in "War Addresses of Woodrow Wilson" 106 (1918).

\(^70\)Id at 109.

\(^71\)Hartnett, supra note 68 at 6-7.


This situation changed near the beginning of World War II. In mid-August 1941, Roosevelt and Churchill met ship-board during a conference in Newfoundland. The resulting "Atlantic Charter" contained two points directly relating to political self-determination:

"[The United States and Great Britain] desire to see no territorial changes that do not accord with the freely expressed wishes of the peoples concerned. [T]hey respect the right of all people to choose the form of government under which they will live; and they wish to see sovereign rights and self-government restored to those who have been forcibly deprived of them." In addition, the Atlantic Charter expressed the desire for international collaboration for economic advancement and social security.

The Atlantic Charter was formally incorporated into the Declaration By United Nations "signed by the United States, Great Britain, the Soviet Union and China on January 1, 1942, and by twenty-two other Allied countries on January 2. By 1945, twenty-one more states had signed the Declaration, bringing the total to forty-seven, or the preponderant majority of the world's essentially independent states." In essence, the Atlantic Charter expressed the principles for which the Allies fought World War II, and which were to become the foundation of the United Nations Charter in 1945.

b) United Nations and International Court of Justice
i) United Nations Charter
According to UN Special Rapporteur Hector Gros Espiell:

"The right of peoples to self-determination is enshrined in the Charter of the United Nations; the International Covenants on Human Right[s]; [and] [Id. at 251-2.

[Id. at 251.

[Id. at 253-4.
Self-determination appears explicitly in the United Nations Charter as follows:

United Nations Charter\textsuperscript{79}

Article 1

The Purposes of the United Nations are...

2. To develop friendly relations among nations based on respect for the principle of equal rights and self-determination of peoples, and to take other appropriate measures to strengthen universal peace.

Article 55

With a view to the creation of conditions of stability and well-being which are necessary for peaceful and friendly relations among nations based on respect for the principle of equal rights and self-determination of peoples, the United Nations shall promote:

a. higher standards of living, full employment, and conditions of economic and social progress and development;

b. solutions of international economic, social, health, and related problems; and

c. universal respect for, and observance of, human rights and fundamental freedoms for all without distinction as to race, sex, language or religion.

Article 56

All Members pledge themselves to take joint and separate action in cooperation with the Organization for the achievement of the purposes set forth in Article 55.

\textsuperscript{78}Hector Gros Espiell (UN Special Rapporteur), "The Right to Self-Determination: Implementation of United Nations Resolutions" 8 (1980).

The significance of Article 1 was emphasized by a United Nations Rapporteur contemporaneous to the drafting of the Charter:

"The 'Purposes' constitute the \textit{raison d'etre} of the Organization. They are the aggregation of the common ends on which our minds met, hence, the cause and object of the Charter to which member states collectively and severally subscribed."\textsuperscript{80}

The consensus of the major powers on self-determination is underscored by the fact that the provisions in Articles 1 and 55 "were proposed jointly by the United States, U.S.S.R., United Kingdom and China ..."\textsuperscript{81} When these provisions were discussed in the drafting committee, "it was strongly emphasized that 'this principle [of self-determination] corresponded closely to the will and desires of the peoples \textit{everywhere}' [emphasis added]."\textsuperscript{82}

\textbf{ii) United Nations General Assembly Resolutions}

A veritable plethora of Resolutions of the United Nations General Assembly has affirmed the right of peoples to self-determination.\textsuperscript{83} The four most important, in chronological order, are: Resolution 1514; the International Covenant on Civil and Political Rights; the International Covenant on Economic, Social and Cultural Rights; and Resolution 2625.

\textsuperscript{80}As quoted in Aureliu Cristescu (UN Special Rapporteur), "The Right to Self-Determination: Historical and Current Developments on the Basis of United Nations Instruments" 21 (1981).

\textsuperscript{81}Ian Brownlie, "An Essay in the History of the Principle of Self-Determination", in C.H. Alexandrcwicz (ed.), \textit{Groatian Society Papers 1968} 90, 98 (The Hague, 1970). See also Charney, infra note 122 at 537-38, where he emphasizes the significance of the "actions of a limited number of states, often only the largest, most prominent, or most interested among them", with the result that: "Traditionally, customary law has been made by a few interested states for all."


\textsuperscript{83}See, e.g., Espiell, supra note 78 at 8, 22-28; Cristescu, supra note 80 at 11.
Resolution 1514

Resolution 1514, titled "Declaration on the granting of independence to colonial countries and peoples", was adopted in 1960 and "has been termed the Magna Carta of decolonization..." According to it:

"All peoples have the right to self-determination; by virtue of that right they freely determine their political status and freely pursue their economic, social and cultural development."

"This Declaration regards the principle of self-determination as a part of the obligations stemming from the Charter, and is not a 'recommendation', but is in the form of an authoritative interpretation of the Charter." Resolution 1514 was so pivotal, that "one could reasonably infer the existence of a distinct majority view that 1960 is critical either in the sense of being the year when a breach occurred or when the dam collapsed" with respect to the issue as to when self-determination matured into a norm of customary international law.

International Covenants on Human Rights

In 1966, the International Covenant on Civil and Political Rights and the International Covenant on Economic, Social and Cultural Rights each spotlighted self-determination with identical language:

Article 1

1. All peoples have the right of self-determination. By virtue of that right they freely determine their political status and freely pursue their economic, social and cultural development.

2. All peoples may, for their own ends, freely dispose of their natural wealth and resources without prejudice to any obligations arising out of international

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84Espiell, supra note 78 at 8.

85United Nations General Assembly Resolution 1514, Article 2 (December 14, 1960).


87Laing, supra note 74 at 231.
economic co-operation, based upon the principle of mutual benefit, and
international law. In no case may a people be deprived of its own means of
subsistence.

3. The States Parties to the present Covenant, including those having
responsibility for the administration of Non-Self-Governing and Trust:
Territories, shall promote the realization of the right of self-determination, and
shall respect that right, in conformity with the provisions of the Charter of the
United Nations.\textsuperscript{88}

The importance to human rights of self-determination has been underscored by both United
Nations Special Rapporteurs on the subject, characterizing it as "a sine qua non for the
existence of human rights and freedoms"\textsuperscript{89} and as "a fundamental right, without which other
rights cannot be fully enjoyed".\textsuperscript{90}

\textbf{Resolution 2625}

Resolution 2625, titled "Declaration on Principles of International Law concerning Friendly
Relations and Co-operation among States in accordance with the Charter of the United
Nations", significantly amplified upon the concept of self-determination:

"By virtue of the principle of equal rights and self-determination of peoples
enshrined in the Charter of the United Nations, all peoples have the right freely
to determine, without external interference, their political status and to pursue
their economic, social and cultural development, and every State has the duty
to respect this right in accordance with the provisions of the Charter.

Every State has the duty to promote, through joint and separate action,
realization of the principle of equal rights and self-determination of peoples, in
accordance with the provisions of the Charter, and to render assistance to the

\textsuperscript{88}International Covenant on Civil and Political Rights", U.N.G.A. Res. 2200, 999
U.N.T.S. 171 (December 16, 1966); "International Covenant on Economic, Social and Cultural
duty of states to promote self-determination is "absolute and immediate" under the first
covenant, while under the second it is "qualified and progressive" but "non-derogable in any

\textsuperscript{89}Espiell, supra note 78 at 65.

\textsuperscript{90}Cristescu, supra note 80 at 32.
United Nations in carrying out the responsibilities entrusted to it by the Charter regarding the implementation of the principle... 

It also declares a duty on states to co-operate with each other:

"States have the duty to co-operate with one another ... in the various spheres of international relations, in order to maintain international peace and security and to promote international economic stability and progress, [and] the general welfare of nations..."

Resolution 2625 also emphasized the importance of self-determination:

"[T]he principle of equal rights and self-determination of peoples constitutes a significant contribution to contemporary international law, and that its effective application is of paramount importance for the promotion of friendly relations among States, based on respect for the principle of sovereign equality[.]"

In sum, this Declaration is "of particular importance" and contains "the most comprehensive formulation of the principle of equal rights and self-determination of peoples..."

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91 United Nations General Assembly Resolution 2625, Article 1 (October 24, 1970). This quote only excerpts part of the language relevant to self-determination.

92 Id.

93 Id.

94 Cristescu, supra note 80 at 23.

95 It may also be of interest to excerpt from the "Helsinki Final Act", Conference on Security and Co-operation in Europe (CSCE), as an example of how self-determination has been included in international instruments not generated under United Nations auspices:

"The participating States will respect the equal rights of peoples and their right to self-determination, acting at all times in conformity with the purposes and principles of the Charter of the United Nations and with the relevant norms of international law, including those relating to territorial integrity of States.

By virtue of the principle of equal rights and self-determination of peoples, all peoples always have the right, in full freedom, to determine, when and as they wish, their internal and external political status, without external interference, and to pursue as they wish their political, economic, social and cultural development."
iii) International Court of Justice Decisions

In 1971, the International Court of Justice had occasion to consider self-determination, in the Namibia case. In its opinion, the Court clearly recognized the right of peoples to self-determination:

"Recognition of the right of peoples to self-determination is expressed by the Court... As for the 'general practice' of States to which one traditionally refers when seeking to ascertain the emergency [sic] of customary law, it has, in the case of the right of peoples to self-determination, become so widespread as to be not merely 'general' but universal, since it has been enshrined in the Charter of the United Nations (Art. 1, para. 2, and Art. 55) and confirmed by the texts that have just been mentioned: pacts, declarations and resolutions, which, taken as a whole, epitomize the unanimity of States in favour of the imperative right of peoples to self-determination. There is not one State, it should be emphasized, which has not, at least once, appended its signature to one or other of these texts, or which has not supported it by its vote. The confirmed rightness of this practice is moreover evinced by the great number of States - no less than 55 - which, since the consecration by the Charter of the right of self-determination, have benefited from it, after having ensured, by the struggles and strivings of their peoples, its definitive embodiment in both the theory and the practice of the new law."\(^{96}\)

In 1975, the International Court of Justice revisited the subject of self-determination in its Western Sahara opinion. The Court once again relied on the right of peoples to self-determination, citing its earlier opinion, the United Nations Charter, and General Assembly Resolutions 1514 and 2625.\(^{97}\) In the Western Sahara opinion, the Court characterized the right of peoples to self-determination as "the need to pay regard to the freely expressed will

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The participating States reaffirm the universal significance of respect for and effective exercise of equal rights and self-determination of peoples for the development of friendly relations among themselves as among all States; they also recall the importance of the elimination of any form of violation of this principle."

Helsinki Final Act, 14 I.L.M. 1292 (August 1, 1975).

96Ammoun in Namibia, supra note 64 at 62-63.

97ICJ Western Sahara 23-25 (1975).
Earlier this year, the International Court of Justice declined to decide a case concerning the East Timorese brought by Portugal against Australia, because Indonesia's rights and obligations were at issue but it had not consented to jurisdiction. The Court nonetheless emphasized:

"In the Court's view, Portugal's assertion that the right of peoples to self-determination, as it evolved from the Charter and from United Nations practice, has an *erga omnes* character, is irreproachable. The principle of self-determination of peoples has been recognized by the United Nations Charter and in the jurisprudence of the Court; it is one of the essential principles of contemporary international law."  

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c) Right of Peoples to Self-Determination as Part of International Law

This section reasons that the right of peoples to self-determination is a recognized part of international law. It may be helpful to present first an historical roadmap which recalls some of the milestones which have already been discussed (see Figure 13).

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98 Id. at 25.

99 1995/19 Communique: International Court of Justice 3 (June 30, 1995).
Table 13: Milestones in the Modern History of Self-Determination

<table>
<thead>
<tr>
<th>Year</th>
<th>Event Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1918</td>
<td>Woodrow Wilson's Fourteen Points Speech. After the carnage of World War I, placed self-determination on international agenda.</td>
</tr>
<tr>
<td>1941</td>
<td>Atlantic Charter. In reaction to aggression by Axis powers, identified principles of Allied war effort.</td>
</tr>
<tr>
<td>1960</td>
<td>UN General Assembly Resolution 1514. In reaction to European colonization, the &quot;Magna Carta&quot; of decolonization.</td>
</tr>
<tr>
<td>1970</td>
<td>UN General Assembly Resolution 2625. In the context of decolonization, more comprehensive formulation of self-determination.</td>
</tr>
<tr>
<td>1975</td>
<td>ICJ Western Sahara case. In dispute over status of Western Sahara, self-determination strongly reaffirmed by International Court of Justice.</td>
</tr>
<tr>
<td>1980/1981</td>
<td>UN Special Rapporteur Reports. In reaction to ongoing violations, analyses in support of self-determination as part of international law.</td>
</tr>
</tbody>
</table>

To determine whether a principle is part of international law, reference is made to the Statute of the International Court of Justice, of which "Article 38 is generally regarded as a complete statement of the sources of international law."\(^{100}\)

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\(^{100}\) Brownlie, supra note 86 at 3.

83
Statute of the International Court of Justice

Article 38

1. The Court, whose function is to decide in accordance with international law such disputes as are submitted to it, shall apply:
   a. international conventions, whether general or particular, establishing rules expressly recognized by the contesting states;
   b. international custom, as evidence of a general practice accepted as law;
   c. the general principles of law recognized by civilized nations;
   d. subject to the provisions of Article 59, judicial decisions and the teachings of the most highly qualified publicists of the various nations, as subsidiary means for the determination of rules of law.

2. This provision shall not prejudice the power of the Court to decide a case ex aequo et bono, if the parties agree thereto.\textsuperscript{101}

While a single such source can suffice to articulate a norm of international law, in the following sections it will be shown that each of the sources of international law enumerated in the Statute of the International Court of Justice contributes to the status of self-determination as a binding norm of international law.

i) International Conventions

The first source of international law categorized by the statute of the International Court of Justice is international conventions or treaties. A series of binding conventions explicitly incorporates the right of peoples to self-determination. As has been seen, the right of peoples to self-determination is "enshrined" in the United Nations Charter.\textsuperscript{102} Indeed, self-determination has been "authoritatively" interpreted as one of the "obligations stemming from the Charter".\textsuperscript{103} Since the United Nations Charter has the nature of a treaty (see below), the obligation of self-determination is therefore binding on all parties, including virtually all states:

\textsuperscript{101} Statute of the International Court of Justice, Article 38, 59 Stat. 1055, T.S. No. 993, 3 Bevans 1179 (June 26, 1945) (emphasis added).

\textsuperscript{102} See text above at footnote 78.

\textsuperscript{103} See text above at footnote 86.
Vienna Convention on the Law of Treaties

Article 26. Pacta Sunt Servanda

Every treaty in force is binding upon the parties to it and must be performed by them in good faith.\textsuperscript{104}

UN Special Rapporteur Cristescu emphasized the dynamic significance and binding nature of self-determination in the United Nations Charter as follows:

"Thus the incorporation of the principle of equal rights and self-determination of peoples in the Charter of the United Nations ... marks not only the legal recognition of the principle (as a constituent part of the Charter, which is a multilateral international treaty, and is a principle of international law), but also the point of departure of a new process - the increasing[ly] dynamic development of the principle and its legal context, its implementation, and its application to the most varied situations of international life."\textsuperscript{105}

Even before the United Nations Charter, the Atlantic Charter gave rise to the Declaration by United Nations which was in the form of a treaty, and "constitutes conventional law between the parties,"\textsuperscript{106} which comprised at that time "the preponderant majority of the world's essentially independent states".\textsuperscript{107}

In addition, the two International Covenants on Human Rights are both highly significant treaties which explicitly require that parties "shall promote the realization of the right of self-determination, and shall respect that right ... [emphasis added]."\textsuperscript{108}


\textsuperscript{105} Cristescu, supra note 80 at 18.

\textsuperscript{106} Laing, supra note 74 at 306.

\textsuperscript{107} Id. at 254.

\textsuperscript{108} See text above at footnote 88.
ii) Customary International Law

Customary international law is the second source of international law identified by the Statute of the International Court of Justice. It arises from state practice of sufficient duration, uniformity and generality, which is viewed as legally binding.\textsuperscript{109} Our discussion of customary international law will be divided into three parts: evidence concerning state practice as adduced by: 1) international conventions and 2) United Nations Resolutions, in addition to 3) actual state practice itself.

\textbf{International Conventions and Customary International Law}

While the international conventions outlined in the previous section represent per se treaty obligations upon states to advance peoples' right of self-determination, they can also be expressive of a customary norm of international law:

"Treaties are as such binding upon the states which are parties to the treaty. But it is undisputed that provisions contained in a treaty can be the expression of a customary norm. In this case, customary law and treaty law contain identical norms."\textsuperscript{110}

The classic jurisprudence espousing this connection involved the \textit{North Sea Continental Shelf Cases}, in which Denmark claimed that Germany was bound by the equidistance principle of the Geneva Convention of 1958, as customary international law, even without having ratified the convention.\textsuperscript{111} While the Court found, in that instance, that the Geneva Convention of 1958 did not express a norm of customary international law, it expressly stated that such a process was "perfectly possible":

"[The issue is whether Article 6 of the Geneva Convention of 1958], while

\begin{flushleft}
\textsuperscript{109} Brownlie, supra note 86 at 4-8.
\textsuperscript{111} North Sea Continental Shelf Cases, ICJ Reports 8-10, 25 (1969).
\end{flushleft}
only conventional or contractual in its origin, has since passed into the general corpus of international law, and is now accepted as such by the opinio juris, so as to have become binding even for countries which have never, and do not, become parties to the Convention. There is no doubt that this process is a perfectly possible one and does from time to time occur: it constitutes indeed one of the recognized methods by which new rules of customary international law may be formed. At the same time this result is not lightly to be regarded as having been attained.\textsuperscript{112}

The Court went on to identify the issues underlying such a process. First, the relevant provision must have the character of a possible norm of customary international law.\textsuperscript{112} Self-determination clearly has the character of a possible norm, with a sole reservation as to residual ambiguity (discussed below at pp.110ff.). The next issue is the generality of participation in the convention, about which the Court observed:

"[E]ven without the passage of any considerable period of time, a very widespread and representative participation in the convention might suffice of itself, provided it included that of states whose interests were specially affected."\textsuperscript{114}

In this regard, participation in the conventions embodying self-determination, e.g. the United Nations Charter and the International Covenants on Human Rights, is effectively universal. Finally, the Court noted with seeming approval that over ten years had passed since the Geneva Convention of 1958 was signed, but deemed as insufficient the passage of a mere year between its coming into force and the breakdown of negotiations between Germany and Denmark, or the passage of only five years between its coming into force and the date of the judgment.\textsuperscript{115} In contrast, the United Nations Charter which enshrines the principle of self-determination celebrated its half-century mark last year, and even the International Covenants on Human Rights have been in force for three decades. Therefore, self-determination seems to readily meet the standards by which conventions can be deemed expressive of customary

\textsuperscript{112}Id. at 41.

\textsuperscript{113}Id. at 41-42.

\textsuperscript{114}Id. at 42.

\textsuperscript{115}Id. at 43.
international law, as articulated in the judgment of the International Court of Justice. Indeed, even less stringent standards were espoused in an influential dissenting opinion by Manfred Lachs, who would have found even the Geneva Convention of 1958 expressive of custom, in accordance with the principle that:

"It is generally recognized that provisions of international instruments may acquire the status of general rules of international law."\(^{116}\)

In sum, the international conventions on self-determination would seem also to be expressive of a norm of customary international law.

**United Nations Resolutions and Customary International Law**

While non-treaty resolutions of the United Nations General Assembly are not per se binding on member states, according to Brownlie the "Magna Carta" of self-determination is an example of a resolution which does represent customary international law:

"[United Nations Resolutions can] provide a basis for the progressive development of the law and the speedy consolidation of customary rules. [One e]xample of [an] important 'law-making' resolution... [is] the Declaration on the Granting of Independence to Colonial Countries and Peoples [Resolution 1514 on self-determination, adopted by 89 votes to none; 9 abstentions]."\(^{117}\)

Another example of a General Assembly Resolution of such "unusual significance" is Resolution 2625 which set out a more comprehensive formulation of self-determination, and "may be considered to state existing international law."\(^{118}\)

UN Special Rapporteur Cristescu also addressed the specific issue of United Nations General

\(^{116}\)Manfred Lachs, id. at 225. Lachs went on to emphasize that acceptance of the convention need not be universal, and that "too much importance need not be attached to" a "few uncertainties or contradictions, real and apparent", quoting from the earlier *Fisheries Case*, ICJ Reports 138 (1951).

\(^{117}\)Brownlie, supra note 86 at 14.

Assembly Resolutions as sources of international law, by quoting from a memorandum by the Office of Legal Affairs of the United Nations Secretariat dated April 2, 1972:

"[I] knew of the greater solemnity and significance of a 'declaration' it may be considered to impart, on behalf of the organ adopting it, a strong expectation that Members of the international community will abide by it. Consequently, in so far as the expectation is gradually justified by State practice, a declaration may by custom become recognized as laying down rules binding upon States."

Cristescu also pointed out that both UN Resolutions 1514 (see above at pp. 78ff) and 2625 (see above at pp. 79ff) are in the nature of such solemn "declarations". He proceeded to conclude that these Resolutions on self-determination reflect binding international law:

"The legal nature of General Assembly Resolutions has been debated at length... But what is beyond challenge is the fact that by a process such as that described in the memorandum by the Office of Legal Affairs mentioned in paragraph 148 above [i.e., the adoption of a 'declaration'], resolutions may be considered to lay down rules which are binding upon states. They become part of customary law in general, that is to say, of the whole body of rules and principles established by general usage and recognized as having the force of law. This clearly applies to the resolutions and declarations of the United Nations concerning self-determination [emphasis added]."

According to Charney: "In theory, ... one clearly phrased and strongly endorsed declaration at a near-universal diplomatic forum could be sufficient to establish new international law." In this context, recall for example the effectively universal adoption of the United Nations Charter in 1945 which includes as one of its purposes the right of peoples to self-determination, or the adoption of UN Resolution 1514 as the "Magna Carta" of self-

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119 Cristescu, supra note 80 at 23.
120 Id.
121 Id.
123 See supra p. 76.
determination without a single vote in opposition. Charney characterizes judicial analysis as follows:

"[T]he International Court of Justice either declares rules to be law without providing proof or relies upon evidence from resolutions of international organizations and multilateral treaties."  

This analytical methodology described by Charney is exactly what the International Court of Justice employed in the Namibia case to find that self-determination had achieved the status of customary international law:

"[T]he 'general practice' of States [pertaining to customary international law] ... has, in the case of the right of peoples to self-determination, become so widespread as to be not merely 'general' but universal, since it has been enshrined in the Charter of the United Nations ... and confirmed by ... pacts, declarations and resolutions which ... epitomize the unanimity of States in favour of the imperative right of peoples to self-determination. There is not one State, it should be emphasized, which has not, at least once, appended its signature to one or other of these texts, or which has not supported it by its vote..."

We have seen that a veritable plethora of international texts, including the United Nations Charter, the Declaration of the United Nations growing from the Atlantic Charter, the International Covenants on Human Rights, and United Nations General Assembly Resolutions 1514 and 2625, show that the right of peoples to self-determination has achieved the status of customary international law. These solemn international instruments are capable of achieving moral and legal force, even if some governments might have signed or ratified as mere political gestures. In the words of United Nations Special Rapporteur Cristescu:

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124 See supra p. 88.

125 Supra note 122 at 529, 537.

126 See text above at footnote 96.

127 Supra footnote 83.

128 According to one distinguished publicist, the Nuclear Test Cases which the International Court of Justice dismissed as moot when France issued a press statement that it had ceased atmospheric testing, "may stand for the proposition that there are circumstances
"Having now been affirmed by international law and entrenched by international practice, the principle of equal rights and self-determination of peoples underlies the idea of co-operation and the very existence of friendly relations among states."\textsuperscript{129}

"The resolutions adopted by the General Assembly and the Security Council, and the decisions of the International Court of Justice, have helped make self-determination a rule of international customary law."\textsuperscript{130}

In sum, the International Court of Justice and UN Special Rapporteur Cristescu conclude that the United Nations instruments catalogued above are evidence that self-determination is definitely a binding norm of customary international law. However, it is possible to question whether actual state practice is inconsistent with a right of peoples to self-determination, and this issue will be addressed next.

\textbf{State Practice and Customary International Law}

State practice can itself be analyzed to determine whether self-determination has attained the status of a rule of customary international law. For pedagogic purposes, let us first articulate the case that actual state practice has vitiated any prospect of self-determination establishing itself as a norm of international law. Ever since the Peace of Westphalia in 1648, which is

\begin{quote}
in which government declarations can be binding - a prospect pregnant with possibilities." Sir Geoffrey Palmer, "The Implications of Climate Change for International Law and Institutions", 2 \textit{Transnational Law and Contemporary Problems} 205, 215 (1992). See also Robert Sherwood, "Roosevelt and Hopkins - An Intimate History" 362-63 (1964), as quoted in Laing, supra note 74 at 287:

"The Atlantic Charter ... turned out to be incalculably more powerful an instrument than the ... British Government intended it to be when they first proposed it ... [Its] effect was cosmic and historic. The British learned that when you state a moral principle, you are stuck with it, no matter how many fingers you may have crossed at the moment ...".

Note also that the doctrine of estoppel in international law is able to hold states to their expressions. Brownlie, supra note 86 at 161-62, 640-42.
\end{quote}

\textsuperscript{129} Cristescu, supra note 80 at 23.

\textsuperscript{130} Id.
commonly taken to mark the birth of the modern nation-state system,\(^{131}\) history is replete with the use of force by states in violation of the principle of self-determination. Examples include European colonization of the Western Hemisphere and Africa, and the "Manifest Destiny" of the United States at the expense of native American Indians.

With respect to the twentieth century, we have the unfortunate choice as to whether to characterize the violations of self-determination by mind-numbing statistics, or by a mind-numbing specific case, and will in fact illustrate the situation with both. Individuals killed in war, genocide, politicide and mass murder by states between 1900 and 1987 number about 180 million souls, representing "the equivalent of a nuclear war".\(^{132}\)

In the specific case of East Timor, a violation of self-determination which has been characterized as a genocide of historic relative proportions is being carried out even today:

"[East Timor was] a tiny, poor country which had won its independence when the Portuguese empire collapsed and began to carry out mild social reforms and national development. It was subjected at once to a very brutal Indonesian attack supported and armed by the U.S. About one-quarter of the population was murdered and most of the rest have been put in resettlement camps, where they can be controlled."\(^{133}\)

Or, in the evocative words of the Portuguese author of a particularly profound analysis of self-determination:

"[T]his study [on self-determination] is due to the unforgettable feeling aroused in me by the sense of abandonment, of silent conformation and of terror of the outside world that was reflected in the eyes of the first refugees that arrived in Portugal, already several years ago. That feeling never ceased to accompany me and was later joined by a need to do something, no matter how inadequate, to respond to a people's desperate plea to the world to put an end to a situation of genocide and of terror." . . .


\(^{132}\)Rummel, infra at notes 240-242.

"I hope that this work is at least useful in making a little better known the suffering of the East Timorese people, victims of their beautiful dreams and their hopeless weakness. Like them, so many others have not understood the egotistical disregard of the world and have added to their suffering the disillusion of discovering the hypocrisy of state and institutional rhetoric. They found themselves forgotten and completely alone: and indifference is the worst answer that can be given to whomever is suffering.

The eyes of those East Timorese refugees were too expressive to be ever forgotten. They expressed terror and sadness. Our international legal system is at fault for that. It is about time to replace such feelings with those of self-respect and confidence in the greatness of our dreams." . . .

"This analysis began with the armed struggle, the executions and the famine in East Timor, only to end up with General Assembly [R]esolution 37/30 which merely glorified a few UN organs and the word self-determination. The distance between these two points was travelled in incremental steps, the total effect of which is hard to justify." 134

With this history of deeply human tragedy as a backdrop, whether viewed through statistics or case study, perhaps our pedagogic case about violating state practice, that it vitiates any custom of self-determination, can be most appropriately summed up in the words of Goethe, one of the most serious authors in any language:

"It may not be the custom, but it's what's commonly done." 135

However, it is just as appropriate to offset the words of Goethe with those of Lao Tsu, one of the most profound philosophers of any historical epoch or culture:

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135 In the original German, "Brauch oder nicht, es gibt sich auch". Johann Wolfgang von Goethe, "Faust", at page 284 of this classic tragedy in the edition translated by Walter Kaufmann (1961), where Mephistopheles, pandering for Faust in exchange for his soul, assures Margaret that while "waiting to be wed" may be the customary norm, "having a lover" is the common conduct.
"All can know good as good only because there is evil."  

In other words, if it were not for violations of a norm, the very existence of the norm would never occur to us.

Pursuing this logic further, clearly nobody would argue that a large number of murders is evidence that there is no domestic law against murder. Suppose Goethe were to retort that international law is derivative of actual state conduct, and so distinguished from domestic law which is typically legislated on the basis of constitutional authority? This retort can be dispatched in two ways. First, customary international law resulting from state practice is not the sole source of international law. As examples, international convention and general principles of international law constitute independent sources of the international law of self-determination (as seen in the previous and following sections, respectively). Second, violations by states can indeed be consistent with the existence of a customary norm of international law. For example, there is no credibility to the argument that a pattern of violations by states of human rights implies that there is no customary international law of human rights. In the words of Louis Henkin, speaking about international law in general but with poignant relevance to self-determination in particular:

"Nor is law destroyed by the fact that it is sometimes violated, even by the fact that it is sometimes hypocritically invoked by the violators."

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136 Lao Tsu, "Tao Te Ching" (ca. 500 BC), stanza two in the translation by Gia Fu Feng.


138 There are writers who regard the high incidence of non-compliance with human rights norms as evidence of state practice that argues against the existence of a structure of human rights principles in international law. Although sight must not be lost of violations of human rights laws, such an approach is not only academically incorrect but also profoundly negative." M. N. Shaw, "International Law" 187-88 (3d ed. 1991).

139 Henkin goes on to point out that "We do not reject scripture merely because the devil may cite it." Henkin, "How Nations Behave" 338 (2d ed. 1979).
This reasoning that a norm of international law can exist despite state conduct which violates it is reinforced by an appeal to the principle of natural law. One of the reasons for our confidence that human rights do indeed constitute international law is that they represent a paradigmatic example of natural law - torture is wrong, and would still violate a jus cogens norm of customary international law even if states attempted to legitimize it by formal convention. As another example, "crimes against humanity" became part of customary international law at Nuremberg with unprecedented rapidity, despite or perhaps even because of the enormity of the immediately preceding contrary state practice. Likewise, no amount of legalistic posturing as a persistent objector by the Republic of South Africa could shake the conviction of the world community that apartheid was wrong - and violated international law. By the same token, at least some violations of self-determination violate natural law and are wrong, and so violate international law despite examples of contrary state practice.

Nor is it necessary to concede that even prominent violations of self-determination imply the absence of general state conduct which is consistent with the norm. As Franck points out: "Disobedience [of international law] is thought - albeit wrongly - to be the prevalent practice . . ." In other words, all the headlines which aren't made about additional violations of the norms of international law truly matter.

In the case of self-determination, it is appropriate to focus first on state conduct during and immediately after World War II. The egregious violations of self-determination in World

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140 Parker, infra note 272 at 437-39.

141 See, e.g., UN Special Rapporteur Espiell, supra note 78 at 13. But see, e.g., Cristescu, supra note 80 at 24.


143 While the date of emergence of the norm of self-determination is subject to "considerable uncertainty", publicists have generally chosen from the Atlantic Charter in 1941 (Laing), the United Nations Charter in 1945 (Quincy Wright, Magarasevic), Resolution 1514 in 1960 (Sahovic) or subsequent state conduct. See Laing, supra note 74 at 216-31.
War II induced countervailing state conduct and, ultimately, the United Nations Charter "enshrining" the right of peoples to self-determination. In a particularly strong scholarly analysis of state conduct during World War II, Laing points out that states fought for, at the price of millions of lives, the principle of self-determination underlying the Atlantic Charter.\footnote{Laing, supra note 74 at 286-87. But see Erich Hula, "National Self-Determination Reconsidered", 10(1) Social Research 1, 1-2 (1943), for a contemporaneous argument against imputing to the Atlantic Charter the premise of self-determination. Hula relies primarily on the absence from the Atlantic Charter of the term "self-determination". However, Hula's restrictive reading does not seem to be a fair interpretation of the text of the Atlantic Charter. (See text above at p. 75).} After a review of Britain and especially United States conduct during and immediately after the war, including an analysis of previously classified military and diplomatic messages, Laing concludes:

"The evidence seems very compelling that the [Atlantic] Charter itself, and the various actions of the United States during 1941-1945 relating to self-determination under the Atlantic Charter, constitute substantial instances of state practice consistent with the existence of a binding norm of customary international law."\footnote{Laing, supra note 74 at 303.}

After the end of World War II, the principles contained in the Atlantic Charter implicitly relating to self-determination morphed into the United Nations Charter in explicit form, with the support of a broad range of states at the San Francisco conference in 1945. First, Australia proposed international oversight of the administration of dependent peoples with the strong support of China and the Soviet Union, and met with success.\footnote{G.S. Windass, "Power Politics and Ideals: The Principle of Self-Determination", 3 International Relations 183 (April 1967).} Then the first Soviet initiative was to include self-determination as a fundamental purpose of the United Nations Charter.\footnote{Id. at 184.} This proposed amendment was in turn jointly sponsored by the Soviet Union,
China, the United Kingdom and the United States.\textsuperscript{148} The proposal was unanimously accepted by the responsible drafting committee.\textsuperscript{149} This process amounted to a "massive assertion of the right of self-determination by the third world, and by the competition between the two great powers for leadership of this new force."\textsuperscript{150}

It is also useful to directly analyze state practice for a selection of states. The former Soviet Union was infamous for its invasions of Hungary, Czechoslovakia and Afghanistan, and its domination of its satellite countries. On the other hand, a significant theme in Soviet doctrine and practice was support of the principle of self-determination. The first constitutional act of the Soviet Union in 1917 affirmed the principle of self-determination, which was subsequently written into the 1923 and 1936 constitutions.\textsuperscript{151} Self-determination was also invoked in Soviet treaty practice, for example the Soviet-Finland Treaty of 1918 (resolving the dispute over the province of Pechanga by means of a plebiscite) and the Turko-Soviet Treaty of 1921.\textsuperscript{152} The Soviet Union consistently demanded complete independence for colonial peoples, and its proposal in 1960 for immediate independence was rejected in favor of the milder version of the "Magna Carta" of decolonization - UN Resolution 1514.\textsuperscript{153} Indeed, according to Soviet doctrine, their tangible support of the armed struggle of colonial peoples against "imperialists" was an affirmative duty.\textsuperscript{154}


\textsuperscript{149}Sureda, supra note 82 at 97.

\textsuperscript{150}Windass, supra note 146 at 184.


\textsuperscript{152}Id. at 139.

\textsuperscript{153}Id.

\textsuperscript{154}Id.
The United States adopted a bifurcated doctrine with respect to colonial peoples subject to other states. On the one hand, recalling its own prototypical Declaration of Independence, it supported self-determination in the form of self-government:

"We surely cannot deny to any nation that right whereon our own is founded - that everyone may govern itself according to whatever form it pleases and change these forms at its own will."155

On the other hand, the United States also supported self-determination in the form of graduated trusteeship, with self-government appropriate for those "who, by their acts, show themselves worthy of it and ready for it".156 Nevertheless, with respect to its own jurisdiction, the United States "has always recognized the right of its colonial peoples to choose freely among many modes of self-determination, including independence. Thus, U.S. colonial territories became self-governing by merger with the United States (Hawaii and Alaska), by association (Puerto Rico) and by full independence (the Philippines)."157 Not surprisingly, the United States attempted to apply self-determination to satellite countries of the Soviet Union, but without success:

"[T]he tide of self-determination has not reached the Communist Empire, where a population far larger than the officially 'dependent' lives under governments installed by foreign troops instead of free institutions."158

Of course, with the demise of the Soviet Empire in the 1990s, the "tide of self-determination" has now reached the former Soviet satellites and even former Soviet republics.

The colonial policy of Great Britain was a constitutional progression toward self-government: crown colony, representative government, responsible government, dominion state - ever since


156 Secretary of State Cordell Hull, quoted in Leland M. Goodrich, Marie J. Carroll (eds.) 5 Documents in American Foreign Relations 6 (1942-43 edition), as cited in id.

157 Id. at 135.

158 President John F. Kennedy, in a speech to the UN General Assembly, as quoted in U.S. Department of State Bulletin 632 (October 16, 1961), as cited in id.

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American independence.\textsuperscript{159} Canada, Australia and South Africa passed through this sequence\textsuperscript{160} and consequently achieved independent sovereignty as well. In the ethnically chauvinistic words of the British Secretary of State for the Colonies in 1938:

"It may take generations, or even centuries, for the peoples in some parts of the Colonial Empire to achieve self-government. But it is a major part of our policy, even among the most backward peoples of Africa, to teach them and to encourage them always to be able to stand a little more on their own feet."\textsuperscript{161}

This progression at times involved disagreement over "the speed with which devolution of power should take place, and in some cases, such as Kenya . . . bloody confrontation".\textsuperscript{162}

However, the constitutional sequence was understood by Great Britain to lead to self-determination, for example quoting British policy toward Sudan:

"Her Majesty's Government is glad to know that the Sudan has for some time been and is now moving rapidly in the direction of self-government. In their view this progress can and should continue on the lines already laid down. Her Majesty's Government will, therefore, give the Governor-General their full support for steps he has taken to bring the Sudanese rapidly to the stage of self-government as a prelude to Self-Determination."\textsuperscript{163}

After analyzing British practice relative to self-determination, Ofuatey-Kodjoe concludes:

"Therefore, the principle of self-determination, defined as the right of colonial peoples to self-government, is one that has legal standing in British constitutional law as well as the constitutional law of the ex-colonies. Consequently, it is evidential of British practice relating to international law."\textsuperscript{164}

\textsuperscript{159} Id. at 130.

\textsuperscript{160} Id.

\textsuperscript{161} Malcolm Macdonald, 32 Hansard 5th Series 1246 (1938), as cited in id. at 130.

\textsuperscript{162} Id. at 131.

\textsuperscript{163} Anthony Eden, speaking in the British House of Commons on November 15, 1941, quoted in Kenneth Robinson, "World Opinion and Colonial Status", 8 I.O. 468 (1954) [emphasis in original], as cited in id. at 131.

\textsuperscript{164} Id.
Turning to other colonial powers, French policy began with the idea of civilizing colonial subjects "by virtue of its superior culture", leading to self-government within the French empire. However, by 1958 France "recognized the right of colonial peoples to choose total independence as their right of self-determination", even though in practice it tended to discourage such independence. Spain had claimed its colonies were part of a "unitary Spanish state" in 1945. However, according to Ofuatey-Kodjo:

"By 1961, Spain had accepted the U.N. General Assembly's designation of its possessions as non-self-governing territories, and declared its intention to abide by the principle as defined by the United Nations. As a result, Equatorial Guinea became independent in 1968." Belgium agreed to the Congo becoming a non-self-governing territory subject to the trusteeship principle in 1946, while still clinging to a vision of remaining integrally linked. Nevertheless, by 1960 Belgium had granted to the Congo its independence. Early in the twentieth century, the Netherlands "affirmed the principle of developing native societies in the East Indies toward self-government" under the rubric of the "Ethical Policy".

According to Ofuatey-Kodjo, the state practice outlined above is significant "in providing evidence of the ripening of the principle [of self-determination] into an international legal right." Ofuatey-Kodjo goes on to summarize the maturation of self-determination into a norm of international law as follows:

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165 Id. at 131-32.
166 Id. at 132-33.
167 Id. at 133.
168 Id.
169 Id. at 133-34.
170 Id. at 134.
171 Id. at 133.
172 Id. at 146.
"Before World War II, it was written into many treaties, and although legally effective, it was not generally recognized as a right under international law. In the immediate aftermath of the war the principle was applied by the colonial powers with varying degrees of conscientiousness. However, it was applied as a policy, emanating from the enlightenment of the colonial powers, not as a duty created by a corresponding right of the subject peoples. During the era of decolonization the principle matured into a right. The charter and practice of the United Nations, and general international practice provided the opinio juris sive necessitatis which developed self-determination into a principle of international law."\textsuperscript{173}

It should also be emphasized that "the massive assertion of the right of self-determination by the third world" has played an important role in its maturation into a norm of international law.\textsuperscript{174} Finally, as Charney points out:

"[W]hen authorities examine the evidence necessary to establish customary law, they consider actions of a limited number of states, often only the largest, most prominent, or most interested among them."\textsuperscript{175}

Therefore, while this analysis focuses on a limited number of states, it includes the superpowers and the dominant colonial powers, in the spirit of Charney's prescription.

\textbf{iii) General Principles}

The "general principles of law" referred to by the Statute of the International Court of Justice is not a precisely defined category of a source of international law.\textsuperscript{176} But at least one member of the drafting committee for the Statute, the Belgian jurist Baron Descamps, "had natural law concepts in mind".\textsuperscript{177} This would seem to apply to self-determination, which

\textsuperscript{173}Id.

\textsuperscript{174}Windass, supra note 146 at 184.

\textsuperscript{175}Charney, supra note 122 at 537.

\textsuperscript{176}Brownlie, supra note 86 at 15-19.

\textsuperscript{177}Id. at 15.
fundamentally underpins human rights.\textsuperscript{178}

Self-determination was specifically characterized as a general rule of international law by UN Special Rapporteur Cristescu:

"As a fundamental principle of international law or - to use an expression frequently employed in judicial decisions - one of the 'well-known and well-established principles' of international law, the principle of equal rights and self-determination of peoples is one of the most important general rules of international law, whose binding nature stems from the fact that it is unanimously accepted and that it expresses some fundamental requirements for the life of the international community. As a principle, equal rights and self-determination of peoples is an important component of the nucleus of international law [emphasis added]."\textsuperscript{179}

In addition, according to Manfred Lachs, who was later to become President of the International Court of Justice, the United Nations Charter provisions on self-determination expressed "in writing a principle which had long been growing and maturing in international society until it gained general recognition" and which was "one of the [existing] elements of international law", which "derive[d] its legal force from a general principle of law ... "\textsuperscript{180}

Judge Cassese has stated this general principle of self-determination particularly clearly:

"[The general principle of international law of self-determination] sets out a general and fundamental standard behavior of behavior: governments must not decide the life and future of peoples at their discretion. Peoples must be enabled freely to express their wishes in matters concerning their condition."\textsuperscript{181}

\textsuperscript{178}See text above at footnotes 89, 90.

\textsuperscript{179}Cristescu, supra note 80 at 22.

\textsuperscript{180}Manfred Lachs, "The Law in and of the United Nations", 1 Indiana Journal of International Law 429, 432 (1960-61), as quoted in Laing, supra note 74 at 218.

\textsuperscript{181}Antonio Cassese, "Self-Determination of Peoples: A Legal Reappraisal" 128 (1995). It should be noted that Judge Cassese's views are entitled to the deference accorded a particularly qualified publicist, as the President of the International Criminal Tribunal for the Former Yugoslavia and as former Chairman of the Council of Europe Committee for the Prevention of Torture.
iv) Judicial Decisions and Publicists

According to the Statute of the International Court of Justice, "judicial decisions and the teachings of the most highly qualified publicists constitute a "subsidiary means for the determination of rules of law". As has been seen, the International Court of Justice has on two occasions strongly affirmed the existence of the right of peoples to self-determination: the Namibia case in 1971 and the Western Sahara case in 1975.

The record of publicists on the subject of the existence of a right to self-determination is long and mixed. However, today, as we shall see: "There is an apparent doctrinal consensus [i.e., agreement among publicists] that the right of self-determination of people and nations is recognized by international law."  

Before presenting a chronological review of publicists' views, it will be useful to present first the conclusions of two Special Rapporteurs, commissioned by the United Nations to prepare official studies on self-determination, as among "the most highly qualified publicists". Each

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182 Supra at notes 100, 101.

183 See supra, page 81.

184 Laing, supra note 74 at 209, who includes a superb doctrinal survey of publicists spanning the 1941-1991 half-century at pages 216-31 which will be referred to below.

185 See notes 78 and 80, supra. These UN Special Rapporteur studies can be viewed as quasi-authoritative:

"The Special Rapporteur wishes to state that this work has been carried out strictly within the framework of the Resolutions which led to the preparation of the present study. In other words, although it freely expresses the views of the author, who alone is responsible for the contents, it is nonetheless a study prepared by the United Nations, with all that that implies as regards the theoretical and practical aspects, as well as the form of the study."

UN Special Rapporteur Espliell, supra note 78 at ix.

This is particularly true where the views of the Special Rapporteur have been repeatedly endorsed by an apparently opposition-free consensus on the part of the United Nations Commission and Sub-Commission responsible for the study. See id. at 2-3.

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of the two UN Special Rapporteur Reports strongly endorses the right of peoples to self-
determination as a part of international law. According to UN Special Rapporteur Espiell:

"Self-determination of peoples and their right to be rid of colonial and alien
domination is today a fundamental principle which all States are bound to
accept under existing international law. Every possible conclusion, both logical
and natural, which flows from that fact must be applied in solving the various
problems of contemporary international law."\(^{187}\)

Likewise, according to UN Special Rapporteur Cristescu:

"The idea of equal rights and the self-determination of peoples, which is now
one of the most important and dynamic concepts in international life, exercises
a very strong influence on both the political and legal planes and also on the
economic, social and cultural planes and is gaining increasingly wider
acceptance, with the result that it has been embodied in international law.

Highly authoritative evidence of this fact has recently been given by the United
Nations General Assembly and the international Court of Justice."

"In the process of affirming the principle of equal rights and self-determination
of peoples as a constituent part of contemporary international law, the
fundamental legal instrument which marks a turning-point is the Charter of the
United Nations ..."

It is clear that the relevant provisions of the Charter have been interpreted in an
increasingly progressive spirit over the years. Today it is generally recognized
that the concept of self-determination entails international legal rights and
obligations and that a right of self-determination definitely exists.\(^{188}\)

Turning next to a chronological review of publicists' views, we will find that they have
evolved over the century to a consensus that self-determination is a right under international
law. We have seen that Woodrow Wilson viewed self-determination as a central precept of

\(^{186}\) Supra, notes 78 and 80, generally.

\(^{187}\) Supra note 78 at 65.

\(^{188}\) Supra note 80 at 17-18.
international relations.  On the other hand, Robert Lansing, his emissary to the Versailles Peace Conference, vigorously opposed the concept. Lansing has frequently been quoted as articulating a passionate case against self-determination:

"The phrase is simply loaded with dynamite. It will raise hopes which can never be realized. It will, I fear, cost thousands of lives. In the end it is bound to be discredited, to be called the dream of an idealist who failed to realize the danger until too late to check those who attempt to put the principle in force. What a calamity that the phrase was ever uttered! What misery it will cause!"

Lansing went on to characterize with a substantial degree of credibility the great power accommodations of territory at Versailles as only nominally deferential to self-determination. However, contextualizing this perspective by means of a fuller recital of Lansing's views shows an attitude of ethnic chauvinism at complete variance with modern standards:

"The more I think about [Wilson's] declaration as to the right of 'self-determination', the more convinced I am of the danger of putting such ideas into the minds of certain races... What effect will it have on the Irish, the Indians, the Egyptians, and the nationalists among the Boers? Will it not breed discontent, disorder, and rebellion? Will not the Mohammedans of Syria and Palestine and possibly of Morocco and Tripoli rely on it? How can it be harmonized with Zionism, to which [Wilson] is practically committed?"

"The future of Canada, with its vast undeveloped resources, its very life as a British colony, depended upon denying the right of 'self-determination'."

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189 See generally, "War Addresses of Woodrow Wilson" (1918), "The Public Papers of Woodrow Wilson" (1972). Note Wilson's stature, not just as President of the United States, but also as a potential "publicist" of international law, due to his Professorship of Politics at Princeton.

190 J.H.W. Verzijl, 1 International Law in the Historical Perspective 321 (1968), quoting Robert Lansing's diary of the peace negotiations.

191 Robert Lansing, "The Peace Negotiations: A Personal Narrative" 97-98 (1921), quoting from his own contemporaneous notes of the negotiations.

192 Id. at 98-100.

193 Id. at 97, 103.
In the 1950's, after the adoption of the United Nations Charter, publicists divided over whether self-determination constituted a right under international law.\textsuperscript{194} On the one hand, a series of publicists concluded that self-determination had not achieved the status of a legal norm. For example, Rivlin acknowledged the existence of international procedures for realization of self-determination, but denied that it was a legal concept.\textsuperscript{195} Eagleton characterized the inclusion of self-determination in the United Nations Charter as irrelevant, and the claims as to its legal status as fantastic and wild, similar to claims in other fields such as human rights. . .\textsuperscript{196} Starke, writing in 1958, emphasized the (then) mere draft status of the International Covenants on Human Rights and pointed out that the right to self-determination was denied by several important states, concluding that self-determination was not a binding legal norm.\textsuperscript{197} On the other hand, Quincy Wright \textsuperscript{198} and Magarsevic\textsuperscript{199} emphasized the significance of the United Nations Charter as a binding legal obligation, concluding that self-determination was already part of international law.

This view of self-determination as part of international law was affirmed in the 1960's by Manfred Lachs, who characterized it as a general principle of international law;\textsuperscript{200} Higgins, [194]See Laing, supra note 74 at 217-18.

\textsuperscript{195}Benjamin Rivlin, "Self-Determination and Colonial Areas", \textit{International Couns.} No. 501, 195 &199 (1955) (citing A. Quincy Wright, "Recognition and Self-Determination", \textit{American Society of International Law Proceedings} 23-27 (1954)). This and the following characterizations of publicists' views and cites to their works are from Laing, supra note 74 at 217-31.

\textsuperscript{196}Clyde Eagleton, "Excesses of Self-Determination", 31 \textit{Foreign Affairs} 592, 593 (1953).


\textsuperscript{198}Supra note 195.

\textsuperscript{199}Alexander Magarsevic, "A View on the Right of Self-Determination in International Law", \textit{Jugoslavenka Revista za Medunarodno Pravo} 27, 32 (1956).

\textsuperscript{200}Supra note 180.
relying on United Nations practice;\textsuperscript{201} and Pace, articulating the official view of the United States.\textsuperscript{202} A number of additional publicists expressed qualified or guarded views.\textsuperscript{203} However, several publicists continued to deny to self-determination the status of a binding norm of international law. Schwarzenberger claimed that it was "a formative principle of great potency but not part and parcel of international customary law".\textsuperscript{204} Verzijl wrote that self-determination was essentially political and was incapable of ever becoming "the subject of a genuine rule of international law vested with an enforceable universal validity."\textsuperscript{205} Sinha claimed that state practice in support of self-determination fell short of the standard of customary international law and that state signatures to UN Resolutions did not necessarily signify a belief that they were legally bound.\textsuperscript{206}

In the 1970s, the doctrinal debate reached its peak.\textsuperscript{207} Green restrictively interpreted the United Nations Charter, and claimed that state voting patterns on UN Resolutions should be given little significance and that self-determination was not part of customary international law, thereby concluding that self-determination was not a binding norm of international law.\textsuperscript{208} Mustafa argued that self-determination should not be included as a human right, since it was

\textsuperscript{201} Rosalyn Higgins, "The Development of International Law Through the Political Organs of the United Nations" 103-4 (1963).


\textsuperscript{203} See Laing, supra note 74 at 218-19.


\textsuperscript{205} Verzijl, supra note 190 at 324, 557.


\textsuperscript{207} Laing, supra note 74 at 225.

\textsuperscript{208} Leslie Green, "Self-Determination and Settlement of the Arab-Israeli Conflict", 65 American Society of International Law 40 (1971).
not listed in the Universal Declaration of Human Rights in 1948.\textsuperscript{209} Several publicists took intermediate positions, such as that of Devine who viewed a right to self-determination as "probably in nascendi".\textsuperscript{210} The affirmative side of the issue in the 1970's included: Bokor-Szego,\textsuperscript{211} and Williams and Mestral,\textsuperscript{212} relying on the entire set of United Nations activities; Sahovic, emphasizing the overwhelming support of Resolution of 1514,\textsuperscript{213} Bassiouni, inferring that recurring UN Resolutions on self-determination gave rise to a general principle of international law;\textsuperscript{214} Ofuatey-Kodjoe, analyzing the state practice of Great Britain, France, the Netherlands, Spain, Belgium, the United States, Portugal and South Africa to conclude that a litany of international conventions had "spilled over" into customary international law;\textsuperscript{215} in addition to Brownlie in a new edition of his classic textbook in international law, focusing on the conclusion of the International Court of Justice in the \textit{Western Sahara} case.\textsuperscript{216}

More recently, the two UN Special Rapporteur Reports and their strong support for the existence of a right of peoples to self-determination under international law have already been

\begin{footnotes}
\item[209] Zubeida Mustafa, "The Principle of Self-Determination in International Law", 5 \textit{The International Lawyer} 479-87 (1971).
\item[212] Sharon A. Williams, Armand L.D. de Mestral, "An Introduction to International Law", 48 (1979).
\item[215] Ofuatey-Kodjoe, supra note 151 at 178-79.
\item[216] Ian Brownlie, "Principles of Public International Law", 595 (3rd ed. 1979).
\end{footnotes}
Indeed, with the exception of isolated holdouts, a consensus among publicists on self-determination as part of international law has developed:

"In the closing years of the 1980s and the early 1990s the dust generally settles. Self-determination is generally accepted as a "principle" or as a "right" recognized in customary international law, by parties to specific agreements, and as U.N. law binding all members by virtue of the fact that it represents conventional law, particular custom or a hybrid of both."

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\footnote{217}{Supra at page 104.}

\footnote{218}{See, e.g., Michla Pomerance, "Self-Determination in Law and Practice: The New Doctrine in the United Nations" 9, 11-13, 73-76 (1982). While acknowledging self-determination as a "moral right or political desideratum", she denies its status as a "legal right" because of the complexities of what turn out to be inherently competing claims to self-determination. However, Pomerance goes on to argue for a "more realistic, flexible" ongoing "continuum of rights", which seems actually consistent with the nature of the right of peoples to self-determination as described in the following section [emphasis in original].}

\footnote{219}{Laing, supra note 74 at 230. See also, e.g., Karl Doehring, "Self-Determination", in Bruno Simma (ed.), \textit{The Charter of the United Nations} 56-58 (1994), where he states that whether self-determination is "entrenched in customary international law may remain open to question, although good arguments can be made to support this position". However, Doehring goes on to state unequivocally that "the right of self-determination is part of the law of the [United Nations] Charter and is thus binding on members of the UN." See also Thomas M. Franck, "Fairness in the International Legal and Institutional System: General Course on Public International Law", \textit{240 Recueil des Cours / Collected Courses of the Hague Academy of International Law 1993} 125-49 (1994); Eric Kolodner, "The Future of the Right to Self-Determination", \textit{10 Connecticut Journal of International Law} 153 (1994); and Hurst Hannum, "Autonomy, Sovereignty and Self-Determination" (1990).}
v) Relationship Between Existence and Nature of the Right of Peoples to Self-Determination

We have seen above that self-determination is definitely a binding norm, arising from each of the sources of international law identified in the Statute of the International Court of Justice: international conventions or treaties, customary international law, general principles of international law, judicial decisions, and teachings of the most highly qualified publicists of the various nations. One recurring issue is the relationship between this existence of a norm of self-determination and any ambiguity about its nature, i.e. who is entitled to what. For example, one author concludes that this ambiguity prevents self-determination from achieving the status of international law, but rather relegates it to the category of a myth, albeit an "important" and "valid" myth, which serves to "explain and justify" an existing phenomenon.\(^{220}\) Perhaps the strongest articulation of this reservation would focus on Franck's first attribute of legitimacy for a norm, and argue that self-determination lacks sufficient determinacy.\(^{221}\)

All the same, we have already seen above that self-determination has definitively achieved the status of a binding norm of international law.\(^{222}\) The "reification" of the term self-determination, or using the term itself as a substitute for a concrete and precise concept, is one way to explain the assimilation of self-determination into international law in the face of a residuum of ambiguity about its content.\(^{223}\) Therefore, it has been appropriate to establish first the existence of the norm of self-determination and turn next to an analysis of the evolution of its content, because this sequence reflects the historical evolution of the norm of self-determination itself.

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\(^{221}\) Franck, supra note 142 at 50-66.

\(^{222}\) See above, pp. 82-109.

\(^{223}\) Escarameia, supra note 134 at 377.
2. NATURE OF THE RIGHT OF PEOPLES TO SELF-DETERMINATION

As has been seen above, the right of peoples to self-determination is a binding norm of international law. Before discussing the nature of self-determination, it is helpful to first recall its characterization as flexible and dynamic by the two UN Special Rapporteurs:

"Every possible conclusion, both logical and natural, which flows from that fact [that self-determination is a binding norm of international law] must be applied in solving the various problems of contemporary international law."\(^{224}\)

"[T]he incorporation of ... [self-determination in the United Nations Charter] marks ... the point of departure of a new process - the increasing dynamic development of the principle and its legal content, its implementation, and its application to the most varied situations of international life."\(^{225}\)

We shall see that it is precisely that dynamic flexibility of self-determination which has enabled it to evolve beyond its original political core of decolonization. In fact, "much of international law is the same as self-determination or shares the same values", and self-determination can be seen as "principle norm of international law today".\(^{226}\) Historically, self-determination was at times seen to be opposed to and stunted by the principle of territorial integrity\(^{227}\) or else involved competing claims on the part of intermixed or neighboring peoples.\(^{228}\) Today however, the duty of states to advance peoples' right of self-determination, at least in the particular form of a modern duty to pursue sustainable development as the freely expressed will of the peoples of the world, will be seen to be a constructive paradigm in the mutually reinforcing interest of the entire community nations as it faces new and extraordinary challenges on a global scale.

\(^{224}\)Supra page 104, quoting UN Special Rapporteur Espiell.

\(^{225}\)Supra page 85, quoting UN Special Rapporteur Cristescu.

\(^{226}\)Louis Henkin, interview of November 17, 1995.

\(^{227}\)See, e.g., Thomas Franck, "Fairness in International Law and Institutions", 146ff (1995).

\(^{228}\)See generally Hartnett, supra note 68.
The nature of self-determination will now be analyzed by considering its scope, its beneficiaries and obligors, the binding nature of its various aspects, and its characterization as an international trust.

a) Scope

The classic brief characterization of the scope of self-determination was first stated in Resolution 1514:

"All peoples have the right to self-determination; by virtue of that right they freely determine their political status and freely pursue their economic, social and cultural development." 229

This wording has been consistently reaffirmed. 230 According to UN Special Rapporteur Cristescu:

"... United Nations practice has clarified and developed the content of the equal rights of people and their right to self-determination; that right is being steadily extended to include the political, economic, social and cultural aspects of the life of peoples." 231

Before discussing each of these aspects of self-determination in turn, it is appropriate to quote UN Special Rapporteur Espiell, who emphasized their interdependence:

"Before going into the content of each of these specific and necessary aspects of the general concept of self-determination, it should be emphasized that they are closely and indissolubly linked, since they are all interdependent and each of them can only be fully realized through the complete recognition and implementation of the others." 232

i) Political

The classic core of self-determination is its political dimension:

\[\text{229 Supra at note 85.}\]

\[\text{230 Supra pages 78 to 80.}\]

\[\text{231 Cristescu, supra note 80 at 45.}\]

\[\text{232 Espiell, supra note 78 at 22.}\]
"The United Nations resolutions listed in the report of the Secretary-General all refer to the political content of the right of peoples to self-determination, although in some cases they also deal with other aspects ..."\(^{233}\)

The early dominant component of the political dimension was decolonization.\(^ {234}\) However, while decolonization may have been the original core meaning of self-determination, the legal right has survived the era of decolonization and continues to evolve.\(^ {235}\) While it could be claimed that self-determination only applies to decolonization, decolonization was actually one remedy for a particular violation of the norm of self-determination:

"If however, self-determination fundamentally entails a standard of governmental legitimacy that benefits all segments of humanity, a different interpretation of decolonization ensues: Decolonization procedures did not themselves embody the *substance* of the norm of self-determination; rather they were measures to *remedy* a sui generis deviation from the norm that existed in the prior condition of colonialism. Self-determination precepts define a standard in the governing institutional order, a standard with which other institutions of government also may conflict.

The substantive content of the international norm of self-determination, therefore, inheres in the precepts by which the international community held colonialism illegitimate and which apply universally to human beings in regard to their governing institutions. The *substance* of the norm - the precepts that define a standard of governmental legitimacy - must be distinguished from the *remedial* prescriptions that may follow a violation of the norm, such as those developed to undo colonization [emphasis in original]."\(^ {236}\)

It should be emphasized that political self-determination has not only an external aspect associated in the extreme with colonization or war,\(^ {237}\) but also an internal aspect associated in

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\(^{233}\)Id.

\(^{234}\)See, e.g., id. at 10.

\(^{235}\)Escarameia, supra note 134 at 110; Franck, supra note 219 at 140-49.

\(^{236}\)Anaya, supra note 65 at 144.

\(^{237}\)With respect to war, in the words of UN Special Rapporteur Cristescu: "Because of the right of peoples to self-determination, their political, economic, social and cultural rights and human rights and fundamental freedoms, the various aspects of development are
the extreme with apartheid\textsuperscript{238} or democide.\textsuperscript{239} According to one scholar:

"[T]he global democide [defined as genocide, politicide and mass murder by states] from 1900 to 1987 probably amounts to a fantastic 150,944,000 people killed\textsuperscript{240}... The overall, absolute high democide estimate may be around an inconceivable 335,000,000 killed; the absolute low near a hardly less horrible 70,000,000 killed."\textsuperscript{241}

"We have experienced in the toll from democide ... the equivalent of a nuclear war ..."\textsuperscript{242}

In a recent and insightful analysis of political self-determination, Anaya characterizes it as comprised of constitutive and ongoing aspects.\textsuperscript{243} According to Anaya:

"In self-determination's constitutive aspect, core values of freedom and equality translate into a requirement that individuals and groups be accorded meaningful participation, commensurate with their interests, in procedures leading to the creation of or change in the institutions of government under which they live."\textsuperscript{244}

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interlinked and interdependent. They are also dependent on initial conditions of order, because international peace and security create the possibility of sustained development at all levels." Cristescu, supra note 80 at 55.
\end{flushright}

\textsuperscript{238}See Espiell, supra note 78 at 52-54.

\textsuperscript{239}See generally R.J. Rummel, "Power Kills; Absolute Power Kills Absolutely" (October 20, 1991), in "National Security Law Supplementary Reading" 9-17 (Fifth National Security Law Institute, June 4-17, 1995).

\textsuperscript{240}Of this estimate, most of the individuals were killed by their own state. This estimate of 150 million democidal killings by states in the twentieth century is about five times the 30,683,000 estimated non-democidal deaths in international wars over the same period, even though it includes World Wars I and II. See id. at 16, 21-23.

\textsuperscript{241}Id. at 14.

\textsuperscript{242}Id. at 24.

\textsuperscript{243}Anaya, supra note 65 at 145.

\textsuperscript{244}Id.
"Apart from its constitutive aspect, which applies at discrete episodes of institutional birth or change, self-determination applies continuously in what I have designated its ongoing aspect. Ongoing self-determination requires a governing institutional order under which individuals and groups are able to make meaningful choices in matters touching upon all spheres of life on a continuous basis."

In other words, perspectives ranging from legal scholars such as Anaya to recognized world leaders such as the Dalai Lama belie the caricature of political self-determination as equivalent only to classical independent statehood.

ii) Economic
According to UN Special Rapporteur Espliell, the economic component of self-determination can be summarized as follows:

"The economic aspects of the right of peoples to self-determination are manifested, first in the right of all peoples to determine, in freedom and sovereignty, the economic system or régime under which they are to live."

"Without prejudice to this general meaning of self-determination from the economic standpoint, it is necessary to specify that the economic content of the right of peoples to self-determination finds its expression in particular - without prejudice to many other different manifestations - in the right to permanent sovereignty over natural resources ... "

As can be seen, this characterization of economic self-determination is quite comprehensive.

iii) Social
With respect to the social dimension of self-determination, it is once again most appropriate to directly quote UN Special Rapporteur Espliell:

245Id. at 151.

246The Dalai Lama, in a speech at the John F. Kennedy School of Government (September 10, 1995).

247Espliell, supra note 78 at 26.
"Every people has the right to choose and determine the social system under which it is to live, in accordance with its free and sovereign will and with due respect for its traditions and special characteristics."{248}

He goes on to link self-determination with social progress and development:

"This aspect of self-determination is covered by various General Assembly resolutions, especially the Declaration on Social Progress and Development, which proclaims 'national independence based on the right of peoples to self-determination' to be a primary condition of social progress and development."{249}

Finally, even before the coinage of the term "sustainable development", UN Special Rapporteur Esplieh distinguished between development and "mere economic growth", and underscored the inseparability of self-determination and development:

"The texts which deal with the economic aspects of the right of self-determination ... take into consideration, expressly or implicitly, the social content of development and consequently the social aspects of the right to self-determination; today, development, which is not the same as mere economic growth, is inconceivable without effective respect for the right of peoples to self-determination."{250}

iv) Cultural

It is useful to refer to both UN Special Rapporteur Reports with respect to the cultural component of self-determination. In general, Esplieh characterizes cultural self-determination as follows:

"Every people, in the exercise of its right to self-determination, has the right to determine and establish the cultural régime or system under which it is to live ... "{251}

More specifically, UN Special Rapporteur Cristescu uses the text from Resolution 3148, titled "Preservation and further development of cultural values", to describe the cultural component

{248}Id. at 28.

{249}Id.

{250}Id.

{251}Id.
of self-determination:

"[C]ultural values, both material and spiritual, [should be] an integral part of development efforts by giving attention in particular to ... the identification, preservation and development of the varied cultural values of each region in order to maintain and make the widest possible use of development plans, especially as regards the improvement of living conditions and the general quality of life."252

b) Beneficiaries and Obligors

i) All Peoples as Beneficiaries

Turning to the issue as to who are the beneficiaries of the right of peoples to self-determination, UN Special Rapporteur Cristescu studied the discussions of the United Nations Committee which drafted Resolution 2625.253 He noted with approval the following view:

"With regards to the beneficiaries of the principle and the meaning of the word 'peoples', several representatives pointed out that the term should be given the broadest possible definition; the principle had to be formulated so as to take account of all peoples."254

This seems to be a natural and even compelling interpretation, since Resolutions 1514 and 2625 and the International Covenants on Human Rights each specifically vest the right in "all" peoples.255

UN Special Rapporteur Cristescu himself emphasized how the United Nations Charter interlinked equal rights and self-determination, noting that:

"[I]n the two cases where it expressly mentions the principle of equal rights and self-determination of peoples, the Charter speaks of a principle, and by

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252 Cristescu, supra note 80 at 15-16.

253 Recall that Cristescu characterized Resolution 2625 as "the most comprehensive formulation" of self-determination (supra at page 80).

254 Cristescu, supra note 80 at 11-12.

255 See supra, pages 78 to 80.
using the singular emphasizes that this is a single principle.\textsuperscript{256}

Cristescu went on to quote the contemporaneous UN Rapporteurs for the United Nations Subcommittee and Committee respectively which oversaw the drafting of the language:

"[T]he principles of equal rights of people and that of self-determination are two component elements of one norm."

"The Committee understands that the principle of equal rights of peoples and that of self-determination are two complementary parts of one standard of conduct."\textsuperscript{257}

The net result of this line of reasoning leads us back to the perspective of Anaya:

"[S]elf-determination fundamentally entails a standard of governmental legitimacy that benefits all segments of humanity ..."\textsuperscript{258}

Some authors would restrict the right of self-determination to only those peoples under colonial domination.\textsuperscript{259} The better approach is that:

"In fact, the principle is relevant to all peoples [emphasis added], whether dependent or independent ... The modern principle of self-determination is the right, not only of groups that fall within [the classic ethnocentric category articulated by the Permanent Court of International Justice in applying the Minorities Treaties to the Greco-Bulgarian case], but in fact to groups that may be non-racial, non-national, and that may form majorities. The legitimate "self", therefore, is a collection of individuals having a legitimate interest which is primarily political, but may also be economic, cultural, or any other kind. When it is identified with the whole population of a state there is no doubt at

\textsuperscript{256}Cristescu, supra note 80 at 21.

\textsuperscript{257}Cristescu, supra note 80 at 2.

\textsuperscript{258}Anaya, supra note 65 at 144 (emphasis added).

\textsuperscript{259}See, e.g., Espiell, supra note 78 at 10. However, it would seem that this position is not consistent with his categorization of South African apartheid as a violation of self-determination. Furthermore, since he concludes that the right of self-determination survives decolonization (see pp. 8, 64), this would lead to an invidious distinction where decolonized peoples enjoyed more rights than other peoples, violating the \textit{equal rights} component of the principle.
all that they are entitled to exercise the right."260

The doctrinal bugaboo that vesting self-determination in all peoples would cause the community of nations to splinter into an anarchy of microstates is simply avoided, by recognizing that the form of an appropriate and legitimate remedy if self-determination is violated will depend on the circumstances:

"To say that literally all peoples have the right to self-determination, however, is not to say that all are entitled to a self-determination remedy. A remedy is only possible if there is a violation of the norm. In the context of classical colonialism, a remedial regime was developed to address the particular dysfunction widely identified with that genre of political ordering. Whether in any other situation there is a violation of self-determination, and if so, the particular remedy that might be forthcoming, must be determined according to the relevant circumstances. What is called for, then is a case-by-case approach to address the multitude of contemporary group demands that invoke the principle or right of self-determination."261

A question remains as to whether the right of self-determination vests only in collective peoples, or whether individuals are also endowed with a corresponding human right.262 At this point, it will suffice to recall that the collective right of peoples to self-determination underlies the entire suite of human rights.263

ii) Every State as Obligor
All signatories of the International Covenants on Human Rights have assumed a binding duty to "promote the realization of the right of self-determination" and to "respect that right".264


261 Anaya, supra note 65 at 162.

262 As an illustration of the doctrinal divide, Cristescu states that: "The right of peoples to self-determination is not an individual right; it is a collective right ..." Cristescu, supra note 80 at 30. On the other hand, according to Espliell: "Self-determination may be regarded also ... as a right of the individual." Espliell, supra note 78 at 10.

263 See supra, p. 79.

264 Supra p. 78.
All members of the United Nations have affirmatively pledged themselves "to take joint and separate action in cooperation with the Organization for the achievement of the purposes set forth in Article 55", which in turn are "based on respect for the principle of equal rights and self-determination of peoples". Still more generally, Resolution 2625 asserts that every state has the role of obligor for self-determination:

"Every state has the duty to promote, through joint and separate action, realization of the principle of equal rights and self-determination of peoples..."  

In the words of UN Special Rapporteur Esipiell:

"[A]ll states have a positive legal duty to respect, promote and assist the exercise of the right of peoples to self-determination and a negative duty to refrain from any measures which deprive peoples of that right."  

"The violation by a State of the right of peoples to self-determination constitutes a ground for international responsibility."  

UN Special Rapporteur Cristescu amplifies on this duty of states to promote self-determination, with special reference to economic, social, and cultural development, and differentiating the duty of states towards all peoples from its even stronger responsibility towards its constituent peoples:

"The Charter of Economic Rights and Duties of States, adopted by the United Nations General Assembly in Resolution 3281 (XXIX) of 12 December 1974, contains important provisions which are of particular significance for the development of the right to self-determination. The Charter includes equal rights and self-determination of peoples among the 'fundamentals of international economic relations'." ... 


\[265\] United Nations Charter, Articles 55 and 56. 

\[266\] Supra page 79. See also, e.g., J.G. Starke, "Introduction to International Law" 124 (Tenth Ed., 1989). 

\[267\] Esipiell, supra note 78 at 14. 

\[268\] Id. at 16.
"In article 7, it also recognizes that every state has the primary responsibility to promote the economic, social and cultural development of its people and that, to this end, each state has the right and the responsibility to choose its means and goals of development, fully to mobilize and use its resources, to implement progressive economic and social reforms and to ensure the full participation of its people in the processes and benefits of development; all states have the duty, individually and collectively, to co-operate in eliminating obstacles that hinder such mobilization and use. In article 9, it recognizes that all states have the responsibility to co-operate in the economic, social, cultural, scientific and technological fields for the promotion of economic and social progress throughout the world, especially that of the developing countries. In article 17, the Charter states that international co-operation for development is the shared goal and common duty of all states and that every state should co-operate with the efforts of developing countries to accelerate their economic and social development by providing favourable external conditions and by extending active assistance to them, consistent with their development needs and objectives, with strict respect for the sovereign equality of states and free of any conditions derogating from their sovereignty."269

c) How Binding are Different Aspects of Self-Determination?

In this section we will discuss how the binding nature of different aspects of self-determination can range from jus cogens to a standard norm of international law, and in some respects can extend beyond into the realm of a non-binding political principle.

Certain norms of international law which are considered so fundamental as to be inalienable are termed jus cogens,270 and are non-derogable even by treaty:

Vienna Convention on the Law of Treaties

Article 53. Treaties Conflicting with a Peremptory Norm of General International Law (Jus Cogens)

A treaty is void if, at the time of its conclusion, it conflicts with a peremptory norm of general international law. For the purposes of the present Convention, a peremptory norm of general international law is a norm accepted and

269 Cristescu, supra note 80 at 14.

270 Brownlie, supra note 86 at 512-13.
recognized by the international community of States as a whole as a norm from which no derogation is permitted and which can be modified only by a subsequent norm of general international law having the same character.\textsuperscript{271}

Besides being non-derogable by treaty, \textit{jus cogens} norms may supersede certain judicial doctrines which can otherwise thwart judicial relief, in addition to generating universal jurisdiction.\textsuperscript{272} The judicial doctrines which a \textit{jus cogens} norm may supersede include: the "act of state" doctrine, whereby "courts of one nation ... refrain from ruling on or providing relief for acts done by another nation in its own territory";\textsuperscript{273} the "political question" doctrine, which "requires judicial abstention in cases raising issues more properly resolved by the executive or legislative branches of government";\textsuperscript{274} the "self-execution" doctrine, requiring that treaties operate of themselves without legislation for them to be justiciable;\textsuperscript{275} the "last in time" rule, by which subsequent inconsistent legislation could supersede a non-peremptory norm of international law;\textsuperscript{276} and "standing barriers", which interpose requirements such as individual harm.\textsuperscript{277} Furthermore, \textit{jus cogens} norms may support universal jurisdiction since a violation disrupts international order, and violators may be subject to this universal jurisdiction in their individual capacity.\textsuperscript{278}

Opinion is divided as to whether self-determination has achieved the status of \textit{jus cogens}.


\textsuperscript{273}Id. at 445.

\textsuperscript{274}Id. at 447.

\textsuperscript{275}Id. at 449.

\textsuperscript{276}Id. at 450-51.

\textsuperscript{277}Id. at 452-54.

\textsuperscript{278}Id. at 455.
Brownlie variously characterizes self-determination as *jus cogens* either "probably" or by "general agreement". Esipiell, Parker and Kiss agree that self-determination is *jus cogens*. Other writers such as Cristescu disagree. A more textured interpretation would admit the possibility that the *jus cogens* nature of self-determination is a function of which element within its scope is being considered. For example, among Brownlie's "least controversial examples" of *jus cogens* are "the law of genocide" and "the principle of racial non-discrimination", violations of which would also constitute clear violations of self-determination.

The next stage beyond *jus cogens* is that of a regular norm of international law, arising by convention, custom or general principles. The International Covenants on Human Rights define self-determination to include the free determination of political status and free pursuit of economic, social and cultural development, and this articulation has extended into customary international law to bind even non-signatories. "External self-determination"

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279 Brownlie, supra note 86 at 513, 515.

280 Esipiell, supra note 78 at 11-12.

281 Parker, supra note 272 at 440-41.


283 E.g., Cristescu, supra note 80 at 24.


285 Brownlie, supra note 86 at 513.

286 See, e.g., Esipiell, supra note 78 at 52-54, characterizing South African apartheid as a particularly egregious violation of self-determination.

287 Supra, p. 78.

288 Supra pp. 88ff.
serves to insulate a nation from outside interference into control over its own destiny, and is reflected in its right to control its own resources,289 and freedom from unjustified use of force,290 transboundary pollution and degradation of the global commons.291 In addition, "internal self-determination" calls for the opportunity for meaningful political participation by the citizens of a nation.292

In some circumstances, some of these principles can fail to attain the status of binding international law and remain only at the level of non-binding political principles. As an example, while policies of powerful Western nations with respect to international financial institutions or even their own economies can powerfully impact the economic development of other nations, any involvement of the principle of self-determination would seem to be a political rather than legal issue.

289According to UN Special Rapporteur Espiell:
"[T]he economic content of the right of peoples to self-determination finds its expression in particular - without prejudice to many other different manifestations - in the right to permanent sovereignty over natural resources."
Espiell, supra note 76 at 26. See also "UN General Assembly Resolution on Permanent Sovereignty over Natural Resources", A/RES/1803 (December 14, 1962).

290See, e.g., Henkin, "How Nations Behave" 134 (2d ed. 1979):

Freedom from unjustified use of force can be characterized as a jus cogens norm, and is a central principle enshrined in the United Nations Charter in 1945 by the war-weary peoples of the world. See, e.g., 1 Restatement of the Foreign Relations Law of the United States, Third 28 (1987):
"It is generally accepted that the principles of the United Nations Charter prohibiting the use of force "... have the character of jus cogens."

291See below, p. 203.

Figure 14: How Binding are Different Aspects of Self-Determination?²⁹³

²⁹³ Figure 14 was inspired by an interview with Louis Henkin, and benefited further from a discussion with Isaak Dore.
Figure 14 represents an initial attempt to portray a textured interpretation of the degree to which different aspects of self-determination are binding under international law. This figure displays classical aspects of self-determination such as political development, along with other principles included in the right of peoples to determine their future, i.e. self-determination (see p. 140 below). The boundaries between the realms of political principle, standard international law, and *jus cogens* should be considered somewhat uncertain, and are therefore depicted as grey zones.\textsuperscript{294} The structure of this figure allows for the possibility that even different aspects of self-determination which fall in the same realm, e.g. *jus cogens*, might be capable of relative prioritization, although this is not a well defined issue in international law.\textsuperscript{295} The horizontal bars in Figure 14 are intended to convey, in a qualitative sense, where different publicists might be prepared to place a variety of situations which could typically arise under each aspect of self-determination. It should be emphasized that extreme cases could fall outside this interval. For example, freedom from unjustified degradation of a commons could rise to the extreme limit of *jus cogens* in the case of ecocide as an instrument of war, or in the case of global warming unjustified by necessity or consent which jeopardized the national survival of island states. Such examples also demonstrate the inseparability of the different aspects of self-determination: degradation of the commons could constitute an unjustified use of force, which also contravened economic development.

\textsuperscript{294}According to Marks, speaking of human rights in general but with equal specific applicability to self-determination:

"It is often difficult to distinguish between rules *lex lata* and rules *de lega ferenda*, between positive law and law in the making, between "hard" law and "soft" law. As Professor Georges Abi-Saab put it, 'In reality, law does not come out of social nothingness, nor does it come into being with a "big bang." In most cases, it is a progressive and [imperceptible] growth over a large grey zone separating emerging social values from the well established legal rule; a zone which is very difficult (and sometimes even impossible) to divide \textit{a posteriori} between the two.'"


\textsuperscript{295}Henkin et al, supra note 59 at 92.
It should be noted that the term "unjustified" itself encompasses tremendous potential for controversy, and is used here in the sense of "reification", or agreeing on a label without a precise and concrete definition. It is precisely in giving concrete effect to notions such as unjustified degradation of the global commons, for example by effective negotiations, that states are able to realistically pursue sustainable development.

Those aspects of self-determination which are placed at the extreme of non-derogable *jus cogens*, such as apartheid or genocide, are firmly supported by principles of natural law. Ecocide, in the sense of destroying the ecosphere in terms of its ability to support human civilization, would of course preclude all political, economic, social and cultural development and would violate any natural law of responsible stewardship. In fact, Figure 14 can be seen to come full circle, in that one way that ecocide could conceivably occur could be unjustified degradation of the global commons, e.g, by the destruction of the stratospheric ozone layer, run-away global warming, or nuclear winter following a large-scale nuclear attack. Finally, as can be seen from this figure, "much of international law is expressive of the larger principle of self-determination."  

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296 Supra p. 110.

297 See generally below, pp. 204ff, 270ff.

298 Ecocide in the more limited sense of "massive destruction of the environment to the detriment of human, animal or plant life" has been considered for an enlargement of, or companion convention to, the Genocide Convention of 1948. Boutros-Boutros Ghali, "The United Nations and Human Rights: 1945-1995" 23 (1995). In addition, in considering the draft "Code of Crimes against the Peace and Security of Mankind", the International Law Commission "took the view that protection of the environment was of such importance that some particularly serious attacks against this fundamental interest of mankind should come under the Code and the perpetrators should incur international criminal responsibility." UN Special Rapporteur Ksentini, "Human Rights and the Environment: Second Progress Report" 35 (Jul. 26, 1993). See also Lynn Berat, "Defending the Right to a Healthy Environment: Toward a Crime of Geocide in International Law", 11 Boston University International Law Journal 327, 338ff (1993).

d) Right of Peoples to Self-Determination as an International Trust

Woodrow Wilson escorted self-determination onto the world stage using language evocative of trusts:

"[E]very territorial settlement involved in this war must be made in the interest and for the benefit of the populations concerned ... [emphasis added]."\textsuperscript{300}

This approach has deep historical roots:

"The concept and practice of trusteeship ... has a lineage hardly less old than that of self-government."\textsuperscript{301}

Edmund Burke, speaking in the British Parliament in 1783, affirmed that:

"[A]ll political power which is set over men ... ought to be some way or other exercised ultimately for their benefit [emphasis added]."

"[E]very species of political dominion ... are all in the strictest sense a trust [emphasis in original]."\textsuperscript{302}

As will be seen below, self-determination in the context of an international trust has already been recognized in the Mandate and Trusteeship systems. A new and promising reconceptualization of the international law of self-determination is that it represents an international trust with respect to all peoples.

\textsuperscript{300}Supra at page 74.

\textsuperscript{301}H. Duncan Hall, "Mandates, Dependencies and Trusteeship" 97 (1948), characterizing the Mandate System of the League of Nations as a trusteeship.

\textsuperscript{302}Id. at 981, quoting from 2 "The Works of Edmund Burke" 296 (1839).
i) Self-Determination and the International Trust of the Mandate and Trusteeship Systems

The International Court of Justice has repeatedly applied the principle of self-determination and the concept of a trust to the Mandate system of the League of Nations and the Trusteeship system of the United Nations.303

In 1950, Judge Sir Arnold McNair of the International Court of Justice stated in the International Status of South-West Africa case that "the governing principle of the Mandates is to be found in the trust ...", and went on to emphasize the legitimacy of the concept of a trust in such a context:

"Nearly every legal system possesses some institution whereby the property (and sometimes the persons) of those who are not sui juris, such as a minor or a lunatic, can be entrusted to some responsible person as a trustee or tuteur or curateur. The Anglo-American trust serves this purpose, and another purpose even more closely akin to the Mandates System, namely, the vesting of property in trustees, and its management by them in order that the public or some class of the public may derive benefit or that some public purpose may be served. The trust has frequently been used to protect the weak and the dependent, in cases where there is 'great might on the one side and unmight on the other', and the English courts have for many centuries pursued a vigorous policy in the administration and enforcement of trusts."304

In the South-West Africa cases, Judge Bustamante provided the following authoritative interpretation of the Mandate System as a trust:

"In summary form, the doctrinal interpretation of the Mandates System instituted by the Covenant may be stated as follows: a 'sacred trust' for the benefit of the under-developed peoples of the former colonies was entrusted to the Members of the League of Nations, which represented the international


community. Each of those States Members is bound, jointly and severally with the League, by the obligation and by the responsibility to promote the purposes envisaged in Article 22 of the Covenant, namely, to assist, advance and protect the peoples concerned. In consequence, each State Member has an individual legal interest in seeing that the Mandates entrusted by the League of Nations to the various Mandatories are properly performed and fulfilled. In the Mandate agreements the States Members are thus not alien elements or 'third persons' having no connection with the contractual relationship, but joint parties with the League of Nations for the achievement of its objectives. 305

Note the emphasis on the joint and several responsibility inspired by the "sacred trust" on all states and the League of Nations to "advance and protect the peoples concerned". In addition, each state has an "individual legal interest" in the proper discharge of trust responsibilities. Judge Jessup pointed out that this individual legal interest of states "did not directly touch their 'material' interests or those of their nations", thus depriving an objecting state of the argument that a complaining state did not have standing, even if the complaining state did not have a further individuated interest such as territorial contiguity or participation in the administration of a territory. 306

According to the International Court of Justice in 1971, when it had reason to discuss the Mandate System:

"It is self-evident that the 'trust' had to be exercised for the benefit of the peoples concerned ..." 307

"[T]he ultimate objective of the sacred trust was the self-determination and independence of the peoples concerned." 308

A quarter century after the establishment of the Mandate System, "the Charter of the United Nations made provision for an 'International Trusteeship System', which was described by a

305 Judge Bustamante, South-West Africa cases, ICJ Reports 318 at 63 (1962).

306 Judge Jessup, id. at 114.

307 Namibia, ICJ Reports 16 (1971).

308 Id. at 19.
Resolution of the [General] Assembly ... as embodying 'principles corresponding to those declared in [the Mandate System]." 309

In particular, the Trusteeship System clearly showed the objective of self-determination, as evidenced by its language:

**Charter of the United Nations**

**International Trusteeship System**

"The basis objectives of the trusteeship system ... shall be ... to promote the political, economic, social, and educational advancement of the inhabitants of the trust territories, and their progressive development towards self-government ..." 310

While the Trusteeship System has encountered various difficulties,311 it has on balance been a constructive influence.312


310 United Nations Charter, chapter XII.

311 "Disparity between the administering authorities' concept of the trusteeship system as an institution for supervision of colonial administration, with promotion of political development only a secondary and long-term concern, and the anti-colonials' interpretation of the system as a channel for rapid attainment of independence by trust peoples gave rise to constant friction and conflicts." George Thullen, "Problems of the Trusteeship System: A Study of Political Behavior in the United Nations" 120 (1964).

"Two aspects of [Trusteeship] Council functioning have developed, however, which were not foreseen by the Charter. The first is that, whether for better or worse, the trusteeship system generally, and the Council in particular, have been caught up in the whirlpool of the East-West struggle. . . The second development results from the ambiguity of the Charter as to the precise relation of the Trusteeship council to the General Assembly. This has resulted in disputes concerning the proper role of the latter within the trusteeship system." James N. Murray, Jr., "The United Nations Trusteeship System" 241-42 (1957).

312 "Whatever its shortcomings, the trusteeship system has rendered the transition of the trust territories into the modern world relatively painless." Thullen, supra at 185.
In sum, what we have shown above is recognition by the members of the International Court of Justice that:

1. The Mandate system constituted a trust for the benefit of the applicable peoples, with all the states in the League of Nations as joint trustees with a duty to advance the right of the peoples to self-determination, and with each state possessing an individual legal interest in any breach of the trust.

2. The successor Trusteeship system of the United Nations embodies corresponding principles.

At this point, the question arises: Since we have demonstrated that all peoples have the right to self-determination,\(^{313}\) is it appropriate to consider that they are beneficiaries of a corresponding international trust with all states as joint trustees?\(^{314}\)

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"A survey of the formation and functioning of the trusteeship system leaves the over-all impression that the system is functioning - and functioning well." Murray, supra at 239.

\(^{313}\) Supra, pp. 117-119.

\(^{314}\) Forty-five years ago, in his discussion of the Mandate system, Judge Sir Arnold McNair wrote:

"I am convinced that in its future development the law governing trust is a source from which much can be derived."

ii) Right of Self-Determination as an International Trust for the benefit of All Peoples

To summarize what we have determined so far about the nature of the right of peoples to self-determination: its scope includes political, economic, social and cultural dimensions;\(^{315}\) all peoples have the right to self-determination;\(^{316}\) all states have the duty to advance peoples' self-determination;\(^ {317}\) states have a stronger responsibility for self-determination of their constituent peoples;\(^{318}\) and remedies for breaches of the norm will depend on circumstances.\(^{319}\)

Is this set of rights and duties equivalent to an international trust for the benefit of all peoples, with all states as joint trustees?

To answer this question, it is appropriate to draw lessons from standard trust law, as, in the words of Judge Bustamante:

"In my view there is no valid reason for disregarding the applicability of the legal principles governing certain private law institutions in the field of international law. During the elaboration of legal doctrine recourse has sometimes been had - and this is well known - to municipal legal sources to establish and shape, on the principle of analogy, new systems to regulate the legal relationships between peoples. One such case is that of international tutelage [i.e., "trust"], where the striking analogy with municipal guardianship can be seen in [the Mandate and Trusteeship systems]."\(^{320}\)

The definition of a trust has been stated as:

"In its technical legal sense, a trust is defined as the right, enforceable solely in

\(^{315}\) Supra pp. 112ff.

\(^{316}\) Supra pp. 117ff.

\(^{317}\) Supra pp. 119ff.

\(^{318}\) Supra pp. 120ff.

\(^{319}\) Supra pp. 119ff.

\(^{320}\) Judge Bustamante, *Southwest Africa* cases, ICJ Reports 319 at 39 (1962). See also Charney, supra note 122 at 535-36, for a discussion of the process whereby domestic legal systems can constitute a source of general principles of law in the international arena.
equity, to the beneficial enjoyment of property the legal title to which is vested in another.\textsuperscript{321}

The right of peoples to self-determination fulfills this definition of a trust: \textit{First}, all peoples have the right to "beneficial enjoyment" of self-determination.\textsuperscript{322} \textit{Second}, states by virtue of their sovereignty can be seen to be vested with "legal title" to self-determination of their constituent peoples:

"The principle of self-determination by states with respect to their political, constitutional, socio-economic system and cultural identity has become a central element of sovereignty (UNGA Res. 2625 (XXV))."\textsuperscript{323}

In fact, considering the breadth and dynamism of the term "self-determination",\textsuperscript{324} including a range of rights and duties,\textsuperscript{325} it could in the limit subsume the "totality of international rights and duties recognized by international law as residing in ... the state" which is the common meaning of sovereignty.\textsuperscript{326} Such a correspondence between self-determination and sovereignty could alleviate some of the problems with the term "sovereignty",\textsuperscript{327} and help to reconcile the


\textsuperscript{322}Supra pp. 117ff.

\textsuperscript{323}Helmut Steinberger, "Sovereignty", in the "Encyclopedia of Public International Law" 412 (1987), citing Resolution 2625 which says: "[S]overeign equality includes... the right freely to choose and develop its political, social, economic and cultural systems...".

\textsuperscript{324}Supra pp. 111ff.

\textsuperscript{325}Supra pp. 117ff.

\textsuperscript{326}This definition of sovereignty is found in Crawford, supra note 303 at 27, quoting in turn the \textit{Reparations Case}, ICJ Reports 174, 180 (1949).

\textsuperscript{327}The term 'sovereignty' has a long and troubled history, and a variety of meanings." Id.

Or, more poetically: "To begin with, one initial statement should be made, namely that the
The historic tension between self-determination and territorial integrity.\textsuperscript{328} Third, remedies for breaches of self-determination depend on circumstances, which in the context of any possible adjudication would involve a court able to administer equity such as the International Court of Justice.\textsuperscript{329} Of course, non-judicial "enforcement measures" such as internal or international political pressure would also strongly depend on the equities of a particular situation. Finally, the duties of states to advance even nonconstituent peoples' rights to self-determination\textsuperscript{330} along with the role which states play in recognizing each others' sovereignty\textsuperscript{331} show that the right of peoples to self-determination is in the nature of an international trust.

The primary elements of this international trust are: beneficiaries\textsuperscript{332} - all the peoples of the world; joint trustees\textsuperscript{333} - states, who have the strongest duties toward their constituent peoples;

\textsuperscript{328} "Nothing in the foregoing paragraphs shall be construed as authorizing ... any actions which would impair ... the territorial integrity ... of sovereign and independent states conducting themselves in compliance with the principle of equal rights and self-determination of peoples ..." (emphasis added). (Resolution 2625).

\textsuperscript{329} The equitable jurisdiction of the International Court of Justice can arise from the \textit{ex aequo et bonto} provision of Article 38(2) of the ICJ Statute (which however can connote compromise and conciliation) or from the "general principles of law" provision of Article 38(1). Supra page 84.

\textsuperscript{330} Supra pp. 79ff, 120ff.

\textsuperscript{331} See generally Crawford, supra note 303 at 16-25.

\textsuperscript{332} "Beneficiaries" are the ones with the right to a beneficial interest of the trust. Corpus Juris Secundum, supra note 321 at 718.

\textsuperscript{333} "Joint trustees" are two or more persons who are intrusted with property for the benefit of one or more others." Id. at 716.
and trust property\textsuperscript{334} - the right to self-determination. Other elements of this international trust include: custodians\textsuperscript{335} - the governments of the respective states;\textsuperscript{336} and settlors\textsuperscript{337} - once again, all the peoples of the world.

It is possible to interpose objections to the characterization of the right of peoples to self-determination as an international trust: Unlike the Mandate and Trusteeship systems, there is no express writing spelling out the trust arrangement; however, this does not preclude formation of a "resulting trust" where the arrangement is based on conscious intent\textsuperscript{338} or a "constructive trust" where it is implied by "the demands of justice" irrespective of the intent of the parties.\textsuperscript{339} There is an element of ambiguity in the concept of self-determination\textsuperscript{340} and therefore in the international trust; however, this trust is in the nature of an "executory trust" and need not embody detailed specifications for the conduct of trustees.\textsuperscript{341} Further, as Oliver Wendell Holmes pointed out: "The trust is not a metaphysical entity ... which flies to pieces

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\textsuperscript{334}[T]rust property denotes the interest held in trust ... " Id. at 718.
\textsuperscript{335}A custodian exercises operational control over the trust property.
\textsuperscript{336}For the distinction between states and governments, see Crawford, supra note 303 at 27-29.
\textsuperscript{337}"The [settlor]... furnishes the consideration for the creation of a trust ..." Corpus Juris Secundum, supra note 321 at 717.
\textsuperscript{338}[A] resulting trust has been defined to be one raised by implication of law and presumed always to have been contemplated by the parties ..." Id. at 725.
\textsuperscript{339}[T]he term 'constructive trust' ... has been variously defined as [a] trust not created by any words, either expressly or impliedly evincing a direct intention to create a trust, but by the construction of equity in order to satisfy the demands of justice; one not arising by agreement or intention, but by operation of law ... " Id. at 726-27.
\textsuperscript{340}Espie, supra note 78 at 9.
\textsuperscript{341}An executory trust is one in which the limitations are imperfectly declared, and the donor's intention is expressed in such general terms that something not fully declared is required to be done, in order to complete and perfect the trust, and give it effect." Id. at 729-30.
\end{flushleft}
if broken in any part.\(^{342}\) Finally it could be said that characterization of self-determination as an international trust has not been articulated by publicists before; but in the words of Judge Ammoun: "Law is a living deed, not a brilliant honours-list of past writers whose work of course compels respect but who cannot, except for a few great minds, be thought to have had such a vision of the future that they could always see beyond their own times."\(^{343}\)

It should be emphasized that this international trust is actually in the interests of states, since the world is faced with global threats which have created a need to reconceptualize sovereignty. According to Sir Geoffrey Palmer:

"My experience [in government and international negotiations, including as the Minister for the Environment and as the Prime Minister of New Zealand] convinced me not only that the problems we face today are grave, but also that the state of international law and the structure of our international institutions are defective: both are incapable of dealing effectively with the problems of the biosphere. Thus, a new approach is necessary."\(^{344}\)

Charney articulates a similar belief in the necessity of a new approach:

"The international community of the late twentieth century faces an expanding need to develop universal norms to address global concerns." . . . "Current threats to the environment highlight the importance of establishing norms to control activities that endanger all nations and peoples, regardless of where the activities take place." . . . "To resolve such problems, it may be necessary to establish new rules that are binding on all subjects of international law regardless of the attitude of any particular state."\(^{345}\)

Discussing the future of sovereignty, Bleimaier expresses the view that:

"As we project the future of sovereignty in the twenty-first century, let us hope

\(^{342}\)Oliver Wendell Holmes, in \textit{Landram v. Jordan}, 203 U.S. 56, 63 (1906).

\(^{343}\)Ammoun, in \textit{Namibia}, supra note 64 at 75, emphasizing how self-determination had evolved into international law and that "the almost unanimous will of the peoples of the world ... is incomparably more decisive than [the opposition of a few states]."

\(^{344}\)Palmer, supra note 128 at 206.

\(^{345}\)Charney, supra note 122 at 529.
that the positive elements of the concept may evolve and flourish in the interests of the common wealth and that the negative connotations of sovereignty may be overcome through the positive development of international law.\textsuperscript{346}

The late Judge Nagendra Singh, former President of the International Court of Justice and member of the World Commission on the Environment and Development, most eloquently stated the necessity for a new approach in international law in order to achieve sustainable development:

"National boundaries are now so very permeable that traditional distinctions between local, national, and international issues have become blurred. Policies formerly considered to be exclusively matters of 'national concern' now have an impact on the ecological basis of other nations' development and survival."

"The international legal framework needs to be significantly strengthened in support of sustainable development."\textsuperscript{347}

Some of these questions are addressed in a recent compilation of contributions about the evolving nature of sovereignty:

"The state of the global environment is an issue that governments can no longer ignore. As awareness of environmental problems deepens and spreads, it has become apparent that many of the most pressing threats to survival and well-being are international or even global in scope.\textsuperscript{348}

"[Is there] a qualitative shift in the authority relationship between states and the


\textsuperscript{347} H.E. Judge Nagendra Singh, in the forward to Experts Group on Environmental Law of the World Commission on Environment and Development, "Environmental Protection and Sustainable Development: Legal Principles and Recommendations" ix,x (June, 1986).

\textsuperscript{348} Ken Conca, "Environmental Protection, International Norms, and State Sovereignty: The Case of the Brazilian Amazon", in Gene M. Lyons, Michael Mastanduno, "Beyond Westphalia: Sovereignty and International Intervention" 147 (1995). Conca goes on to recall the first view of Earth from space as powerful "planetary symbolism" which with "the call for active, coordinated management of global-scale natural systems" and other environmental pressures would have "complex implications for national sovereignty" - combining new restrictions and new responsibilities.
international community? Are we, in effect, moving beyond Westphalia?" 349

The concept of self-determination as an international trust provides a foundation tantamount to an international constitution by which modern sovereignty can be reconciled with the new array of global threats. This international trust comprises a matrix of rights and duties. In particular, states as joint trustees must respect the wishes of peoples as beneficiaries. The International Court of Justice has even defined self-determination as "the need to pay regard to the freely expressed will of peoples ... ". 350 Judge Dillard emphasized this point by stating: "It is for the people to determine the destiny of the territory and not the territory the destiny of the people." 351 For example, if the peoples of the world are demonstrating their wish for democratic governance, this imposes on states a corresponding duty under international law to establish and maintain democratic political systems. 352 By the same token, we will show next that the peoples of the world have expressed a desire, which is binding on states, for the pursuit of sustainable development.

349Gene M. Lyons, Michael Mastanduno, in id. at 15.

350Western Sahara, ICJ Reports 25 (1975).

351Judge Dillard, id. at 97.

352See Thomas M. Franck, "The Emerging Right to Democratic Governance", 86 American Journal of International Law 46, 56 (1992), where he writes that "the deeply embedded roots of self-determination also anchor the legitimacy claims of other, more recent, components of the democratic entitlement."
3. The Right of Peoples to Self-Determination as the Source of a Duty of States to Pursue Sustainable Development

There are two main components of the proposition that the law of self-determination constitutes a source of a duty of states to pursue sustainable development. First, self-determination can be characterized as "essentially the right of peoples to determine their future." And since sustainable development is one possible objective of peoples as they determine their future, the pursuit of sustainable development is therefore encompassed by the broad scope and dynamic character of self-determination. Second, this possible objective has actually been adopted by the peoples of the world, as evidenced by solemn convocations such as the United Nations Conference on the Environment and Development (see below pp. 143ff.).

a) Self-Determination - the Right of Peoples to Determine their Future - Encompassing Sustainable Development as a Possible Objective

In demonstrating that self-determination encompasses, as one possible objective, sustainable development, it is first appropriate to recall Resolution 1514:

By virtue of the right of self-determination, peoples "freely determine their political status and freely pursue their economic, social and cultural development."  

This language has been echoed substantially verbatim by the International Covenants on Human Rights and by Resolution 2625. The nature of self-determination has been shown

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333Louis Henkin, interview of November 17, 1995. See also supra, pp. 111-139, especially Figure 14.

354Supra p. 78.

355Supra p. 78.
to be flexible and dynamic.\textsuperscript{356} Its scope includes political, economic, social and cultural dimensions, all of which are broadly interpreted and indissolubly interdependent.\textsuperscript{357}

The underlying theme connecting the different interrelated dimensions of self-determination is choice with respect to pursuing human welfare.\textsuperscript{358} For example, self-determination specifically encompasses "development [beyond] mere economic growth"\textsuperscript{359} in addition to "the improvement of living conditions and the general quality of life."\textsuperscript{360} And of course, the pursuit of human welfare is the theme which underlies in turn the various definitions of sustainable development. In particular, the systems / social choice definition of sustainable development explicitly focuses on ongoing improvement in human welfare, as operationalized by a legitimately constructed social preference relation (see supra p. 39).

In other words, sustainable development amounts to a choice of imposing a constraint of ongoing improvement: which is one possible choice of peoples in determining their future: and therefore their right to choose by virtue of self-determination: subject only to any potential feasibility constraint.\textsuperscript{361} Therefore, peoples are able to exercise their right of self-determination by choosing to pursue their welfare by means of sustainable development. Further, since "states have a positive legal duty to respect, promote and assist the exercise of the right of peoples to self-determination . . . "\textsuperscript{362} a choice of sustainable development by peoples of the world would in turn give rise to a duty of states to pursue it. Finally, it is

\textsuperscript{356} Supra pp. 111-139.

\textsuperscript{357} Id.

\textsuperscript{358} See generally id.

\textsuperscript{359} Supra p. 116.

\textsuperscript{360} Supra p. 117.

\textsuperscript{361} Note that a choice by peoples to pursue their welfare by sustainable development is not tautological. See, for example, Figure 11, supra at p. 57.

\textsuperscript{362} Supra p. 120.
precisely because self-determination is best viewed as a flexible, broad and dynamic synthesis in international law that it is the paradigm of choice by which to address the challenge of sustainable development, which itself encompasses an integrated set of political, economic, social and environmental issues.\textsuperscript{363}

Such a duty of states to pursue sustainable development would be binding to the extent that any failure to pursue it infringes upon aspects of self-determination which themselves would be binding. In this respect, a failure to effectively coordinate and implement policies for ongoing improvement of the world system (i.e., the pursuit of sustainable development) could materially infringe upon, as illustrative examples, freedom from unjustified degradation of the global commons or transboundary pollution; control over natural resources; or political, economic, social and cultural development. As seen in Figure 14, these aspects of self-determination together represent broadly binding norms of international law, so that a failure to fulfill a duty to pursue sustainable development could in turn violate international law.

It could be argued that the aspects of self-determination recounted above can in some situations be considered as political principles rather than legal norms, with the result that any failure to fulfill a duty to pursue sustainable development should have only political repercussions not compounded by the legal dimension. This is a fair critique, and there are three responses:

First, if this argument has an element of validity because it relies on the stili-evolving nature of various aspects of self-determination, then it can be appropriate to categorize any duty to pursue sustainable development as an emerging rather than mature norm of international law. Of course, as was seen a half century ago, the consequent maturation of what is perceived as a vital norm can be quite rapid.

Second, one of the most powerful enforcement mechanisms is an argument in the political arena itself: that violations of a duty to pursue sustainable development delegitimize a state or its government. And of course, this enforcement mechanism remains strong even if a duty

\textsuperscript{363}See supra p. 65.
to pursue sustainable development includes a political rather than legal nature.

Third, the argument itself - that a material failure to fulfill a duty of states to pursue sustainable development would not infringe international law despite the various, broadly binding, aspects of self-determination that it would plausibly impair (see Figure 14 on p. 125 above) - is weak on its own terms. Indeed, a stronger argument is that any duty of sustainable development - which by its nature has powerful moral motivations, e.g. protecting the interests of future generations - would rise to the level of a *jus cogens* norm.

b) Sustainable Development as Expressed Will of Peoples of the World

We have seen above that a choice of sustainable development by the peoples of the world would be encompassed by their right of self-determination, which would in turn give rise to a duty of states to pursue it. We will now demonstrate that the peoples of the world have indeed freely expressed their wish for the pursuit of sustainable development, by means of a series of solemn global convocations with increasingly explicit declarations for the pursuit of sustainable development.

i) United Nations Charter

In 1945, the war-weary peoples of the world gathered in San Francisco, determined to secure their own welfare and that of "succeeding generations" - in the first instance by avoiding the scourge of war, in addition to "promot[ing] social progress and better standards of life in larger freedom".

**United Nations Charter**

**Preamble**

"*We the peoples* of the United Nations determined to save *succeeding generations* from the scourge of war, which twice in our lifetime has brought untold sorrow to mankind, and to reaffirm faith in fundamental human rights, in the dignity and worth of the human person, in the equal rights of men and women and of nations large and small, and to establish conditions under which justice and respect for the obligations arising from treaties and other sources of international law can be maintained, and to *promote social progress and better standards of life in larger freedom*, and for these ends to practice tolerance and
live together in peace with one another as good neighbors, and to unite our strength to maintain international peace and security, and to ensure, by the acceptance of principles and the institutions of methods, that armed force shall not be used, save in the common interest, and to employ international machinery for the promotion of the economic and social advancement of all peoples, have resolved to combine our efforts to accomplish these aims.

Accordingly, our respective Governments, through representatives assembled in the city of San Francisco, who have exhibited their full powers found to be in good and due form, have agreed to the present Charter of the United Nations and do hereby establish an international organization to be known as the United Nations [emphasis added]."

As can be seen, the peoples of the world, by means of representatives of their respective governments, solemnly resolved: "to promote social progress and better standards of life in larger freedom" and "to employ international machinery for the promotion of the economic and social advancement of all peoples". This goal, and the explicit concern for "succeeding generations", would seem to indicate a wish not only for development, but also for its being "sustainable". As we shall see, the clarity of articulation of this goal progressively matured over the subsequent decades, particularly after coinage of the term "sustainable development".

ii) Stockholm Declaration
In 1972, the Stockholm Conference brought together representatives from 113 countries, 400 nongovernmental organizations, and nearly every significant intergovernmental organization, along with 1,500 journalists, achieving "a universally recognized significance". The Stockholm Declaration was adopted by acclamation, without a single negative vote. In fact, "a strong case may be made that the Declaration, with such a large measure of international support, is itself a source of customary international law". Therefore, the principles enumerated in the Declaration clearly expressed the wishes of the peoples of the world.


365 Palmer, supra note 128 at 216.

366 Id. at 218.
Since the phrase "sustainable development" was not yet in currency in 1972, it will be helpful to excerpt portions of the Stockholm Declaration to determine what it called for:

Stockholm Declaration (1972)

"The United Nations Conference on the Human Environment

Having considered the need for a common outlook and for common principles to inspire and guide the peoples of the world in the preservation and enhancement of the human environment,

proclaims that:

2. The protection and improvement of the human environment is a major issue which affects the well-being of peoples and economic development throughout the world; it is the urgent desire of the peoples of the whole world and the duty of all Governments.

states the common conviction that:

Principle 1
Man has the fundamental right to freedom, equality and adequate conditions of life, in an environment of a quality that permits a life of dignity and well-being, and he bears a solemn responsibility to protect and improve the environment for present and future generations. In this respect, policies promoting or perpetuating apartheid, racial segregation, discrimination, colonial and other forms of oppression and foreign domination stand condemned and must be eliminated.

Principle 2
The natural resources of the earth including the air, water, land, flora and fauna and especially representative samples of natural ecosystems must be safeguarded for the benefit of present and future generations through careful planning or management, as appropriate.

Principle 3
The capacity of the earth to produce vital renewable resources must be maintained and, wherever practicable, restored or improved.

Principle 6
...The just struggle of the peoples of all countries against pollution should be
supported.

Principle 14
Rational planning constitutes an essential tool for reconciling any conflict between the needs of development and the need to protect and improve the environment. ...

Principle 26
Man and his environment must be spared the effects of nuclear weapons and all other means of mass destruction. States must strive to reach prompt agreement, in the relevant international organs, on the elimination and complete destruction of such weapons."

In sum, implicit throughout the Stockholm Declaration was a desire on the part of the peoples of the world to pursue sustainable development. Further, the two sentences which make up Principle 1 explicitly connect the classic conceptions of sustainable development and self-determination.

A series of multilateral fora continued to develop this theme after the Stockholm Convention. In 1974, the United Nations General Assembly proclaimed "that the protection, preservation and management of the environment for present and future generations is the responsibility of all states". 367 1982 saw two important documents: the World Charter for Nature - which called for safeguarding nature and integrating it into economic development, and the Convention on the Law of the Sea - which characterized the sea-bed as the common heritage of mankind. In 1987, the World Commission on Environment and Development sounded its clarion call for "sustainable development". This momentum carried the world community to Rio de Janeiro five years later.

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367Kiss and Shelton, supra note 364 at 42, characterizing the Charter of Economic Rights and Duties of States, UNGA Res. 3281 (12/12/74).
iii) United Nations Conference on Environment and Development

In 1992, the United Nations Conference on Environment and Development convened in Rio de Janeiro with representatives from 178 countries and 1500 non-governmental organizations, along with 7000 journalists.

The Secretary-General of the United Nations, Boutros Boutros-Ghali, characterized the significance of the conference in his opening statement:

"Let us try to grasp, first of all, what this Earth Summit means: here we have a gathering of nations, united before us, represented at the highest level by their leaders, supported by an exceptional rallying of peoples, and determined to reflect - and then act - in concert to protect their planet." 368

The Rio Declaration was adopted by consensus, and revolves around the theme of sustainable development. Sustainable development is explicitly referenced in 12 of the 27 principles, and implicitly permeates every sentence of the document. Perhaps the best way to characterize the Rio Declaration is to quote several selections which will prove to be of particular interest:

**Rio Declaration (1992)**

**Principle 1**

Human beings are at the centre of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature.

**Principle 10**

Environmental issues are best handled with the participation of all concerned citizens, at the relevant level. At the national level, each individual shall have appropriate access to information concerning the environment that is held by public authorities, including information on hazardous materials and activities in their communities, and the opportunity to participate in decision-making processes. States shall facilitate and encourage public awareness and participation by making information widely available. Effective access to judicial and administrative proceedings, including redress and remedy, shall be provided.

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Principle 24
Warfare is inherently destructive of sustainable development. States shall therefore respect international law providing protection for the environment in times of armed conflict and cooperate in its further development, as necessary.

Principle 25
Peace, development and environmental protection are interdependent and indivisible.

Principle 27
States and people should cooperate in good faith and in a spirit of partnership in the fulfillment of the principles embodied in this Declaration and in the further development of international law in the field of sustainable development."369

In sum, the progression of the United Nations Charter, Stockholm Declaration and Rio Declaration clearly expresses the wish of the peoples of the world to pursue sustainable development, with the consequence that states have a corresponding duty to pursue it.

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This section considers whether the international law of human rights provides an independent source of a duty of states to pursue sustainable development. There is a threefold significance to this issue. First, an independent conceptual basis for the duty to pursue sustainable development serves to reinforce the "compliance pull" of the norm. Second, an argument that a state is delegitimization itself because its conduct violates human rights standards is particularly powerful in the political arena. Third, there may be procedural advantages in the case of justiciable violations of human rights, due to the variety of available forums and the possibility of legal standing for individuals.

The issue of a human right to sustainable development is first contextualized by relating self-determination to human rights and discussing the structure of human rights law. Next, human rights to development and the environment are considered individually. Finally, a human right to sustainable development is considered according to two lines of reasoning: 1) as the synthesis of rights to development and environment, in the sense of the right to development being qualified by a sustainability constraint in the form of the right to environment; and 2) as a commitment in the United Nations Charter, according to an authoritative interpretation by the United Nations General Assembly.

a) Relationship between Self-Determination and Human Rights

There is a deep relationship between self-determination and human rights. While classically the right of peoples to self-determination is considered to be a collective right, its prominent placement as Article 1, paragraph 1 of the International Covenants on Human Rights\textsuperscript{370} has been interpreted to mean that self-determination is a human right as well:

\textsuperscript{370}Supra, p. 78.
"The World Conference on Human Rights considers the denial of the right of self-determination as a violation of human rights and underlines the importance of the effective realization of this right." \(^{371}\)

This interpretation of self-determination as a human right is not settled, and even the two special rapporteurs on self-determination reached opposite conclusions. \(^{372}\) Just the same, both special rapporteurs of the United Nations did agree that self-determination provided an indispensable foundation of human rights, \(^{373}\) and this perspective has been forcefully articulated by the UN Human Rights Commission:

"[T]he right of self-determination is of particular importance because its realization is an essential condition for the effective guarantee and observance of individual human rights and for the promotion and strengthening of those rights." \(^{374}\)

In this respect, it is interesting to note that the UN Human Rights Committee is empowered to receive complaints that a state is not fulfilling its obligations under the International Covenant on Civil and Political Rights, \(^{375}\) and the promotion of self-determination is prominently


\(^{372}\) See Espiell and Cristescu, supra notes 78, 80.

\(^{373}\) Supra, p. 79.


"It is for that reason that states set forth the right of self-determination in a provision of positive law in both Covenants [on human rights] and placed this provision as article 1 apart from and before all of the other rights in the two Covenants."

\(^{375}\) International Covenant on Civil and Political Rights, Art. 41(1) (Dec. 16, 1966). Note that this power to receive and ultimately review complaints is limited to situations where the complaining and responding state have both recognized the competence of the United Nations Human Rights Committee.
included in Article 1 as an obligation of state parties.\textsuperscript{376}

b) Structure of the International Law of Human Rights

In important respects, the law of human rights parallels the law of self-determination in its structure and historical development.\textsuperscript{377} Recall that self-determination was first enshrined in the United Nations Charter, although in general terms. Later, Resolution 1514 "authoritatively" interpreted self-determination as one of the binding obligations of the Charter. After that, self-determination was reaffirmed and amplified on by the International Covenants on Human Rights and Resolution 2625.

In a parallel manner, human rights are enshrined in the United Nations Charter:

\begin{quote}
\textbf{United Nations Charter}

\textbf{Article 1}

The Purposes of the United Nations are: . . . To achieve international cooperation . . . in promoting and encouraging respect for human rights and fundamental freedoms for all without distinction as to race, sex, language, or religion[.]

\textbf{Article 55}

. . . \textit{The} United Nations shall promote: . . . universal respect for, and observance of, human rights and fundamental freedoms for all without distinction as to race, sex, language, or religion.

\textbf{Article 56}

All Members pledge themselves to take joint and separate action in cooperation with the Organization for the achievement of the purposes set forth in Article 55.
\end{quote}

\textsuperscript{376}Id. at Art. 1.

\textsuperscript{377}See generally supra, pp. 75ff.
Human rights were enshrined in the United Nations Charter in reaction to World War II:

"Modern international human rights law dates from the 1940's. To understand the new institutions it is necessary to recall events during which an estimated 50 million people were killed. . . . World War II manifested an horrendous extension of principles of sovereignty that had come to dominate international relations during preceding years. . . .

Germany carried out atrocities against millions of its citizens and nations of neighboring countries during the 1930's and 1940's with little interference from other nations. It argued that treatment of citizens was not a matter of international concern, and other governments apparently were reluctant to intervene. The war and Holocaust demonstrated that unfettered sovereignty could not exist without untold suffering and ultimately the danger of destroying most human society.

Formulating plans for new international structures, political and juridical leaders looked to the promotion and protection of human rights as an end and a means of helping to ensure international peace and security."

The United Nations Charter was followed three years later by the Universal Declaration of Human Rights:

**Universal Declaration of Human Rights**

**Preamble**

*Whereas* recognition of the inherent dignity and of the equal and inalienable rights of all members of the human family is the foundation of freedom, justice and peace in the world, . . .

Now, therefore, The General Assembly, Proclaims this Universal Declaration of Human Rights as a common standard of achievement for all peoples and all nations, to the end that every individual and every organ of society, keeping this Declaration constantly in mind, shall strive by teaching and education to promote respect for these rights and freedoms and by progressive measures, national and international, to secure their universal and effective recognition and observance, both among the peoples of Member States themselves and among the peoples of territories under their jurisdiction.379

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The Universal Declaration of Human Rights was adopted by a vote of 48 to 0, with eight abstentions. While the Universal Declaration was not in the form of a binding convention, it is generally considered to be an authoritative interpretation of the United Nations Charter:

"Perhaps [the Universal Declaration's] greatest significance is that it provides an authoritative guide, produced by the General Assembly, to the interpretation of the provisions in the Charter."\(^{381}\)

For example, the International Conference on Human Rights of 1968, in its Proclamation of Tehran, underscored the significance of the Universal Declaration:

**Proclamation of Tehran**

The Universal Declaration of Human Rights states a common understanding of the peoples of the world concerning the inalienable and inviolable rights of all members of the human family and constitutes an obligation for the members of the international community.\(^{382}\)

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\(^{380}\)The abstainers were Byelorussian S.S.R., Czechoslovakia, Poland, Saudi Arabia, Ukrainian S.S.R., U.S.S.R., Union of South Africa, and Yugoslavia. However, "The Communist states of Europe later accepted the Universal Declaration, expressly in the Final Act of the Conference on Security and Cooperation in Europe (Helsinki 1975)." Henkin et al, supra note 59 at 606.

\(^{381}\)Brownlie, supra note 86 at 570-71.

\(^{382}\)Proclamation of Tehran, par. 2, as found in "The United Nations and Human Rights: 1945-1995" 247 (1995), and cited by Henkin et al, supra note 59 at 606-7, which includes additional references.
In the next stage, "the Universal Declaration was bifurcated into two distinct and different covenants, a Covenant on Civil and Political Rights, and another Covenant on Economic, Social and Cultural Rights." This "bifurcation" reflected the ideological split between the West, which insisted that civil and political rights which limit state power vis-a-vis the individual should have a superior status, and the Soviet bloc, which believed that fulfillment of basic economic and social needs was more fundamental and underlay all other rights. However, the two covenants themselves recognized the necessary interdependence between civil and political rights on the one hand, and economic, social and cultural rights on the other.

It is important to discuss further the categorization of sets of rights, since a still newer set of rights, including development and environment, is often referred to as "third generation" rights. In this terminology, three generations of rights can be loosely identified with the triumvirate of principles heralded by the French Revolution: liberté, égalité, and fraternité:

"The first generation of political and civil rights, embodied in the Universal Declaration and the Covenant on Civil and Political Rights, are freedoms from state intrusion: liberté. The second generation furthers realization of the first generation by guaranteeing minimum standards demandable upon the state, of education and health, a liveable wage, decent working conditions, and social insurance for all persons: égalité . . . Third generation rights cannot be realized without shared objectives and commitment to concerted group action. These rights require all the organs of society - individual, state, regional, and international - to cooperate in order for the rights to be realized: fraternité."

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386 Jennifer Downs, "A Healthy and Ecologically Balanced Environment: An Argument for a Third Generation Right", 3 Duke Journal of Comparative and International Law 351, 363-
Marks attributes the broad historical genesis of rights to:

a) the "bourgeois" revolutions in France and America in the 18th century, attempting to secure the first generation of civil and political rights;

b) the "socialist" revolutions of the 20th century, on behalf of the second generation of economic, social and cultural rights;

c) the "anti-colonial" revolutions after World War II, giving rise to the right of peoples to self-determination; and

d) "major planetary concerns" of "renewed urgency" providing the impetus for the third generation of rights, such as development and environment.\textsuperscript{387}

The notion of "third generation rights" was forged by Karel Vasak, who characterized them as "solidarity rights":

"[Third generation solidarity rights] are new in that they may both be invoked against the State and demanded of it; but above all . . . they can be realized only through the concerted efforts of all the actors on the social scene: the individual, the State, public and private bodies and the international community."\textsuperscript{388}

Philip Alston is the commentator most prominently identified with questioning the desirability of a "third generation" of human rights. Alston argues that human rights are indivisible and interdependent, and that dividing them up by characteristics is not feasible.\textsuperscript{389} Alston goes on to say that the tradition of human rights is already essentially dynamic, so that a static


\textsuperscript{388}Karel Vasak, International Institute of Human Rights (Inaugural lecture, July 1979), as quoted in id. at 441.

perspective of successive generations is counterproductive.\textsuperscript{390} Further, he believes that even though establishing substantive criteria for new rights is not very promising, "quality control" of new rights can be achieved by agreeing on formal procedural requirements for their creation within the United Nations.\textsuperscript{391}

While Alston's arguments have merit, it is also true that:
1) characterizations of different generations of rights can be viewed as heuristically valuable categories with a real historical basis, even if the categories are imprecise or overlap, or are subject to other theoretical infirmities;
2) such heuristic categorization of rights into "generations" need not imply the atrophy of "earlier" generations or even relative prioritization; nor is such heuristic categorization inconsistent with the fundamental interdependence among the entire suite of human rights;
3) notwithstanding the possibility that Alston's procedural proposal could yield real benefits, as seen in the case of self-determination there already exists an established process by which human rights can be determined to have matured into norms of international law, namely: convention, custom, general principles, judicial decisions and the writing of publicists.\textsuperscript{392}

The foundation of human rights is a series of binding conventions, the primary ones being the United Nations Charter, the International Covenant on Civil and Political Rights, and the International Covenant on Economic, Social and Cultural Rights. Building on that foundation, some human rights norms have evolved into customary international law, in a process reinforced by the conventions and United Nations General Assembly Resolutions.\textsuperscript{393}

\textsuperscript{390}Id. at 314, 316.


\textsuperscript{393}See, e.g., \textit{Filartiga v. Pena-Irata}, 630 F.2d 876 (2d Cir. 1980), as excerpted in Newman, supra note 378 at 597ff.
Human rights are established still further as general principles of law, and in this process the Universal Declaration of Human Rights has special significance:

"It has been suggested that the Universal Declaration, after the U.N. Charter, is the most influential instrument of the second half of the twentieth century. It underlies the entire international law of human rights, but, as the Declaration itself contemplated, its principal influence may have been to secure the recognition of human rights into the national constitutions and laws of virtually all states. The Universal Declaration has been copied or incorporated by reference in numerous constitutions of new states."\textsuperscript{394}

In addition, more or less developed regional human rights systems in Europe, the Americas and Africa\textsuperscript{395} reinforce the status of human rights as general principles of law.

Through a series of decisions, the International Court of Justice has affirmed the incorporation of human rights into international law.\textsuperscript{396} In sum, egregious violations by states in the past were actually the driving force by which human rights principles matured into norms of international law, notwithstanding state conduct which does not uniformly meet minimum standards even today:

"While those events [atrocities perpetrated by sovereign states upon millions of

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\textsuperscript{394}Henkin et al, supra note 59 at 608.

\textsuperscript{395}Id. at 656ff.

their own citizens in the 1930's and 1940's] spelt unprecedented tragedy for huge numbers of people, they also spelt the *reductio ad absurdum* of strict legal positivism, and of a strict application of the doctrine of national sovereignty. . . .

Since then, several [human rights] treaties have entered into force. . . . These now impose obligations on many governments as to what they may or may not do to individuals over whom they are able to exercise State power. To the extent of those obligations, the strict doctrine of national sovereignty has been cut down in two crucial respects. First, how a State treats its own subjects is now the legitimate concern of international law. Secondly, there is now a superior international standard, established by common consent, which may be used for judging the domestic laws and the actual conduct of sovereign States within their own territories and in the exercise of their internal jurisdictions, and may therefore be regarded as ranking in the hierarchy of laws even above national constitutions. . . .

[M]any nations have already modified their laws and practices in order to conform more closely with these international obligations, especially in the case of the regional human rights conventions. . . . However, it undoubtedly remains the case that too many other nations have not yet accepted, or do not yet conform, or conform only inadequately, with the new obligations under international human rights law. But it seems at least doubtful whether that fact can support a fundamental objection to the meaning or validity of this entire area of law, any more than the continued prevalence of crime in many places can be used to support an argument that all criminal law is fundamentally meaningless and invalid. . . .

[T]he international instruments in which these concepts are now formulated have been freely negotiated, adopted, and ratified by many nations in all parts of the world, covering the entire spectrum of existing cultural, religious and political orientations.  

While human rights are strongly grounded in convention, custom, general principles, judicial decisions and the writings of publicists, it is necessary to apply these standards to the specific rights in question - development, environment and sustainable development - in order to evaluate whether those specific rights have emerged as binding norms of international law.

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c) Human Right to Sustainable Development:
An Emerging Norm of International Law?

In general, the support for a right to development is particularly strong in the "south", while the support for a right to environment is particularly strong in the "north". This is natural, since the "south" does not want environmental concerns to thwart its development, and the "north" is particularly concerned about the global environmental impact of its own and the "south's" activities. As we will see, the United Nations Conference on Environment and Development effectively synthesized the objectives of development and environment - earlier considered to be antagonistic and now considered to be largely complementary - into the objective of sustainable development.

In this section, we will discuss the right to development and right to environment in turn, and then analyze the case for a right to sustainable development - either as their synthesis, or as a commitment with its own direct roots in the United Nations Charter.

i) Human Right to Development

There are two main arguments for the existence of a right to development: international convention and customary international law. There are no global conventions which explicitly establish a right to development.\textsuperscript{398} However, the Banjul Charter, which is regionally applicable to Africa, does explicitly establish a right to development, as seen below.

\textsuperscript{398}See, e.g., IUCN, "Draft International Covenant on Environment and Development" 42 (March, 1995).
Banjul Charter

Article 22

1. All peoples shall have the right to their economic, social and cultural development with due regard to their freedom and identity and in the equal enjoyment of the common heritage of mankind.

2. States shall have the duty, individually or collectively, to ensure the exercise of the right to development. 399

At the global level, the United Nations Charter seems to bind member states to jointly and separately promote development, at least in general terms:

United Nations Charter

Article 55

With a view to the creation of conditions of stability and well-being which are necessary for peaceful and friendly relations among nations based on respect for the principle of equal rights and self-determination of peoples, the United Nations shall promote:

a. higher standards of living, full employment, and conditions of economic and social progress and development;
b. solutions of international economic, social, health, and related problems; and international cultural and educational cooperation; and
c. universal respect for, and observance of, human rights and fundamental freedoms for all without distinction as to race, sex, language or religion. 400

Article 56

All Members pledge themselves to take joint and separate action in cooperation with the Organization for the achievement of the purposes set forth in Article 55.


As can be seen, each member state of the United Nations has affirmatively obligated itself to "joint and separate action" to promote "higher standards of living, . . . social progress and development . . . [and] human rights".

In 1966, the International Covenant on Economic, Social and Cultural Rights contained more specific obligations on parties with respect to development, including, inter alia, the rights of everyone to "an adequate standard of living for himself and his family", "the continuous improvement of living conditions", "be free from hunger", "the enjoyment of the highest attainable standard of physical and mental health", "education", "take part in cultural life", "enjoy the benefits of scientific progress and its applications"; the Covenant also identified specific measures that state parties are obligated to take to advance those rights.\(^{401}\)

Subsequent to the United Nations Charter and the International Covenant on Economic, Social and Cultural Rights, the right to development has been explicitly codified in the Declaration on the Right to Development, adopted in 1986 by a vote of 146 for, one against and eight abstaining.\(^{402}\)

\(^{401}\)International Covenant on Economic, Social and Cultural Rights, Arts. 11, 12, 13, 15.

Declaration on the Right to Development

Article 1
1. The right to development is an inalienable human right by virtue of which every human person and all peoples are entitled to participate in, contribute to, and enjoy economic, social, cultural and political development, in which all human rights and fundamental freedoms can be fully realized.
2. The human right to development also implies the full realization of the right of peoples to self-determination, which includes, subject to the relevant provisions of both International Covenants on Human Rights, the exercise of their inalienable right to full sovereignty over all their natural wealth and resources.

Article 2
1. The human person is the central subject of development and should be the active participant and beneficiary of the right to development.

3. States have the right and duty to formulate appropriate national development policies that aim at the constant improvement of the well-being of the entire population and of all individuals, on the basis of their active, free and meaningful participation in development and in the fair distribution of the benefits resulting therefrom.

Article 3
1. States have the primary responsibility for the creation of national and international conditions favourable to the realization of the right to development.

3. States have the duty to cooperate with each other in ensuring development and eliminating obstacles to development.

Article 5
States shall take resolute steps to eliminate the massive and flagrant violations of the human rights of peoples and human beings affected by situations such as those resulting from apartheid, all forms of racism and racial discrimination, colonialism, foreign domination and occupation, aggression, foreign interference and threats against national sovereignty, national unity and territorial integrity, threats of war and refusal to recognize the fundamental right of peoples to self-determination.  

The Declaration on the Right to Development was in the form of a non-binding resolution, so that any contribution to the legal status of the right to development would involve customary international law. As was seen earlier in the discussion of Resolutions 1514 and 2625 as expressive of a customary norm of self-determination, even non-binding UN General Assembly Resolutions can perform that function, especially when they are: 1) phrased in the form of a "Declaration", 2) clearly phrased, and 3) strongly endorsed at a near-universal diplomatic forum.\textsuperscript{404} The Declaration on the Right to Development clearly meets these criteria, and by a simple numerical yardstick its "voting score" of 146-1-8 compares quite closely with the "voting score" of 89-0-9 associated with Resolution 1514, which has been generally conceded to be expressive of customary international law.\textsuperscript{405}

However, the analysis of the degree to which the Declaration on the Right to Development is expressive of customary international law cannot be disposed of this superficially. In the words of the arbiter appointed by the International Court of Justice to resolve a dispute between Texaco and Libya about compensation for nationalized oil interests:

"[I]t is impossible to deny that the United Nations' activities have had a significant influence on the content of contemporary international law. In appraising the legal validity of the [United Nations General Assembly] Resolutions, this Tribunal will take account of the criteria usually taken into consideration, i.e., the examination of voting conditions and the analysis of the provisions concerned. . . .

[The legal value of the resolutions which are relevant to the present case can be determined on the basis of circumstances under which they were adopted and by analysis of the principles which they stated.\textsuperscript{406}"

In the Texaco case, Resolution 1803, which called for "appropriate compensation", had passed by "87-2-12", and the arbiter stated that:

\textsuperscript{404}Supra, pp. 88ff.

\textsuperscript{405}Id.

\textsuperscript{406}Rene-Jean Dupuy (sole arbiter), \textit{Texaco Overseas Petroleum et al v. Libyan Arab Republic}, 17 I.L.M. 1 (1978), as excerpted in Henkin et al, supra note 59 at 137, 139.
"It is particularly important to note that the majority voted for this text, including many States of the Third World, but also several Western developed countries with market economies, including the most important one, the United States."

The arbitrator next evaluated the Resolutions which Libya relied upon to claim that the dispute was not subject to the arbitration clause found in the concessions because nationalization was an act of sovereignty subject only to domestic law. Especially with respect to the specific issue at hand - compensation for nationalization of interests disregarding the role of international law - the arbitrator found that the most important industrialized market economies either abstained or voted against the Resolutions (or relevant paragraphs) and even a number of developing countries abstained. In addition, the arbitrator contrasted the content of the alternative provisions, with Resolution 1803 "stating the existence of a right on which the generality of states has expressed agreement", while the alternative provisions were considered as inconsistent with international law, at least by some states. The arbitrator concluded that Resolution 1803 was expressive of customary international law, because it "was supported by a majority of Member States representing all of the various groups", and on the basis of the principles which it stated.

The reasoning in Texaco can be applied to the Declaration on the Right to Development, in order to evaluate the degree to which that Declaration is expressive of customary international

\footnote{Id. at 137, referring to "General Assembly Resolution on Permanent Sovereignty over Natural Resources" A/RES/1803 (XVII) (Dec. 14, 1962), which stated: "[In the case of nationalization] the owner shall be paid appropriate compensation, in accordance with the rules in force in the State taking such measures in the exercise of its sovereignty and in accordance with international law." (Emphasis added.)}

\footnote{Id. at 138-39.}

\footnote{Id.}

\footnote{Id. at 140.}

\footnote{Id.}
law. The overall vote in the Declaration, "146-1-8", compares favorably to the overall vote in Resolution 1803, "87-2-12", which was found to be expressive of customary international law in Texaco. However, the United States, a highly interested country with the world's largest economy, had voted in favor of Resolution 1803 but affirmatively opposed the Declaration on the Right to Development.\footnote{412} Indeed, the United States has in recent years rather consistently characterized development as a "goal" and opposed its characterization as a "right".\footnote{413} Further, other important developed economies such as West Germany, Japan and the United Kingdom abstained from the Declaration on the Right to Development, calling the "authoritativeness of the declaration into question", at least to the extent that some commentators view it as non-binding.\footnote{414}

Should the Declaration on the Right to Development be considered expressive of customary international law to which the United States may be a persistent objector? In particular, were the abstaining countries indicative of insufficient generality for the Declaration to express a norm binding on all states except the United States? In the aggregate, the countries abstaining from the Declaration account for about 5% of the world's (non-U.S.) population and a third of its GNP.\footnote{415} In addition, the 146 countries who affirmatively supported the Declaration with their vote included not only all the developing countries, but a broad cross-
section from even the most developed economies of the world. Further, the content or the principle of the right to development has already been seen to be expressed in general terms in the United Nations Charter and more specifically in the International Covenant on Economic, Social and Cultural Rights (see above, pp. 160ff). Of course, it is appropriate not to be too insistent when forming a judgment:

"[I]t is extremely difficult to determine with certainty the legal force of declaratory resolutions. . . . [I]t is] impossible to lay down a general rule in this respect. . . . [T]he legal value of the declaratory resolutions therefore includes an immense gamut of nuances."\(^{417}\)

Just the same, it seems that there is a legitimate argument that the Declaration on the Right to Development is expressive of a norm of customary international law, but one against which the United States may be entitled to claim the status of persistent objector (at least with respect to any maturation of the norm beyond the United Nations Charter which has not been waived by its signing, though not ratification, of the International Covenant on Economic, Social and Cultural Rights in 1977).

\(^{416}\)For example, the following states, all of whom the World Bank calculates or estimates to be in the "high-income" category of per capita GNP, were supporters of the Declaration on the Right to Development: Australia, Austria, Bahamas, Belgium, Brunei, Canada, Cyprus, France, Ireland, Italy, Kuwait, Luxembourg, Netherlands, New Zealand, Norway, Qatar, Singapore, Spain, United Arab Emirates. World Bank, "Social Indicators of Development" (1994); Guruswamy, infra note 460 at 1302.

It is useful to quote also from the 1992 Rio Declaration, which posits a right to development and seeks only to qualify it in the sense of imposing some sort of sustainability constraint:

**1992 Rio Declaration**

**Principle 3**

"The right to development must be fulfilled so as to meet equally developmental and environmental needs of present and future generations (emphasis added)."

In addition, the World Conference on Human Rights in 1993 explicitly reaffirmed the right to development, even characterizing it in *universal* terms:

"The World Conference on Human Rights reaffirms the right to development, as established in the Declaration on the Right to Development, as a universal and inalienable right and an integral part of fundamental human rights."\(^{418}\)

The issue of the right to development as customary international law can be further studied by exploring state conduct itself. While the dimension of *opinio juris et necessitas* remains as elusive of documentation as ever, state practice can be evaluated according to whether it "recognizes developing countries as a special category" and engages in "consistent, widespread and coherent responses to the problems of developing countries."\(^{419}\) Two particularly significant areas of state conduct toward developing countries are official development assistance and international trade.\(^{420}\)

With respect to official development assistance, state practice toward developing countries seems to have at least some element of uniformity and generality:

"[A]ll members of the Development Assistance Committee (DAC) of the Organization for Economic Co-operation and Development (OECD) 'have adopted the promotion of Third World development as one of their serious and demonstrated national objectives.'

\(^{418}\) Vienna Declaration, par. 10, supra note 371 at 450.


\(^{420}\) See generally id. at 303-11.
The provision of development assistance is not limited to Western countries. Member States of the Organization of Petroleum Exporting Countries (OPEC) annually contribute nearly 3% of their GNP to development assistance. It could well be said that all countries not in need of aid, with the possible exception of the Soviet-bloc [sic], provide aid to developing nations.

These facts demonstrate that ODA [official development assistance] is a significant, nearly universal practice. The DAC has stated that 'global solidarity' is the motivation behind ODA. Thus, ODA is arguably an obligation of developed countries. The existence of such an obligation implies that the duty to cooperate has become part of international law.

But can it be said that ODA is an obligation imposed by international law? Professor Schacter argues that the international law of development incorporates 'a new conception of international entitlement to aid and preferences based on need.' The long history of grants of assistance and preferences to developing countries provides evidence of the acceptance by developed countries of this new responsibility. In addition, the obligation to provide ODA forms a part of the domestic laws of several nations.

Thus, it may be that on the basis of state practice, the obligation to provide ODA is now part of international law and forms an important part of the right to development."\(^{421}\)

With respect to recent state practice, it is particularly significant that developing countries are preferentially differentiated in the recent series of global environmental accords, as illustrated by the following excerpts:

**Montreal Protocol on Substances that Deplete the Ozone Layer**

**ARTICLE 5. SPECIAL SITUATION OF DEVELOPING COUNTRIES**

2. The parties undertake to facilitate access to environmentally safe alternative substances and technology for Parties that are developing countries and assist them to make expeditious use of such alternatives.

3. The Parties undertake to facilitate bilaterally or multilaterally the provision of subsidies, aid, credits, guarantees or insurance programmes to Parties that are developing countries for the use of alternative technology and for substitute products.

\(^{421}\)Rich, supra note 419 at 304-6 (footnotes omitted).
United Nations Framework Convention on Climate Change

ARTICLE 4: COMMITMENTS

3. The developed country Parties . . . shall provide new and additional financial resources . . . [to] developing country Parties [to help them carry out commitments of the convention].

8. [T]he Parties shall give full consideration to what actions are necessary under the Convention, including actions related to funding, insurance and the transfer of technology, to meet the specific needs and concerns of developing country Parties arising from the adverse effects of climate change and/or the impact of the implementation of response measures . . .

Convention on Biological Diversity

Article 20. Financial Resources

2. The developed country Parties shall provide new and additional financial resources to enable developing country Parties to meet the agreed full incremental costs to them of implementing measures which fulfill the obligations of this Convention . . .

Article 21. Financial Mechanism

1. There shall be a mechanism for the provision of financial resources to developing country Parties for purposes of this Convention on a grant or concessional basis . . .

As can be seen, there appears to be a strong element of uniformity as to the inclusion in recent conventions of the recognition of developing countries as a special category with special treatment accorded to their problems, although adherence to the conventions themselves is far from universal.

Further, the conduct of international financial institutions such as the World Bank, arguably acting as agents of their subscriber if not client states, can be seen as incorporating an element of preferential treatment toward developing countries.422 On the other hand, the conduct of the World Bank and IMF has also been criticized for insufficiently integrating the

422See generally id. at 306-7.
human rights framework into their agenda.\textsuperscript{423}

State conduct in international trade can also be interpreted as evidence of preferential treatment toward developing countries consistent with a right to development.\textsuperscript{424} Rich recounts how a recognition of the special position of developing countries changed the General Agreement on Tariffs and Trade (GATT) to promote the exports of less-developed countries.\textsuperscript{425} In addition, the second United Nations Conference on Trade and Development unanimously agreed in 1968 that preferences to developing countries should be established, and such preferences were incorporated into GATT in due course.\textsuperscript{426} Rich goes on to say that:

"The changes in state practice . . . confirm that developing countries constitute a special group in international law. Inclusion in this group is not identified primarily by colonial links, geography, or domestic economic systems. Rather, state practice has lifted the veil of sovereignty and recognized different levels of economic development underneath. Next, international law as determined by state practice now appears to recognize the principle of differential treatment."\textsuperscript{427}

\textsuperscript{423}See, e.g., Balakrishnan Rajagopal,"Crossing the Rubicon: Synthesizing the Soft International Law of the IMF and Human Rights", 11 Boston University International Law Journal 81, 97 (1993): "The IMF has changed its character to that of a medium- and long-term financial institution with an increasingly development-oriented mandate. As a result, it cannot ignore the changing contours of development which now encompass human rights. Also, this concern with development has led to closer collaboration between the IMF and development agencies. Such collaborative work has to coordinate the mutual positions on human rights. It is clear from the foregoing analysis that the right to development is an appropriate theoretical framework for the integration of human rights into current IMF policies and decisions. It provides a legitimate basis for the IMF to include human rights into its current agenda." (Footnotes omitted.) With respect to both the IMF and the World Bank, see also Danilo Turk, "Development and Human Rights", in Louis Henkin, John Hargrove (eds.), "Human Rights: An Agenda for the Next Century" 177-80 (1994).

\textsuperscript{424}Rich, supra note 419 at 307-11.

\textsuperscript{425}Id. at 307.

\textsuperscript{426}Id. at 308-9.

\textsuperscript{427}Id. at 309.
In sum, taking into account the relevant conventions, resolutions and state conduct, the views of publicists on the issue of whether the right to development has achieved the status of a norm of customary international law span the spectrum. Rich believed that the norm was in the process of emerging. Other publicists believe there is no binding right to development, while some believe it has already achieved the status of customary international law. Perhaps a legitimate middle ground can be found by viewing the emergence of some right to development as having largely transpired, but admitting that the operational binding content remains substantially unspecified, at least beyond the primary duty of states toward their constituent people(s) and some core minimum duty of developed states toward developing countries (e.g., of cooperation and/or aid which does not materially impair their own interests).

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429See, e.g., McClymonds, supra note 402 at 606.


431This characterization is an attempt to harmonize the dual aspects of "existence" and "ambiguity of content" in a way that reflects the actual course and current status of international discourse and conduct. For a discussion of this issue as it relates to self-determination, see supra p. 110.
ii) Human Right to Environment

According to one distinguished source: "There is a growing movement towards recognition of a basic human right to a safe environment." There are several familiar bases in international law to consider when analyzing the existence of a right to environment: conventions, customary international law, and general principles; in addition, a right to environment may be imputed to international law as a corollary to already established rights such as the right to life.

As in the case of the right to development, there are no global conventions explicitly establishing a right to environment, and we turn for leadership in that regard to a regional charter for Africa:

Banjul Charter

Article 24

All peoples shall have the right to a generally satisfactory environment favorable to their development.

More support for a right to environment can be found in the area of customary international law. According to the Stockholm Declaration:

Stockholm Declaration

Principle 1

Man has the fundamental right to freedom, equality and adequate conditions of life, in an environment of a quality that permits a life of dignity and well-being, and he bears a solemn responsibility to protect and improve the environment for present and future generations [emphasis added].

As seen earlier, the Stockholm Declaration achieved such broad support that there is a strong case that it is expressive of customary international law.\(^{433}\)

\(^{432}\) Henkin et al, supra note 59 at 1393.

\(^{433}\) Supra pp. 144ff. See also Gormley, supra note 446 at 98; Iveta Hodkova, "Is There a Right to a Healthy Environment in the International Legal Order?", 7 Connecticut Journal of International Law 65, 67 (1991), which also quotes the World Commission on Environment
A right to environment could also arise as a "general principle[ ] of law recognized by civilized nations."\textsuperscript{434} UN Special Rapporteur Ksentini summarizes provisions in sixty-one constitutions, numerous legislative pronouncements and a number of regional instruments dedicated to the environment.\textsuperscript{435} Of course, as Schachter points out, "considerable caution is still required in inferring international law from municipal law, even where the principles of national law are found in many 'representative' legal systems."\textsuperscript{436} However, Schachter's most important caveat, "that the principle be appropriate for application on the international level",\textsuperscript{437} seems easily met by environmental principles which naturally include transboundary and global commons dimensions. A more telling reservation might relate to the degree of uniformity with which the principle of environmental protection is enunciated in various municipal systems, both with respect to its content and its form as a human right.

Perhaps the strongest component of a case for a right to environment is imputing it as a corollary to already established human rights.\textsuperscript{438} UN Special Rapporteur Ksentini emphasizes

\begin{quote}
and Development, "General Principles concerning Natural Resources and Environmental Interferences" 25 (1986):

"All human beings have the fundamental right to an environment adequate for their health and well-being."
\end{quote}

But see Melissa Thorme, "Establishing Environment as a Human Right", 19 Denver Journal of International Law and Policy 301, 314 (1991), citing the "[a]bsence of a large segment of United Nations membership from the Stockholm Conference", but then claiming that its principles could have passed into customary international law in the subsequent decades.

\textsuperscript{434}Statute of the International Court of Justice, Article 38(1)(c).

\textsuperscript{435}UN Special Rapporteur Fatma Zohra Ksentini, "Human Rights and the Environment: Final Report" 81ff (July 6, 1994).

\textsuperscript{436}Oscar Schachter, "International Law in Theory and Practice" 50-55 (1991), as excerpted in Henkin et al, supra note 59 at 108.

\textsuperscript{437}Id.

\textsuperscript{438}The nature of the corollary relation has been variously interpreted as a "prerequisite or precondition", or as "an integral part of their enjoyment". Dinah Shelton, "Human Rights,
this connection between environmental and other human rights as follows:

"Although the provisions of the Universal Declaration of Human Rights and the International Covenant on Civil and Political Rights do not expressly establish any relationship between the environment and human rights, article 3 of the Universal Declaration and article 6 of the International Covenant refer to the right to life as inherent in the human person. Furthermore, this right is linked to a number of other rights. Thus, if the right to health, suitable working conditions, decent living conditions and so on was not respected, the right to life would be endangered; conversely, when that right is respected, the right to life is respected also. Hence, the question of the effect of the environment may be fitted into the same line of argument. A healthy and well-conserved environment would be a prerequisite for a healthy life.

Furthermore there are other rights which cannot be properly realized in the absence of a healthy environment. This applies to the economic, social and cultural rights stated in article 25 of the Universal Declaration of Human Rights and reflected in the International Covenant on Economic, Social and Cultural Rights, in particular 'the right [of everyone] to a standard of living adequate for the health and well-being of himself and of his family, including food, clothing, housing and medical care . . . '; these rights may be endangered by degradation of the environment."\(^{439}\)

This theme also underlies the Worldwatch Institute report on human rights and the environment by Aaron Sachs:

"Although existing human rights conventions were written too early to reflect an awareness of environmental issues, many accepted rights have implicit environmental components. The International Covenant on Civil and Political Rights, for instance, guarantees the basic right to life, and the International Covenant on Economic, Social and Cultural Rights guarantees the right to the highest attainable standard of health - both of which depend on a healthy environment."\(^{440}\)


While some connection exists between the environment and essentially the entire nexus of
human rights, the strongest corollary relationship relates to the most basic human right of all,
the right to life:

"According to Professor Galicki, 'The right to life is the most important among
all human rights legally guaranteed and protected by contemporary international
law. On the other hand, the right to life is the one which is, most of all,
connected to and dependent on proper protection of the human environment. It
is because this right, like no other, may be directly and dangerously threatened
by detrimental environmental measures. The right to life and the quality of life
depend directly on positive or negative environmental conditions.
Simultaneously, we cannot forget that this is an original right from which all
other human rights derive.'"441

This inseparability between environment and the right to life is further underscored by
Glavovic, a South African commentator:

"The most basic human right of all must surely be the right to survive. This
is an environmental issue, for the simple reason that human life will come
to an end if the environment is destroyed, and in recent years recognition
of a new human right to a minimum decent environment has emerged. Quite apart
from the issue of survival, there is a growing belief that the concepts of human rights
and civil rights should include some reference to the basic entitlement of every
individual to an amenable environment, which implies clean air and water, and
a natural and built environment which is not degraded."442

The Hague Declaration on the Environment, promulgated by a twenty-four state conference
initiated by France, the Netherlands and Norway, prominently highlighted the connection
between the environment and the right to life in its first two paragraphs:

Hague Declaration

The right to live is the right from which all other rights stem. Guaranteeing
this right is the paramount duty of those in charge of all States throughout the
world.

441 UN Special Rapporteur Ksentini, "Human Rights and the Environment: Preliminary
Report" 15 (Aug. 2, 1991), quoting a private communication from Professor Galicki of
Poland.

442 PD Glavovic, "Human Rights and Environmental Law: the Case for a Conservation Bill
Today, the very conditions of life on our planet are threatened by the severe attacks to which the earth's atmosphere is subjected.\textsuperscript{443}

In the words of Downs:

"[T]he right to a healthy and ecologically balanced environment is a highly reasonable derivative of the specifically enumerated rights to life and health."\textsuperscript{444}

However, as in the case of the right to development, the views of publicists with respect to a human right to environment span the spectrum: from "nonexistence"\textsuperscript{445}, to "emerging"\textsuperscript{446} or "desirable"\textsuperscript{447}, or even to "already in existence".\textsuperscript{448}

One of the strongest arguments against a right to environment is the lack of precision in its content. UN Special Rapporteur Ksentini addresses this issue directly:

"In the absence of a precise definition and content for this right, the Special Rapporteur considers that it would be a mistake to strive against all odds to delimit a notion whose main characteristic - and the source of its richness - is that it evolves."\textsuperscript{449}


\textsuperscript{444}Downs, supra note 386 at 377.

\textsuperscript{445}See, e.g. Frits Hondius, "Environment and Human Rights", 41 Annuaire de l'A.A.A. 76 (1971); Shutkin, supra note 50 at 505; Noralee Gibson, "The Right to a Clean Environment", 54 Saskatchewan Law Review 5, 10, 14-17 (1990), but saying that a right to environment was a right of individuals but not falling within the human rights category.


\textsuperscript{447}See, e.g., Downs, supra note 386 at 385; Thorme, supra note 433 at 341; Shelton, supra note 438 at 138.

\textsuperscript{448}See, e.g., Hodkova, supra note 433 at 80.

UN Special Rapporteur Ksentini goes on to quote Alexandre Kiss, comparing the need to invoke the social context in interpreting the content of a right to environment to the same need in well-accepted human rights:

"[I]n reality the situation is not so very different from that generally met with in the day-to-day implementation of human rights. Even when it comes to determining the content of 'traditional' rights and freedoms that have been recognized and practised in the democracies for a long time past, it may be necessary to resort to concepts that elude strict definition.

In most cases it is impossible to give an interpretation of the rights and freedoms guaranteed to the individual without reference to a historical and social context . . . It is reasonable to think that the same applies to the right to the environment; this right, like so many others, cannot be understood or applied without reference to the economic and social context of the time. Nowadays there is quite certainly a fairly clear picture in the public mind of an environment which should be conserved and from which everyone should be able to benefit."\(^{450}\)

In the final analysis, it seems reasonable to conclude that there is a strong case for the existence of a right to environment as a corollary to established human rights, reinforced by general principles and an element of custom. The core content of the right to environment can be identified as the environmental corollary to the right to life itself. The full content of the right to environment is as yet incompletely specified and is subject to further explication by general principles, custom and of course conventions.\(^{451}\)


\(^{451}\) See, e.g., the "Draft Principles on Human Rights and the Environment" contained in UN Special Rapporteur Ksentini, "Human Rights and the Environment: Final Report" 74-77 (July 6, 1994), which includes the affirmation that:

"All persons have the right to a secure, healthy and ecologically sound environment."
iii) Human Right to Sustainable Development

The issue addressed in this section is the existence of a right to sustainable development, either as a synthesis of rights to development and environment, or directly on its own terms. In this context, the synthesis of the rights to development and environment takes the form of the right to development being qualified or constrained by a sustainability constraint represented by the right to environment.

It is first necessary to point out the historical tension between developmental and environmental objectives, and to show how they have now been reconciled into largely reinforcing components of the new paradigm of sustainable development. Silveira described the significance of the United Nations Conference on Environment and Development (UNCED) in signalling the merger of development and environment:

"What, then, is the significance of the international agreements signed at UNCED? The Rio Declaration, Agenda 21, the Forest Principles, the Framework Convention on Climate Change and the Biodiversity Convention, together and separately, mark the marriage of environment and development. This is a major achievement. For decades there has been a tug of war between environment and development. For many countries and many different actors, they were viewed as irreconcilable opposites. Their respective proponents often spoke quite different languages. Now, for the first time in international law, a common language has been developed and a common purpose embraced.

Imagine, there is a consensus that this and future generations have the right to equitably satisfy their developmental and environmental needs. This is revolutionary! This marks an agreement and points the way toward a strategy, detailed in Agenda 21, for all people to work together to meet their needs, and those of their children and their children's children. In this sense, Rio is more than the culmination of fifty years of international environmental law. It is truly a new beginning."\(^{452}\)

Boutros Boutros Ghali, in his report "An Agenda for Development" as Secretary-General of the United Nations, further emphasized the link between development and the environment:

"Development and the environment are not separate concepts, nor can one be successfully addressed without reference to the other. The environment is a resource for development. Its condition is an important measure and its preservation a constant concern of development. Successful development requires policies that incorporate environmental concerns. This link was accepted at the United Nations Conference on Environment and Development (UNCED) in 1992." 453

In this regard, recall Principles 3 and 4 of the Rio Declaration:

"The right to development must be fulfilled so as to meet equitably developmental and environmental needs of present and future generations.

In order to achieve sustainable development, environmental protection shall constitute an integral part of the development process and cannot be considered in isolation from it."

This qualification of the right to development by a sustainability constraint was reaffirmed in nearly identical language at the World Conference on Human Rights in Vienna, 1993:

"The right to development should be fulfilled so as to meet equitably the developmental and environmental needs of present and future generations." 454

One of the world's most respected publicists, the late Judge Nagendra Singh, anticipated this synthesis of the rights to development and environment shortly after the Declaration on the Right to Development was promulgated by the United Nations. 455 Judge Singh first

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453 Boutros Boutros Ghali, "An Agenda for Development: Report of the Secretary-General" (par. 69), A/48/935 (May 6, 1994).


455 See Nagendra Singh, "Right to Environment and Sustainable Development as a Principle of International Law", Studia Diplomatica 45 (1988). Judge Singh was President of the International Court of Justice, a member of the Permanent Court of Arbitration, and had advanced legal degrees from four different countries.
underscored his belief in the existence of rights to development and environment:

"The aforesaid [Declaration on the Right to Development] confirms beyond doubt that a right to development is a recognised principle of international law, beyond any dispute.

It would be correct to state that the right to environment insofar as it relates directly to human existence and human survival is of the same category and potency as the right to life and peace[,] being a right claimed in the name of humanity . . . ." 456

Judge Singh reasoned that references in the Declaration on the Right to Development to duties of human beings to their communities and the requirement for cooperation among states resulted in a right to development qualified by a sustainability constraint:

"The exercise of the right to development involves exploitation of the environment and its limited natural resources and this gives rise to the concept of sustainable development because the environment has to be shared by the individuals of a nation with the entire human community in relation to human survival. Thus the two rights, namely that to environment and also to development go together as inseparable adjuncts and both have to be exercised subject to proper regulatory control." 457

One could not hope to summarize Judge Singh's analysis underlying a right to sustainable development any better than by quoting his own words:

"It is submitted that when individual rights are seen as rights which may be claimed by the whole of mankind, they become assimilated to an element of higher international law, namely the concept of the UN Charter. That category would also include the right to life, the right to peace, the right to an adequate environment and the right to sustainable development, all of which can be characterised as not merely political or moral rights, but also as juridical rights. They are part of modern natural law and are inalienable rights of a peremptory nature." 458

In a real sense, this right to sustainable development should not be viewed as some revolutionary newcomer in the pantheon of human rights. Rather, it is a progressive

456Id. at 48, 47.

457Id. at 48.

458Id. at 45-46.
qualification of the right to development by a sustainability constraint represented by the right to environment. The progressive specification and articulation of human rights, especially "third generation solidarity rights" such as development and environment, has always been contemplated as an adjunct to their legal evolution. In this sense, the synthesis of the rights of development and environment into a right to sustainable development is completely natural; though of course the progressive definition of the content of the right to sustainable development has far to go. In sum, it seems to be a reasonable perspective that to the extent the existence of the rights to development and environment are acknowledged, interpreting them in combination as a right to sustainable development has a credible analytic foundation.

In addition, a right to sustainable development, one version of which is derived above as an analytical synthesis of rights to development and environment, can also trace its roots directly to the United Nations Charter.

**United Nations Charter**

*Preamble*

We the peoples of the United Nations determined to save succeeding generations from the scourge of war . . . to reaffirm faith in fundamental human rights . . . to promote social progress and better standards of life in larger freedom . . . to employ international machinery for the promotion of the economic and social advancement of all peoples, have resolved to combine our efforts to accomplish these aims.

*Article 55*

[T]he United Nations shall promote:
(a) higher standards of living . . . and economic and social progress and development;
(b) solutions of international economic, social, health, and related problems; . . .
(c) universal respect for, and observance of, human rights and fundamental freedoms.

*Article 56*

All Members pledge themselves to take joint and separate action in cooperation with the Organization for the achievement of the purposes set forth in Article 55.

This binding pledge of states to promote social progress and development seems to
correspond to the component of "improvement of the world system" in the systems/social choice definition of sustainable development (see above pp. 28-39). However, as in the case of self-determination, this commitment in the United Nations Charter was phrased in general terms.

In 1969, the United Nations Declaration on Social Progress and Development interpreted the "social progress and development" of Article 55 in the Charter in the following terms:

**Declaration on Social Progress and Development**

*The General Assembly,*
*Mindful of the pledge of Members of the United Nations under the Charter to take joint and separate action in co-operation with the Organization to promote higher standards of living, full employment and conditions of economic and social progress and development,*
*Desirous of promoting the progress of all mankind towards these goals and of overcoming all obstacles to their realization,*
*Solemly proclaims this Declaration on Social Progress and Development and calls for national and international action for its use as a common basis for social development policies:*

**Part I, Principles**

**Article 1**

All peoples and all human beings, without distinction as to race, colour, sex, language, religion, nationality, ethnic origin, family or social status, or political or other conviction, shall have the right to live in dignity and freedom and to enjoy the fruits of social progress and should, on their part, contribute to it.

**Part II, Objectives**

Social progress and development shall aim at the *continuous* raising of the material and spiritual standards of living of all members of society, with respect for and in compliance with human rights and fundamental freedoms.

Social progress and development shall further aim at achieving . . . .

The creation of conditions for rapid and *sustained* social and economic development, particularly in the developing countries; change in international economic relations;

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459 Declaration on Social Progress and Development, UN General Assembly Resolution 2542 (Dec. 11, 1969).
new and effective methods of international cooperation in which equality of opportunity should be as much a prerogative of nations as of individuals within a nation.

Note first that Article 1 of the Declaration on Social Progress and Development uses the language of human rights. The Declaration also further underscores the close correspondence, if not equivalence, between the pledge in the United Nations Charter and the comprehensive concept of "improvement of the world system" embedded within sustainable development. Furthermore, by using terms such as "continuous raising of the material and spiritual standard of living" and "sustained social and economic development", the Declaration clearly incorporates the concept of sustainability corresponding to the "ongoing improvement of the world system" embedded within sustainable development (see above pp. 28-39).

It is useful to excerpt still further from the Declaration on Social Progress and Development:

Declaration on Social Progress and Development (cont'd)

Part III, Means and Methods
[T]he achievement of the objectives of social progress and development requires the mobilization of the necessary resources by national and international action, with particular attention to such means and methods as:

Article 14
(a) Planning for social progress and development, as an integrated part of balanced over-all development planning;
(b) The establishment, where necessary, of national systems for framing and carrying out social policies and programmes, and the promotion by the countries concerned of planned regional development, taking into account differing regional conditions and needs, particularly the development of regions which are less favoured or under-developed by comparison with the rest of the country;
(c) The promotion of basic and applied social research, particularly comparative international research applied to the planning and execution of social development programmes.

Article 15
(a) The adoption of measures to ensure the effective participation, as appropriate, of all the elements of society in preparation and execution of national plans and programmes of economic and social development . . .

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The planning procedures outlined in Article 14 seem to be a quite good description of procedural rationality. Article 15 requires the effective participation of all elements of society in the preparation and execution of development strategies. Together, Articles 14 and 15 seem to amount to the legitimacy constraint of rationality and equity on the social preference relation embedded in the systems/social choice definition of sustainable development (see above pp. 34-35).

The net result seems to be that a binding pledge in the United Nations Charter has been interpreted by the United Nations General Assembly in a way which corresponds closely with the systems/social choice definition of sustainable development. With respect to the authoritativeness of this interpretation, the pattern of voting on the Declaration on Social Progress and Development was virtually unanimous, with 119 states for, none opposing, and two abstentions.\textsuperscript{460}

Of course, the legally binding content of the right to sustainable development, as traced directly to the United Nations Charter, need not be exactly equivalent to the interpretation of the Declaration on Social Progress and Development; nor is there any bright line around the extension of the right to sustainable development, as derived from a synthesis of rights to development and environment, beyond a hard core representing a corollary to the right to life. Indeed, it seems reasonable to characterize the human right to sustainable development as emerging, at least in the sense that the substance and clarity of its content can be expected to continue to evolve, as the pursuit of sustainable development is reflected in general principles, custom, or international conventions (to which we now turn).

\textsuperscript{460}Lakshman Guruswamy, Sir Geoffrey Palmer, Burns Weston, "Supplement of Basic Documents to International Environmental Law and World Order: A Problem-Oriented Coursebook" 1300 (1994). Note that this Declaration was adopted without a roll call.
5. INTERNATIONAL CONVENTIONS AND SUSTAINABLE DEVELOPMENT

In this section, international conventions will be analyzed to determine whether they constitute another source of a duty of states to pursue sustainable development. But first, this analysis of international conventions will be contextualized by distinguishing it from the earlier sections on self-determination and human rights.

a) Distinguishing Duties to Pursue Sustainable Development Arising From Self-Determination, Human Rights and International Conventions

The duty of states to pursue sustainable development which arises from self-determination is on behalf of the peoples of the world. This is illustrated in Figures 15a and 15b, where the large ovals represent two states, the small ovals represent their constituent peoples, and the heavy dots represent the governments. The heavy arrows in Figure 15a represent the primary duty of each government and state to advance self-determination of its constituent people(s); the lighter arrows in Figure 15b represent the duty toward non-constituent peoples.

The import of Figures 15a and 15b is that the beneficiaries of the duty to pursue sustainable development arising from self-determination are the peoples of the world, though of course it is states in theory and governments in practice which have the authority, operational capacity and responsibility to vindicate that right.

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461 See above, pp. 69-148 for the duty in general, and pp. 117ff for the beneficiaries of the duty in particular.

462 Note that the extension of this analysis to the case of peoples which extend beyond the boundaries of states is straightforward: states continue to have a primary duty to that portion which they contain.
Figure 15: Duty to Pursue Sustainable Development Arising from Self-Determination, Human Rights and International Conventions

**Self-Determination and Human Rights**

(a) Primary Duty of States to Constituent Peoples

(b) Non-Constiuent Peoples

**International Conventions**

(c) States *qua* States as Beneficiaries

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463 See text for discussion.
Figure 15a also represents the duty of states which arises from a human right to sustainable development. The beneficiaries in this case are the constituent peoples of the state, to the extent that the right to sustainable development is a collective right. However, to the extent that a human right to sustainable development also inheres in individuals, then the arrows representing the duties could be seen to likewise extend all the way to individuals. Duties under international law for which peoples or individuals are the ultimate beneficiaries can also confer upon states the status of obligees, with corresponding rights to demand observance of those norms. For example, to the extent that a human right to sustainable development is an \textit{erga omnes} obligation (see footnote 634 below), then Figure 15b represents the right of states to vindicate that human right of even non-constituent peoples (or individuals); it is not clear however to what extent in this case that the interest of states reaches the stature of a duty.

As we have seen, one basis for the duties (and rights) depicted in Figures 15a and 15b can be international conventions, wherein states agree to bind themselves with respect to self-determination or human rights. Another basis for these duties can be customary international law, and international conventions can be evidence of, and expressive of, such customary international law. In these senses, international conventions can contribute to the legal foundation of the duty of states to pursue sustainable development for which peoples and even individuals are the beneficiaries, as depicted in Figures 15a and 15b.

However, international conventions can also constitute the basis of a conceptually distinct obligation on states to pursue sustainable development, wherein the beneficiaries of the duty are the states \textit{qua} states. This situation is depicted in Figure 15c, wherein three states are shown as mutually bound by a treaty or treaties to pursue sustainable development.

We have already analyzed the legal foundation of a duty to pursue sustainable development based on self-determination as reinforced by human rights, which duty is illustrated by Figures 15a and 15b. We shall now turn to the issue of the existence of international conventions to pursue sustainable development, in the sense of inter-state obligations with states \textit{qua} states as beneficiaries, as illustrated by Figure 15c.
b) Does the Existing Matrix of International Conventions Impose a Duty on States to Pursue Sustainable Development?

There already exists an extensive matrix of international conventions relating to sustainable development. For example, from one perspective, sustainable development can be operationally defined in some sort of comprehensive sense as the work product of the United Nations Conference on Environment and Development, in particular the Rio Declaration and Agenda 21:

"[T]he Rio Declaration and Agenda 21 may be considered the fundamental legal instruments for sustainable development. While neither document is legally binding, they both reflect the consensus of all member states of the United Nations, and, as such, have both political authority and moral weight. Further, they are comprehensive documents in that they attempt to address the full range of legal principles and political objectives, at international, regional, and national levels to reach sustainable development. For this reason, also, together they define sustainable development. Fundamental to this definition is the integration of environment and development." 464

From this perspective, existing conventions which relate to either the Rio Declaration or Agenda 21 also relate to sustainable development. As part of the process of implementing Agenda 21 (Chapter 39: "International Legal Instruments and Mechanisms"), the United Nations Department for Policy Coordination and Sustainable Development has initiated an inventory of existing legal instruments related to the Rio Declaration or Agenda 21, in other words related to sustainable development. 465 This inventory is restricted to regional or universal instruments, but otherwise is based on a liberal interpretation of whether particular instruments are relevant to sustainable development. 466

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465 Id. at 248-49.

466 Id. at 249.
This inventory includes eighty-seven legal instruments, in the draft as of October 30, 1995, which are related to sustainable development.\textsuperscript{467} Of those eighty-seven legal instruments, fully seventy-two represent treaties, conventions or agreements which have come into force. From that number, we will survey nine binding instruments for which the primary obligees are states \textit{qua} states (in the sense discussed above) and which are of particular interest in assessing whether the existing matrix of international treaties, conventions and agreements imposes a duty on states to pursue sustainable development. At the outset, however, it would be fitting to briefly discuss the significance of the United Nations Charter in this context.

1. \textbf{United Nations Charter, 1945}

The United Nations Charter is the basic constitutive document of international law in the post-War era. Its basic themes are international peace and security, human rights in greater freedom, and economic and social progress and development. These themes resonate with the most fundamental dimensions of sustainable development. From one perspective, a major portion of the post-War matrix of international conventions can be seen as the progressive codification of the commitments and agenda proclaimed in general terms in the Charter.

2. \textbf{General Agreement on Tariffs and Trade (GATT), 1948-93}\textsuperscript{468}

GATT mandates that parties extend "most-favored-nation treatment" to other parties (i.e., any import or export preference extended to any country must be extended to all parties); and that parties refrain from discriminating against imports vis-a-vis domestic products, with certain general exceptions. While there are more specific linkages to sustainable development, perhaps the fundamental connection is the theory that reduction of trade barriers increases total economic welfare (at least if it does not forestall "incubating" industry sectors), which is directly related to the "ongoing improvement" component of sustainable development.

\textsuperscript{467}Interagency Consultations on Chapter 39 of Agenda 21: International Legal Instruments and Mechanisms" (Oct. 30, 1995).

\textsuperscript{468}General Agreement on Tariffs and Trade (GATT) (Geneva, Oct. 30, 1947), as quoted in Guruswamy et al, supra note 460 at 1125ff. See also below, pp. 276ff.
3. Convention for the Protection of the World Cultural and Natural Heritage, 1972.\textsuperscript{469} Parties undertake to identify, protect, conserve and preserve the cultural and natural heritage of outstanding universal value located on their territory, to assist other parties in those undertakings if requested, and to refrain from damaging such cultural and natural heritage. Protection of such cultural and natural heritage is a core component of sustainable development, most obviously from the terminological perspective of the "maintenance of capital" paradigm.

4. Convention on International Trade in Endangered Species (CITES), 1973.\textsuperscript{470} Parties place into Appendix I those plants and animals currently endangered by extinction, and strictly regulate their trade, which is "authorized only in exceptional circumstances".\textsuperscript{471} Appendix II species are considered liable to become endangered, and their trade is regulated.\textsuperscript{472} Appendix III species are regulated by one state party seeking enforcement cooperation by other parties.\textsuperscript{473} As in the case of cultural and natural heritage, protection of endangered species is a core component of sustainable development, most obviously from the terminological perspective of the "maintenance of capital" paradigm.\textsuperscript{474}

\textsuperscript{469}UNESCO Convention for the Protection of the World Cultural and Natural Heritage, as quoted in Kiss, supra note 364 at 391.


\textsuperscript{471}Kiss, supra note 364 at 258.

\textsuperscript{472}Id. at 259.

\textsuperscript{473}Id. at 260.

\textsuperscript{474}Of course, the extent of allowable trade-offs between protecting endangered species and other objectives, from the perspective of the capital maintenance paradigm, would depend on the form of any substitutability constraint (see discussion supra, pp. 19ff).

Parties to this convention "endeavour to limit and, as far as possible, gradually reduce and prevent air pollution including long-range trans-boundary air pollution" (art. 2). By means of information exchange, consultation, research and monitoring, parties undertake to "develop without undue delay policies and strategies" to combat air pollution (art. 3). Parties further agree to cooperate in research and development for pollution reduction technology, monitoring, modeling, assessment or alternative policies and education (art 7). These undertakings directly relate to the environmental quality aspect of sustainable development (see above p. 65).


UNCLOS "proclaims that states have a general obligation to protect and preserve the marine environment". In particular, "States must combat pollution of the marine environment from all sources", including "land-based sources, vessel-source pollution, and atmospheric pollution". Flag states, port states and coastal states have an "obligation to take into account or enact and enforce internationally agreed rules and standards". In some cases "the state's duty to adopt laws and regulations conforming to international rules and standards does not depend on its ratification of a particular agreement or its actual participation in the adoption of a rule or standard; it is enough that the international rules and standards be 'generally accepted'. Further, resources on the ocean floor are explicitly designated as the

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477 Kiss, supra note 364 at 168.

478 Id.

479 Id.

480 Id. at 170.
common heritage of mankind. In general, UNCLOS contains extensive provisions able to strongly reinforce sustainable development with respect to pollution of the marine environment and equitable development of resources on the ocean floor.

7. Vienna Convention and Montreal Protocol, 1985-92\textsuperscript{481}

With respect to stratospheric ozone depletion, the Vienna Convention of 1985, Montreal Protocol of 1987, London Revisions of 1990 and Copenhagen Amendments of 1992 represent a remarkable example of the effective incorporation of scientific research into policy formulation and subsequent international agreements, in the context of a situation of extreme potential danger. There is clearly a profoundly close relationship between sustainable development and preservation of the stratospheric ozone layer.\textsuperscript{482}

8. Basel Convention on Control of Transboundary Movements of Hazardous Wastes, 1989\textsuperscript{483}

This convention covers the transboundary movement of a broad range of hazardous wastes. Parties undertake to minimize the generation and transboundary movement of hazardous waste, provide adequate disposal facilities, prevent pollution by hazardous waste and minimize the consequences if it does occur, restrict the import or export of hazardous waste if the environmental soundness of its management would be jeopardized, provide information about transboundary movement of hazardous waste to concerned states, criminalize illegal traffic in hazardous waste, and cooperate with the other parties. As can be seen, these provisions directly reinforce the environmental quality dimension of sustainable development.

\textsuperscript{481}Vienna Convention for the Protection of the Ozone Layer (Mar. 22, 1985), Montreal Protocol on Substances that Deplete the Ozone Layer (Sep. 16, 1987), London Amendments to the Montreal Protocol on Substances that Deplete the Ozone Layer (June 29, 1990), and "Copenhagen Amendments" to the Montreal Protocol (Nov. 23-25, 1992), as quoted in Guruswamy et al, supra note 460 at 424, 454, 471, 504. For further discussion see infra pp. 249ff.

\textsuperscript{482}See infra, pp. 235ff.

\textsuperscript{483}Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (Mar. 22, 1989), as quoted in Guruswamy et al, supra note 460 at 975.

Parties commit to adapt or develop national strategies for the "conservation and sustainable use of biological diversity" (art. 6), including: identifying and monitoring significant components of biological diversity and identifying potentially adverse processes (art. 7), and initiating programmatic "in-situ" (i.e., genetic resources within natural habitats) and "ex-situ" conservation (arts. 8 and 9). Access to genetic resources is under the authority of national governments, and "the results of research and development and the benefits arising from the commercial and other utilization of genetic resources" are to be shared "in a fair and equitable way" with the state providing the genetic resource (art. 15). Developed states commit to providing "new and additional financial resources" to help developing states implement their obligations under the convention (art. 20).


The "ultimate objective" of the Framework Convention on Climate Change is "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system" (art. 2). Underlying principles include: protecting the climate system "for the benefit of present and future generations"; being guided by "specific needs and special circumstances of developing country Parties"; taking "precautionary measures" and adopting comprehensive policies which "cover all relevant sources, sinks and reservoirs of greenhouse gases and adaptation" (art. 3). Parties commit to: inventory national anthropogenic sources and sinks of greenhouse gases; cooperate in archiving climate observations; develop and make available technologies and practices to control anthropogenic emissions of greenhouse gases; cooperate in education and exchange of information; adopt mitigation programmes; and cooperate in adaptation strategies (art. 4(1)).

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484 Convention on Biological Diversity (UNCED, June 5, 1992), as quoted in Guruswamy et al, supra note 460 at 1097.

485 United Nations Framework Convention on Climate Change (UNCED, May 29, 1992), as quoted in Guruswamy et al, supra note 460 at 484.
Designated developed countries further commit to take the lead in developing and submitting detailed information on mitigation strategies "with the aim" of returning anthropogenic emissions of greenhouse gases not already covered by the Montreal Protocol "to their 1990 levels" (art. 4(2)). Specified developed countries further commit to "provide new and additional financial resources" to fund developing countries' obligations under the convention (art. 4(3)), and to "promote, facilitate and finance access to environmentally sound technologies", especially for developing countries (art. 4(5)). Parties to the convention agree to "give full consideration to what actions are necessary ... to meet the specific needs and concerns of developing country Parties arising from the adverse effects of climate change and/or the impact of the implementation of response measures" (art. 4(8)).

In addition, a "Conference of the Parties" is established to oversee the framework convention, with broad authority to: periodically examine obligations; facilitate coordination of measures; consider amendments - to be adopted by consensus, or as a last resort by a three-fourths majority vote, but binding on Parties only upon their individual acceptance; and exercise other functions "required for the achievement of the objective of the Convention" (arts. 7, 15). It is evident that the objectives of the Framework Convention on Climate Change and the breadth of its approach relate across the board to sustainable development, despite the absence as yet of specific binding timetables for emissions reductions or specific financial commitments.
These international conventions speak directly and with authority toward preserving mankind's heritage, including ocean resources, regional air sheds, global climate systems, biodiversity and endangered species, and cultural heritage. There are significant commitments to promote economic growth through trade and to provide new and additional financial support to developing countries. These international conventions call for domestic initiatives and international cooperation to formulate and implement cost-effective strategies to preserve and enhance the environment, based on meaningful research and with the participation of affected countries and broad segments of society including non-governmental organizations.

If the entire matrix of international conventions, represented in part by these ten instruments, were universally ratified and complied with faithfully in both the letter and spirit, then that would accomplish in substantial part at least the environmental component of the pursuit of sustainable development. However, there are several reservations to this conclusion:

1. Not all states have signed all conventions.
2. Compliance is hardly uniform.
3. Duties are not articulated with uniform specificity.
4. Duties are only extra-territorial, in the sense noted in the preamble to the Framework Convention on Climate Change:

"Recalling also that the States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental and developmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction[.]"

Therefore, the set of state obligations resulting from the matrix of international conventions seems so far to relate only partially to any comprehensive mosaic of sustainable development. In particular, the set of duties arising directly from this matrix of international conventions is in some ways less potent than the duty to pursue sustainable development arising from self-determination as reinforced by human rights, which applies both extra-territorially and within borders to all states, for the benefit of the peoples of the world.
6. APPLICATION OF THE LEGAL DUTY OF STATES TO PURSUE SUSTAINABLE DEVELOPMENT: SELECTED ISSUES

This section will address selected issues concerning the application of the legal duty to pursue sustainable development. First, the legal merits of the systems/social choice definition of sustainable development will be discussed. Next, selected hypothetical situations and the analytical approach by which they might be addressed will be presented. We will then examine the feasibility of sustainable development. Finally, the political prospects for sustainable development will be considered.

a) Legal Merits of the Systems/Social Choice Definition

At this stage, it is appropriate to ask the question: are there independent legal grounds which support the systems / social choice formulation of sustainable development, in particular relative to alternative definitions?

Legal grounds in support of the systems / social choice definition include:
1) the fact that it is capable of resolving ambiguities inherent in alternative definitions, and without recourse to unrealistic substitutability assumptions and without disturbing implications from social choice theory;
2) there is significant legal precedent for the legitimacy constraint on the social preference relation embedded in the systems / social choice definition, in particular with respect to the equity constraint of access to information and participation by those affected.

i) Resolution of Ambiguity
The underlying objective expressed by the Stockholm and Rio Declarations can be characterized as safeguarding of human welfare, now and in the future, through both development and environmental protection. Nevertheless, there has been significant ambiguity
concerning what sustainable development means. This ambiguity is overcome by the 
systems/social choice definition of sustainable development, which precisely restates this 
underlying objective as ongoing improvement of the world system according to a legitimately 
constructed social preference relation.

We have seen that unlike the systems/social choice definition, the alternative definitions of 
sustainable development are: 1) unattainable due to vagueness or infeasibility, 2) unrealistic 
in their assumptions, and/or 3) subject to the disturbing concentration of decision-making 
power implied by Arrow's Theorem. In general, ambiguity should be resolved by an 
interpretation which is meaningful, feasible, realistic and beneficial.\textsuperscript{486} Therefore, there is 
support for the systems/social choice definition of sustainable development relative to the 
alternative definitions. The systems/social choice definition is further legitimizes by its deep 
roots in those alternative expressions of sustainable development over the years which have 
been so instrumental in engendering world-wide political support.

\textbf{ii) Legitimacy Constraint of Rationality and Equity}

There is also legal support for the legitimacy constraint on the constructed social preference 
relation. The legitimacy constraint can be characterized as dual constraints of rationality - in 
the form of procedural rationality, and equity - such as a right to information and participation 
by those affected. There is \textit{implicit} legal support for the rationality constraint that the duty 
must be discharged by conduct consistent with procedural rationality. The very concept of a 
duty to pursue an objective would have no meaning if it could be discharged by superficial, 
incompetent or pro-forma conduct which failed even to consider relevant information.

There is also \textit{explicit} legal support for the equity constraint of access to information and 

\textsuperscript{486}Corpus Jurus Secundum Sec. 316 (1994). While this reference applies specifically to a 
statutory construction principle of United States law, the logic of the principle makes just as 
much sense in the context of international law.
participation by those affected. Such a right on the part of a citizenry has been included in domestic laws, interstate treaties, regional accords and United Nations instruments.\textsuperscript{487} In particular, recall that the Rio Declaration called for environmental issues to be addressed "with the participation of all concerned citizens", including "appropriate access to information" in addition to "the opportunity to participate in decision-making processes" (supra p. 147).

Boer has articulated with particular clarity the significance of public participation in this context:

"The Rio Declaration on Environment and Development and Agenda 21 both recognize that it is of vital importance to involve all concerned groups and individuals to achieve environmental goals. In the context of a discussion on human rights and sustainability, this is a particularly significant element.

The nature of this participation is not one of simple 'consultation', but a genuine exchange of information and a role in decision-making. It is seen as a form of partnership implying a long-term commitment.

The minimum participation necessary in national policy development for developing sustainability strategies is effective involvement of all government sectors and its legal system, involvement of different levels of government, NGOs, the private sector and relevant communities."\textsuperscript{488}

There is also support in customary international law for a similar right on the part of affected states: In a thoughtful analysis, Geoffrey Palmer synthesizes the relevance of three cases widely cited by international lawyers: the *Corfu Channel* case stands for the proposition that

\textsuperscript{487}Kiss and Shelton, supra note 364 at 7-16 in the 1994 Supplement.

\textsuperscript{488}Ben Boer, "Implementation of International Sustainability Imperatives at a National Level", in Ginther, supra note 24 at 124-25. See also Philippe Sands, Jacob Werksman, "Procedural Aspects of International Law in the Field of Sustainable Development: Citizens' Rights", in id. at 180-87. But see generally, Barry Munslov, Francois Ekanga Ekoku, "Is Democracy Necessary for Sustainable Development?", 2(2) *Democratization* 158 (1995), which reviews a series of authors which see "participation and empowerment" as key to sustainable development, but concludes that the connection is actually more in the nature of an association able to avoid pathologies of development in some cases.
"a nation that knows of harmful effects that may occur to other nations, and fails to disclose those known facts, will be liable to the nation that suffers damages"; the *Trail Smelter Arbitration* establishes that "no state has a right to use its territory in such a manner as to cause injury to the atmosphere by emissions when serious consequences result, and the injury to the atmosphere is established by clear and convincing evidence"; according to the *Lake Lanoux Arbitration* "there is a duty for the acting state to give notice to another state where the actions of the former may impair the environmental enjoyment of the latter".\(^{489}\)

One expression of these principles is found in the Rio Declaration which proclaims that: "States shall provide prior and timely notification and relevant information to potentially affected states on activities that may have a significant adverse transboundary environmental effect and shall consult with those states at an early stage and in good faith."\(^{490}\)

\(^{489}\)Palmer, supra note 128 at 214.

b) Selected Hypothetical Situations

It may be helpful at this point to apply the foregoing theoretical legal analysis to selected situations in order to identify some of the legal principles which come into play in the different contexts. The situations which will be considered include: 1) a government defying the wishes of the world community and its constituent peoples for sustainable development, 2) a government along with its constituent peoples objecting to sustainable development, 3) a dispute over a regional commons in the form of a fishery in international waters, and 4) a state failing to take into account the interests of other states with respect to global commons issues.

i) Government Violates Duty to Pursue Sustainable Development over the Objection of Constituent People(s)

**Situation**

A government violates its duty to pursue sustainable development, over the objection of its constituent people(s).

**Analysis**

We have seen that states have a positive duty under international law to advance people's right to self-determination, which is a particularly strong responsibility in the case of a state's own constituent peoples.\(^{49}\) Therefore, in this case the government would be in violation of its duty under international law.

The first enforcement mechanism in this case is internal political pressure by the constituent

\(^{49}\text{Supra, p. 120.}\)
people(s), as citizens exercising their "internal" right to self-determination.  Another enforcement mechanism could be political or economic pressure by other states, legitimated by their own sovereignty and by their duty to advance the right of (even non-constituent) peoples to self-determination. However, this enforcement mechanism must be balanced against the territorial integrity of the violating state and by the United Nations Charter stipulation that disputes be resolved peacefully.

Promising future avenues to resolve such issues could also include the International Court of Justice or the Permanent Court of Arbitration. Both are highly respected institutions which have expressed a willingness to perform a constructive role in environmental disputes. 493 According to the International Court of Justice, the result could be substantive legal consequences for a violator, along with enforcement responsibilities for the world community:

"A binding determination made by a competent organ of the United Nations to the effect that a situation is illegal cannot remain without consequence. Once the [International Court of Justice] is faced with such a situation, it would be failing in the discharge of its judicial functions if it did not declare that there is an obligation, especially upon Members of the United Nations, to bring that situation to an end. As this Court has held, referring to one of its decisions declaring a situation as contrary to a rule of international law: 'This decision entails a legal consequence, namely that of putting an end to an illegal situation' ... " 494

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492 The "internal" right to self-determination, sometimes referred to as democratic governance, is expressed for example in the Universal Declaration of Human Rights: "The will of the people shall be the basis of the authority of government; this will shall be expressed in periodic and genuine elections which shall be by universal and equal suffrage and shall be held by secret vote or by equivalent free voting procedures." Article 21(3) Universal Declaration of Human Rights (1948).

493 See below, p.281.

494 Namibia, ICJ Reports 42 (1971).
ii) Government and Constituent People(s) Object to Pursuit of Sustainable Development

**Situation**

The government of a state, along with its constituent people(s), objects to the pursuit of sustainable development.

**Analysis**

In this case, the objecting state has two possibly conflicting duties: towards its constituent people(s) and towards the non-constituent peoples. To resolve this potential conflict, two factors must be considered: 1) the differentiated nature of the two duties, and 2) the relative intensity of the impact on the two sets of peoples. Taking them in turn: 1) While the government of a state may have a duty to advance the right of even non-constituent peoples to self-determination, there is a clearly differentiated and much stronger duty toward its constituent people(s).\(^{495}\) 2) The relative intensity of the impact on the two sets of peoples varies according to the impact: *strictly internal*, *transboundary*, and *global commons*.

A case can be made that for *strictly internal issues*, the objecting state needn't pursue sustainable development if it has the concurrence of its constituent people(s). This follows from the people's right to self-determination and the principle of sovereignty, which is sustained by the principle of territorial integrity.\(^{496}\) However, the case can also be made that in our tightly integrated world permeated by economic, social and ecological interdependency, it is relatively rare that significant environmental or development issues are strictly internal.

For *transboundary issues*, which affect neighboring or regional states, even an objecting state

\(^{495}\) See, e.g., supra p. 120.

\(^{496}\) For example: "States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental and developmental policies..." Principle 2 of the Rio Declaration on Environment and Development (1992).
has a duty under customary international law called "sic utere". This duty forbids causing extra-territorial environmental damage. While "sic utere" may be honored more in the breach than in the observance, it is generally considered by commentators to have achieved the status of customary international law. Furthermore, "sic utere" is conceptually reinforced by the duty of the state objecting to sustainable development to nevertheless respect the right of the affected non-constituent peoples to self-determination and the pursuit of their sustainable development.

For global commons issues, the same principle of "sic utere" might again be applied, but perhaps with less force since it is breached with near-complete generality. The difference in the generality of breaches between transboundary and global commons pollution is presumably because neighboring or regional states have a relatively distinct interest in objecting to transboundary effects, while individual states have a literally diluted interest in objecting to commons degradation, in which they participate anyway.

On the other hand, the duty of the objector state to advance the right of non-constituent peoples to self-determination and the pursuit of sustainable development is correspondingly stronger, since the relative importance of the extra-territorial impact increases due to the cumulative preponderance of non-constituent peoples.

497 This principle of customary international law is referred to as "sic utere tuo ut alienum non laedas", or "use your territory so as not to damage others". For example: "States have ... the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or areas beyond the limits of national jurisdiction." Principle 2 of the Rio Declaration on Environment and Development (1992).


499 Indeed, the complete generality of state conduct in degrading the global commons would seem to militate against such conduct violating customary international law, or at least call into question its legal wrongfulness under doctrines of (implied) consent or necessity. For an exposition of the doctrines of consent and necessity, see Louis Henkin, et al., supra note 59 at 561-62, 564-66.
iii) Policy Coordination for a Fishery in International Waters

Situation
A participating state in a voluntary quota system for a fishery in international waters violates its quota. The participant closest to the fishery, with a predominant quota, unilaterally enforces the quota to prevent exhaustion of the fishery.\textsuperscript{500}

Analysis
Classical legal analysis faults the enforcer for instigating a breach of the peace in international waters. The quota system is voluntary, and the United Nations Charter mandates peaceful settlement of disputes. This situation exemplifies the inadequacy of the classical approach to commons problems. There is a "prisoners' dilemma" where each participant has an incentive to "defect", encouraging an equilibrium determined by the lowest common denominator. From the analysis of the previous situation, we saw that even objector states have a duty to pursue sustainable development with respect to issues with sufficient extraterritorial effects.

It is conceptually possible for policy sets to be consistent with sustainable development even without including coordination of policies concerning a commons resource (though the outcome would presumably be suboptimal if potential gains from coordination were not realized). But if that salubrious consistency with sustainable development has not yet been achieved, a focally attractive strategy and politically opportune alternative is for states to assume an obligation to coordinate their policies towards commons resources. Such an obligation could mature to a norm of customary international law directly by custom, or might

\textsuperscript{500} A very similar situation occurred in an international incident where Canada used force to prevent Spain from disregarding North Atlantic halibut quotas set by the North Atlantic Fisheries Organization. See, eg., Craig Turner, "Canada - Europe Flap over Atlantic Fish Intensifies", \textit{Los Angeles Times} A4 (March 15, 1995).
even be implied by the duty to pursue sustainable development. It should be noted that coordination might conceivably exhaust the commons resource, even consistent with system-level sustainable development (consider, e.g., harvesting all the manganese nodules on the ocean floor). But absent system-level sustainable development, the uncoordinated and suboptimal exhaustion of a commons resource would seem to be distinctly unjustified.

iv) Failure to Take Into Account the Interests of Other States with respect to the Global Commons

**Situation**

A state adopts a policy set which is consistent with sustainable development, with respect to the initial state of the world, an eligible social preference relation, and a particular time horizon. However, it does not effectively take into account the interests of other states about global commons issues during construction of the social preference relation.

**Analysis**

The state has adopted a policy set which is consistent with sustainable development with respect to the initial state of the world, an eligible social preference relation, and a particular time horizon. However, that constructed social preference relation fails the equity component of the legitimacy constraint, since it does not effectively take into account the interests of those affected by the global commons issues. Therefore, the state has not satisfied its duty under international law to advance peoples' right to self-determination and the pursuit of sustainable development.

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501 Consider the following particularly articulate expression of this idea: "In the exploitation of natural resources shared by two or more countries, each State must co-operate on the basis of a system of information and prior consultation in order to achieve optimum use of such resources without causing damage to the legitimate interest of others." Charter of Economic Rights and Duties of States - Draft Resolution of the Group of 77, Article 3, as quoted in Karl P. Sauvant, Joachim W. Muller, "The Collected Documents of the Group of 77 (Volume XX, Special Anniversary Edition)" 359 (1995). See also "Resolution on Co-operation in the Field of the Environment Concerning Natural Resources Shared by Two or More States", UN General Assembly Resolution 3129 (Dec. 13, 1973), 13 I.L.M. 232 (1974).
c) Feasibility of the Duty to Pursue Sustainable Development

There are different perspectives on the feasibility of implementing sustainable development. Some writers focus on alarming projections of ecosystem degradation; others extrapolate past upward trends in human welfare. After discussing the challenges and opportunities below, we will see that: 1) it is inappropriate to prejudge this issue, and 2) the pursuit of sustainable development is certainly possible. In section (d), we will further see that the prospects for political implementation of the pursuit of sustainable development are at least in some respects theoretically encouraging, although complacency is definitely unwarranted.

i) Challenges of Maladaptive Feedback Loops in World System

It might be said that sustainable development is impractical and therefore inconsistent with the notion of a legal duty. The issue of possible infeasibility of sustainable development can be best considered from the perspective of possible maladaptive feedback loops in the world system, including the growth of human population, the tragedy of the commons, and delays or uncertainty in information.

The growth of human population is a dominant positive feedback loop in the world system. As the human population grows, the burden it places on the world system increases. But the scale of human activity could already be above the carrying capacity of the world system. While patterns of development which include some version of the demographic transition can achieve dramatic reductions in population growth, higher standards of living seem to be a precondition. These higher standards of living, and the population increases latent in the existing age distribution of the world population, will increase still further the human impact

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502 See, e.g., Robert Solow, "Sustainability: An Economist's Perspective" (Woods Hole Oceanographic Institute lecture of June 14, 1991), where he compares a duty of sustainable development to an unrealistic duty that somebody fly around a room like Peter Pan.

503 See the discussion in Robert Costanza, Herman E. Daly, "Natural Capital and Sustainable Development", 6(1) Conservation Biology 37 (1992).
on the world system.\textsuperscript{504} If, instead, human population were to suffer a catastrophic collapse, that too could hardly be considered sustainable development.

The \textit{tragedy of the commons} is an example of how partly-open feedback loops can adversely affect the world system.\textsuperscript{505} If the marginal private benefit of resource exploitation exceeds the marginal private cost, the resource will be exploited, even if total costs (including "external" social costs) exceed total benefits. In other words, the decision-maker is failing to take into account important feedback. In effect, it is a dominant strategy not to cooperate when faced with an incentive structure like the prisoner's dilemma. Tradeable property rights\textsuperscript{506} and Pigovian taxes can rectify this problem in some cases. However, global commons are susceptible to excessive exploitation due to the least common denominator syndrome.

\textit{Delays in information} correspond to lags in feedback loops, and are capable of destabilizing the world system. There are a myriad of complex economic and environmental challenges. The longer it takes to recognize the nature and magnitude of a problem, the more likely is a scenario of overshoot and collapse.

These problems are compounded by the nature of the world system in general, and the human social subsystem in particular. These systems are multiple loop nonlinear feedback systems, which are inherently counterintuitive.\textsuperscript{507} Flagrant symptoms often point to focally attractive, \hfill\\

\textsuperscript{504}For example, the World Commission on the Environment and Development called for an economic expansion of 5 to 10 times, in order to achieve an acceptable standard of living for the world's population.


\textsuperscript{506}The Coase theorem states that an efficient outcome will result from well defined, enforceable property rights, costless negotiations, no income effects, and perfect information.

\textsuperscript{507}This discussion follows Jay Forrester, "World Dynamics" 94-95 (1971) and Jay Forrester, "Counterintuitive Behavior of Social Systems" in "Collected Papers of Jay W.
but ultimately insensitive, control points. In fact, truly sensitive control points can be quite rare. In addition, the goals of a subsystem typically conflict with overall system welfare, as in the commons problem. Finally, the short term and long term impact of policy changes can be quite opposite. In that case, politically unacceptable degradation of near-term "development" may be necessary for long term "sustainability".

ii) Perhaps the Sky Can be Kept From Falling?
With respect to the realism of the pursuit of sustainable development in the face of the maladaptive feedback loops of the world system discussed above, it may be helpful to relate the views of upbeat authors and to illustrate the spectrum of options available to government policymakers.

A central issue of environmental projections is resource scarcity. In 1980, Julian Simon bet Paul Ehrlich, John Holden and John Harte that the prices of five metals would not rise during the 1980s. He won the bet in 1990, and has not been taken up on a renewed offer:

"My central proposition here is simply stated: Almost every trend that affects human welfare points in a positive direction, as long as we consider a reasonably long period of time and hence grasp the overall trend."

"I am so sure of all these upbeat statements that I offer to bet on them, my winnings going to fund new research. Here is the offer: You pick (a) any measure of human welfare - such as life expectancy, infant mortality, the price of aluminum or gasoline, the amount of education per cohort of young people, the rate of ownership of television sets, you name it; (b) a country (or a region such as the developing countries, or the world as a whole); (c) any future year, and I'll bet a week's or a month's pay that that indicator shows improvement.

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Forrester" 211, 220-21 (1975).

For example, Jay Forrester expresses the opinion, in "World Dynamics" 95, that birth control technology could be a misleadingly focal policy option which may not significantly affect aggregate birth rates.

relative to the present while you bet that it shows deterioration."  

Simon adopts a variant of the "anthropomorphic principle" of cosmology, i.e., a consistent secular improvement in human welfare is a precondition for the species having gotten this far:

"A general process underlies these specific findings [that 'almost every trend' of human welfare 'points in a positive direction']. That general process is that, on average, human beings create more than they use in their lifetimes. It has to be so or we would be an extinct species. This process is, as the physicists say, an invariancy. It applies to all metals, all fuels, all food, all measures of human welfare. It applies in all countries. It applies in all times. In other words, this is a theory of all of economic history. This is the theory which I believe explains how these good things can all be happening at once."

Likewise, in a compendium which concludes that "the arrow of the human prospect points upward", Easterbrook uses arguments fundamentally based on extrapolation of past trends like Simon, to make the following cases:

"That in the Western world, pollution will end within our lifetimes, with society almost painlessly adopting a zero-emissions philosophy. That several categories or pollution have already ended. That the environments of Western countries have been growing cleaner during the very periods the public has come to believe they are growing more polluted. That First World industrial countries, considered the scourge of the global environment, are by most measures much cleaner than developing nations. That most feared environmental catastrophes, such as runaway global warming, are almost certain to be avoided. That far from becoming a new source of global discord, environmentalism, which binds nations to a common concern, will be the best thing that's ever happened to international relations. That nearly all technical trends are toward new devices and modes of production that are more efficient, use fewer resources, produce less waste, and cause less ecological disruption than technology of the past. That there exists no fundamental conflict between the artificial and the natural. That artificial forces which today harm nature can be converted into allies of nature in an incredibly short time by natural.

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510 Id. at 20-21.

511 Id. at 133-34. See also the relatively optimistic discussion on resource scarcity in Tom Tietenberg, "Environmental and Natural Resource Economics" 343-56 (1992).

standards. Most important, that human kind, even a growing human population of many billions, can take a constructive place in the natural order.

A powerful range of options has been developed to help policy makers redeem these upbeat viewpoints. International negotiations can address global threats, as will be seen in the case of stratospheric ozone depletion. Game theory and mechanism design provide ways to encourage binding negotiations which help overcome the least common denominator syndrome. Green accounting is able to refocus government agencies toward realistic measures of human welfare. Government regulations can be adapted to various challenges, using variants such as performance or command and control standards. Taxation policies are able to at least partly internalize externalities. Market-based policies bear the promise, in certain contexts, of increasing the efficiency in attaining desired environmental objectives. In sum, part of our endowment of human-generated capital is the conceptual groundwork for, and practical experience with, a spectrum of potentially invaluable policy instruments.

The net result is that it is inappropriate to prejudge the feasibility of sustainable development. Indeed, its pursuit is certainly possible. In addition, in the case that strict feasibility is not possible, the systems/social choice definition explicitly provides a set of alternative fall-back objectives from which the social choice mechanism could choose. It should also be pointed out that states are uniquely qualified to provide leadership in the pursuit of sustainable development. They are capable of developing and implementing policies such as those described above. States have the financial resources and institutional machinery to perform or encourage the necessary research and to translate the results into operational programs.

513 Id. at xvi - xvii. Of course, the danger of relying on extrapolation in this context has been compared to the guy who fell out of the 50th story window, and called out as he accelerated past the 10th floor: "So far, so good!" Indeed, Easterbrook's analysis has been characterized as "a deeply flawed book that spawned a vigorous Internet-based competition this summer to see who could find the most scientific errors per page." Stuart L. Pimm, "Nature Lovers and Other Villains" (book review), 378 Nature 104 (Nov. 2, 1995).

514 See supra p. 5.

515 Supra p. 41.
d) Political Prospects for Pursuing Sustainable Development

In the final analysis, the feasibility of effectively pursuing sustainable development depends on the political process. The political process in this case can be parsed into two logical stages: the taking of a national decision to pursue sustainable development, and coordinated implementation at the international level.

The feasibility of implementing coordinated policy sets to pursue sustainable development at the international level, once a decision is taken at the national level, is discussed later.\textsuperscript{516} Here, it is sufficient to briefly preview that analysis as follows: 1) states have a duty to pursue sustainable development, which in the context of the modern array of global threats would seem to incorporate a duty to effectively participate in the development and implementation of coordinated policy sets consistent with sustainable development, and 2) in the context of ongoing relations (i.e., a "repeated game"), it may be possible for the community of nations to effectively and legitimately enforce this duty with respect to a would-be shirker (i.e., coordinate to a "virtuous sub-game perfect Nash equilibrium").

i) Preferences Implicitly Incorporating Sustainable Development

With respect to the political prospects of a national decision to pursue sustainable development, it is helpful to focus first on determining who would be for or against it. Appendix 2 analyzes a model in which actors optimize the present discounted value of an infinite stream of interim utility, where interim utility explicitly incorporates both the value of interim consumption and the existence value of interim capital. Consumption is the control variable over time, and it is optimized using the calculus of variations. While there is absolutely no reason that an actor’s ideal optimization program could not also include an independent constraint for sustainable development (e.g., in the form of monotonically increasing interim utility), the question addressed by this analysis is: under what conditions (i.e., parameters in the utility function and productivity of capital) would such a sustainable development constraint already be implicit in the actor’s unconstrained optimization program?

\textsuperscript{516}See pp. 270ff.
In this model, the condition under which sustainable development is implicitly incorporated into an actor's ideal optimization program is found to be \( g > \pi_c r \), where \( g \) is the productivity of capital, \( \pi_c \) is the weight accorded to consumption (as opposed to the existence value of capital) in the interim utility function, and \( r \) is the discount rate.

This condition can be interpreted to mean that, for a given productivity of capital, actors with sufficiently long time horizons and who place a high enough value on capital per se would implicitly incorporate sustainable development even into their unconstrained optimization programs (see Appendix 2). This model is not specified in sufficient detail to predict which particular consumption path would be selected by an electorate. However, the general inference is that a society with sufficiently high productivity of capital, and comprised of individuals with sufficiently long time horizons and for whom the existence value of capital is high enough, would prefer a course of sustainable development even without explicitly incorporating it as an independent constraint.

ii) Sustainable Development and Capital Maintenance Paradigm
in a World with Bounded Hicksian Income

A different model is presented in Appendix 3, to discuss the politically difficult problem of a hypothetical world with bounded Hicksian income.\(^{517}\) Recall that Hicksian income for a society is defined as that level of consumption which would leave the society no worse off at the end of a period than at the beginning. In this model, Hicksian income is assumed to be bounded because an increase in capital imposes more environmental degradation, and the rate of non-internalized environmental degradation exceeds the return to economic capital above some threshold \( K_{\text{max}} \). In this model, unrestrained growth in economic capital turns out to be infeasible. In particular, the assumptions of bounded Hicksian income, non-internalized environmental degradation which increases with increasing economic capital, and a positive

\(^{517}\) Whether the world system is currently displaying this behavior mode, or is liable to display it in some significant respect over a reasonable planning horizon, may be one of the most divisive subjects today (see, e.g., below pp. 318-19); this paper is only intended to analyze the case of bounded Hicksian income as a hypothetical model.
savings rate, guarantee the eventual violation of each of the four feasibility constraints considered: 1) minimum Hicksian income; 2) minimum total capital (economic and natural); 3) maximum rate of non-internalized degradation; and 4) maximum cumulative externalized natural degradation. Further, the feasibility constraints can be violated even more quickly with an increase in the savings rate or in the marginal net economic product with respect to economic capital.

Furthermore, to cope with a scenario where industrial capital already exceeds the maximum sustainable \( K_{\text{max}} \), progressive disinvestment of industrial capital until it reaches \( K_{\text{max}} \) can be used to increase consumption or for additional investment in "intensive" development which has less environmental impact than "extensive" industrial growth.

iii) Sustainable Development and the Political Process in a World with Bounded Hicksian Income

The political dimension of sustainable development in the hypothetical world of bounded Hicksian income is analyzed in Appendix 4. In the basic version of the model, actors differ only in the amount of capital which they own, and two control variables are considered: the degree of internalization of environmental degradation and the trajectory of capital.\(^{518}\)

**internalization of environmental degradation.** In this model, with perfect information and any type of risk aversion, actors whose wealth is less than the average wealth would prefer that environmental degradation be fully internalized, and conversely for actors with greater than average wealth. Therefore, assuming a positively skewed wealth distribution, the average would be greater than the median, and a median voter would prefer full internalization.\(^{519}\)

\(^{518}\)Here capital is viewed as the *explicit* control variable, even though consumption would still be considered the *implicit* operational control variable.

\(^{519}\)Theoretically, according to Black's theorem, if there were a single-issue election between candidates with distinct platforms, a candidate whose platform called for full internalization of environmental degradation would be elected.
Trajectory of capital. Furthermore, in this model, with perfect information and any type of risk aversion, actors whose normalized wealth exceeds the ratio of "the differential of non-internalized environmental degradation with respect to economic capital" to "the discount rate for non-internalized environmental degradation" would prefer to see capital grow, even if it already were to exceed $K_{m_2}$. However, in the "deterioration interval" above $K_{m_2}$ that ratio is assumed to exceed one. In that case, for a positively skewed wealth distribution, the median voter would prefer a trajectory of capital toward $K_{m_2}$.

Uncertainty over the amount of environmental degradation is seen to be able to enlarge the majority constituencies for full internalization and a trajectory of capital toward $K_{m_2}$. However, as further discussed in Appendix 4, the motivation exists for the wealthiest stratum to engineer a counter-majoritarian outcome, so that complacency is unwarranted. In that sense, this model supports the perspective that democracy can politically reinforce the pursuit of sustainable development.

Finally, Appendix 4 discusses the special significance of sustainable development for the political process. Sustainable development is commonly viewed as having a large and growing substantive significance. Further, it is an extraordinary issue in that: 1) it is important in multiple dimensions of political issue space (e.g., both economics and values) and, 2) it can be framed with either polarity (on the economic dimension, redistribution from corporations and the wealthy due to pollution taxes, or redistribution to capital holders due to externalities; on the values dimension, a duty to preserve the environment for the benefit of future generations, or a mandate for economic growth to help today's poor). In sum, universal relevance and susceptibility to framing and agenda manipulation may powerfully leverage the already powerful substantive significance of sustainable development.

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520 In this case, the majority for a trajectory of capital toward $K_{m_2}$ would be even larger than the majority in favor of full internalization of environmental degradation.
IV. Case Studies: Integrating Proposed Policies into the Pursuit of Sustainable Development

In this section, a series of case studies will be analyzed to: 1) amplify on the concept of sustainable development according to the systems/social choice definition, and 2) illustrate how different policy issues can be integrated into an evaluation of the consistency of a proposed policy set with the pursuit of sustainable development.

First, a series of brief case studies concerning threats of unrecoverable catastrophes in the context of different information regimes will be considered. A method of analysis will be demonstrated which uses the tools of probabilistic uncertainty to quantify some implications for sustainable development, including characterization of the relative significance of a threat.

Then a case study on global climate change will be considered, including stratospheric ozone depletion and global warming. After a background discussion, we will outline the framework of a process which is able to deal with policy issues which are complex, uncertain, and strongly interconnected with the rest of the world system. In addition, the challenge of implementing coordinated policy sets in the face of the commons dilemma will be addressed.

Finally, a comparative analysis of the various case studies will identify some important distinguishing characteristics, discuss the relationship of policy subsets (dealing with particular issues) to complete policy sets, and point out some of the implications of the mutual interdependence of policy sets of different states.
1. Threats of Unrecoverable Catastrophe

a) Large Comet

Situation

There is an on-going threat of an unrecoverable catastrophe, such as a big enough comet, subject to probabilistic uncertainty.

Analysis

As background for this case study, it is helpful to refer to the "Spaceguard Survey Report" prepared by NASA. Discussing the possibility of a global catastrophic impact of an asteroid or comet, the report states:

"At some size, an impact would lead to massive world-wide crop failures and consequent mass mortality, and would threaten the survival of civilization. At still larger sizes, even the survival of the human species would be put at risk."  

The mechanism of such an impact is described in the following terms:

"Primarily there is a massive explosion, sufficient to fragment and partially vaporize both the projectile and the target. ...[H]igh-speed ejecta could subject plants and animals to scorching heat for about half an hour, and a continent-wide firestorm might then ensue. Dust thrown up from a very large crater would lead to daytime darkness over the whole Earth ... for several months. Temperatures could drop as much as tens of degrees Celsius. Nitric acid, produced from the burning of atmospheric nitrogen in the impact fireball, would acidify lakes, soils, streams, and perhaps the surface layer of the oceans. Months later, after the atmosphere had cleared, water vapor and carbon dioxide released to the stratosphere would produce an enhanced greenhouse effect possibly raising global temperatures by as much as 10°C above the pre-existing ambient temperatures. This global warming might last for decades, as there are several positive feedbacks: warming of the surface increases the humidity of


522 Id. at 9.
the troposphere, thereby increasing the greenhouse effect, and warming of the ocean surface releases carbon dioxide which also increases the greenhouse effect.\textsuperscript{523}

The risk of such a globally catastrophic impact is seen in Figures 16 below:

**Figure 16: Spaceguard Risk Analysis**

![Diagram](image)

(a) ![Diagram](image) (b)

According to the Spaceguard Report, the risk can be characterized as follows:

"For purposes of discussion, we adopt a once-in-500,000 year estimate for the globally catastrophic impact."

"If this estimate of the frequency of threshold impacts is correct, then the chance of an asteroid catastrophe happening in the near future - while very low - is greater than the probability of other threats to life that our society takes very seriously."\textsuperscript{524}

\textsuperscript{523} Id. at 9-10.

\textsuperscript{524} Id. at 11.
The magnitude of the risk can be characterized as 2,500 "equivalent annual deaths" around the world, obtained by the product: (annual probability of such an impact) X (probability that such an event would kill a particular individual) X (population of the Earth).\textsuperscript{525}

How is such a risk analyzed in the framework of sustainable development which we have developed? Assume that this possible catastrophe is completely independent of other components of the world system, except possibly for policy reactions. Under what circumstances is this threat sufficient by itself to preclude sustainable development?

Recall the increase in a von Neumann-Morgenstern utility function necessary to compensate for an ongoing probabilistic threat of an unrecoverable catastrophe (supra p. 46):

\[
\frac{U_{t+1}}{U_t} > \frac{1}{1 - P_c},
\]

where $P_c$ is the probability of catastrophe over one interval and $U_t$, $U_{t+1}$ are the successive utilities.

In this case, even a conservative estimate of the annual probability of catastrophe might use a value of $P_c = 10^{-5}$ (see Figure 16). In that case, the annual increase in utility needed to compensate for this threat in isolation is:

\[
\frac{U_{t+1}}{U_t} > \frac{1}{1 - 10^{-5}}
\]

which is almost exactly equal to one. This calculation demonstrates that the threat of the cometary impact does not pose a significant additional constraint, if utility is already improving by a significant amount (e.g., see below at page 228).

\textsuperscript{525}Id. at 12.
In sum, while precautions such as investment in a space survey or development of a response capability (i.e. deflection or destruction of the prospective impactor) are not contra-indicated by this analysis and could provide valuable utility-enhancing spinoffs, they are not mandated by the pursuit of sustainable development. Rather, any significant ongoing improvement in utility would dwarf the risk of this catastrophe. Furthermore, any ongoing improvement which included technological advances could also presumably increase the capability of society for dealing later with this threat.\(^{527}\)


\(^{527}\)An interesting summary of the issue of large comets impacting Earth can also be found in Peter Tyson, "Cometbusters", MIT Technology Review 22-30 (February/March 1995).
b) Viral Mutation

**Situation**

There is an on-going threat of an unrecoverable catastrophe, such as a new and highly contagious airborne virus which is rapidly lethal after a 12 year latency period, subject to non-probabilistic uncertainty.

**Analysis**

As background for this case study, it is helpful to quote Stephen S. Morse, an international expert on emerging viruses:

"Long believed to be all but conquered, infectious diseases have returned with a vengeance. They have included not only the recent deadly outbreak of Ebola in Africa and the worldwide AIDS epidemic but also Lyme disease, cholera, new strains of influenza, and hantavirus pulmonary syndrome, which causes death from respiratory failure in over half the people infected."

"Unfortunately, too, infections are more likely than ever to reach vast numbers of people."

"An infection may come to light anywhere in the world and span continents within days or weeks."\(^{528}\)

However, our current "readiness posture", to borrow a phrase from the jargon of national security, is woefully inadequate:

"[S]everal expert groups, including the Committee on Emerging Microbial Threats to Health at the Institute of Medicine of the National Academy of Sciences, have concluded that a surveillance system to spot emerging infections - an "early warning system" - is an essential first line of defense. But so far we aren't even close to having such a system. In 1993, with sponsorship from the Federation of American Scientists, ProMED - the International Program for Monitoring Emerging Diseases - was launched, and in September of that year, the organization, along with the World Health Organization (WHO), convened 60 public health experts from around the world. They unanimously agreed that

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capabilities for surveillance of infectious diseases, at both the national and international level, were dangerously inadequate and greatly in need of strengthening."

"As of now, humanity remains vulnerable to a staggering array of infections. We have no unified system for global surveillance, let alone one for response."529

How is such an issue addressed in the framework of sustainable development, using the systems / social choice approach? In the spirit of bounded rationality, the first step is to efficiently invest an appropriate amount of resources to generate and analyze information about the threat. Based on such information, promising policy strategies should be identified, where a policy strategy is a policy set function path which implements particular future policy sets depending upon then-available information.

For example, one part of a candidate policy strategy might be:

**Immediate policy subset**

1) Arrange for an independent, interdisciplinary and international group of experts and laymen to periodically evaluate the threat and make recommendations as to surveillance and response programs.
2) Initiate and maintain appropriate institutional expertise to provide an early warning surveillance system designed to recognize new clinical syndromes, undertake epidemiological field investigations and provide laboratory diagnosis support,530 with special priority given to "areas of high biodiversity undergoing major ecological or demographic changes."531
3) Establish a response system, integrated with the surveillance system, comprised of a comprehensive range of contingency plans.532
4) As one aspect of accomplishing these three objectives, ensure stable and sufficient funding for the Center for Disease Control (in the United States) and the World Health Organization (at the international level).

529Id. at 56, 61.

530Id. at 56. See also Adrianne Appel, Ehsan Masood, "Health Bodies Urge Backing for Early Warning Procedures", 377 Nature 668 (Oct. 26, 1995).

531Id. at 59.

532Id. at 60.
If evaluations indicate a greater, specific threat:

1) Increase resources to, and possible replicate the functions of, the expert group and research/response institutions, with regional emphasis as warranted.
2) Develop detailed contingency plans for relevant emergency situations.

Upon occurrence of emergency:

1) Rapidly re-evaluate any relevant contingency plans and execute response measures. For example, implement a series of emergency public health measures to prevent new infections, e.g. "controlling mosquitoes or rodents, protecting the water supply, or administering immunizations or anti-microbial agents." 533
2) Allocate increased resources to address the emergency and related possible future threats. 534

Given a policy strategy which is considered promising, the next step is to generate qualitative expectations about the future. Based on the available information, what is the best judgment about future prospects? Can we expect the threat to increase with continued deforestation, poverty, refugees, access to world travel, or even global climate change? 535 Will new medical advances reduce the threat?

Finally, the future prospects over the appropriate time horizon are evaluated. Will this particular danger be getting worse or better over time? If a doomsday scenario were to loom

533 Id. at 56.

534 For a discussion of policy responses to emergent public health hazards in general, see Christopher H. Foreman, Jr., "Plagues, Products, and Politics: Emergent Public Health Hazards and National Policymaking" (Brookings Institution, 1994).

535 See, e.g., Janet Raloff, "How Climate Perturbations Can Plague Us", 148(13) Science News 196-97 (September 23, 1995), for a description of how a deadly hantavirus outbreak in the southwest United States has been associated with the change in rainfall patterns due to an El Nino event in the equatorial ocean-weather system. According to Paul R. Epstein and other scientists at the recent Conference on Human Health and Global Climate Change in Washington, this episode "may provide a useful analog of the sort of health consequences that can be anticipated under any global warming". Id.
sufficiently large in the projection over the appropriate time horizon, then this threat by itself is sufficient to preclude sustainable development. Otherwise, the potential effect of this threat over time must be considered along with projections of the rest of the world system, taking into account the relevant inter-relationships.\textsuperscript{536}

This evaluation process should be inclusive, incorporating the judgment of the general public directly and by representation. Depending on the result of this evaluation, the policy set upon which projections were based can be characterized as consistent with sustainable development or not. An appropriate investment in iterating the process of policy strategy identification, future projection and evaluation can then be made.\textsuperscript{537}

\begin{footnotesize}
 \textsuperscript{536}This need to consider a public health issue in its entire context is emphasized in Josef Decosas, Joel Finlay, "International AIDS Aid: The Response of Development Aid Agencies to the HIV/AIDS Pandemic", 7 \textit{AIDS} S281, 285 (1993), which also quotes an OECD report to the effect that "good health ... is a prerequisite of development". Id. at S283.

\textsuperscript{537}This case study is not a prediction, but a hypothetical \textit{gedanken}, or thought experiment. The heuristic value of discussing an "Andromeda strain" is that it could conceivably \textit{by itself} preclude sustainable development, and has a high magnitude of non-probabilistic uncertainty. See, e.g., 269 \textit{Science} 483 (July 28, 1995) for an issue which has perhaps been insufficiently appreciated in this context...
\end{footnotesize}

Recent publications on the topic include: Laurie Garrett, "The Coming Plague: Newly Emerging Diseases in a World Out of Balance" (1994); Arno Karlen, "Man and Microbes" (1995); Malcolm Gladwell, "The Plague Year: The Unscientific Origins of our Obsession with Viruses", \textit{The New Republic} 38-46 (July 17 & 24, 1995); Bernard Dixon, "Power Unseen: How Microbes Rule the World" (1994); and Richard Preston, "The Hot Zone" (1994), which includes the following exchange between the author and Karl Johnson, a highly respected virologist who co-discovered the Ebola virus:

"'Are you worried about a species-threatening event?''
He stared at me. 'What the hell do you mean by that?'
'I mean a virus that wipes us out.'
'Well, I think it could happen. Certainly it hasn't happened yet. More likely it would be a virus that reduces us by 90 percent.'"

The Ebola virus and its cousin the Marburg virus are documented in Frederick A. Murphy, Michael P. Kiley, Susan P. Fisher-Hoch, "Filoviridae: Marburg and Ebola Viruses", in B.N. Fields, D.M. Knipe, et al. (eds.) \textit{Virology} 933-942 (1990). The fictional work which bestowed its name on a hypothetical species-threatening virus is "The Andromeda Strain"
c) Large-Scale Nuclear Attack

**Situation**

There is an ongoing threat of an unrecoverable catastrophe, such as a large-scale nuclear attack, subject to non-probabilistic uncertainty.

**Analysis**

Assume that such an attack would be the result of a malfunction or human decision, and that it is not possible to derive a probability distribution function for all the relevant attack scenarios. Therefore, we are faced with a situation of non-probabilistic uncertainty. As in the viral mutation situation, it is possible to first identify promising policy strategies, such as negotiation of a stabler force structure, and to then project and evaluate the expected effects on the world system. However, it is helpful to use probabilistic analysis and an assumed von Neumann-Morgenstern utility function (supra page 45ff) in order to develop heuristic benchmarks to discuss the significance of the threat of a large-scale nuclear attack.

As we saw earlier, a threat of an unrecoverable catastrophe necessitates a counter-balancing improvement in non-catastrophic utility in order to achieve ex ante sustainable development. Fortunately, in some respects there has been such a secular historical trend of improving utility, at least if we do not adopt a Rawlsian focus solely on the worst off. One measure of the significance of the threat of a large-scale nuclear attack is to ask: what portion of the secular increase in utility is needed to counterbalance the threat?

Suppose first that for heuristic purposes we assume that the dangerous half-century after World War II posed a cumulative 50-50 threat of a large-scale nuclear attack amounting to an unrecoverable catastrophe.\(^{538}\) According to a recent analysis by a senior fellow at the

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\(^{538}\)See, e.g., Robert Ehrlich, "Waging Nuclear Peace" 200-10 (1985), for a discussion on the prospects of recovery following a large-scale nuclear attack.
Brookings Institution, there was a much greater danger of inadvertent nuclear war than previously thought:

"The Soviet system, contrary to widespread belief, undertook emergency preparations for nuclear combat on many occasions. Because both sides had this strong propensity to raise alert levels even when tensions were only slightly heightened, the crisis threshold at which the two systems could have become entwined in escalatory nuclear alerting could have been crossed much earlier than is commonly assumed.

The U.S. and Soviet systems, again contrary to widespread belief, were geared for launch on warning. This became the primary mode of command system operation for both postures, placing both nations at risk of going to war on the basis of false early warning information. . . .

The rapid reaction postures of both adversaries depended on early warning systems of dubious reliability. The questionable performance of the warning networks created a greater danger of inadvertence during a crisis than was recognized.

Taken as a whole, these summary findings drive home the broader conclusion: cold war antagonism became embodied in command and control systems that put the nuclear superpowers at substantial mutual risk of a catastrophic failure of negative control [i.e., launching inadvertently] as they strived to fulfill the difficult operational demands of positive control [e.g., executing a retaliatory strike].

This quote raises the point that an evaluation of the consistency of a policy set with sustainable development is implicitly premised upon a particular "information set", i.e. what is known (or believed to be known) about the world and future prospects. Thus, one might conclude that the United States achieved sustainable development in the post-World War II period in an ex post sense (there was no nuclear attack). If, however, based on either what we now (see Blair's quote) or even contemporaneously (see subsequent quotes) believe(d), the threat of a nuclear catastrophe counterbalanced real economic growth (see later analysis), then post-War policy sets could be viewed as having been inconsistent with sustainable development in an ex post-risk sense (i.e., based on our knowledge now about previous risk, but still unaware of the outcome) or even an ex ante sense respectively. The rest of this case study will consider sustainable development in an ex post-risk sense, i.e. based on current beliefs about the level of risk we were exposed to, but without an assurance of the outcome.

This issue is incorporated into the analytical framework of the systems/social choice definition of sustainable development through its requirement that the social preference relation satisfy a legitimacy constraint of procedural rationality (e.g., an appropriate investment of resources to
As has been stated, the situation is inherently subject to non-probabilistic uncertainty, so that our assumption of a cumulative 50-50 threat should be viewed as a heuristic benchmark.\textsuperscript{540} Under this assumption, a benchmark value for an independent annual probability of 

effectively develop the information set upon which to evaluate alternative policy sets) and equity (e.g., appropriate access to information and participation in its evaluation by those affected, which in the case of security questions such as the nuclear threat involves sensitive topics such as unbiased intelligence subject to effective Congressional oversight).

\textsuperscript{540}A discussion of the plausibility of this benchmark from different perspectives could include the fact that members of the security establishments of both superpowers seriously recommended premeditated first strikes, and these individuals were taken seriously.

Further, as Kahn noted in 1962:

"Many people believe that the current system must \textit{inevitably} end in total annihilation."

citing also C. P. Snow's belief in the \textit{certainty} of nuclear war if the superpowers engaged in an arms race, and the widespread belief that a nuclear war would result in an "unrecoverable catastrophe":

"Surprisingly large numbers of both laymen and experts believed [by the middle 1950s] that any and all thermonuclear wars would automatically mean not only mutual [superpower] annihilation, but very likely the end of all human life."
Herman Kahn, "Thinking About the Unthinkable" 26, 25, 104 (1962) (emphasis added), citing C. P. Snow, "The Moral Un-Neutrality of Science", \textit{Science} (January 27, 1961). Kahn goes on to express his personal opinion that "there is always a serious chance that our efforts to avoid [nuclear] war may not be successful". Id. at 83.

Kahn's own last thinking on the subject can be found in "Thinking About the Unthinkable in the 1980s" 28-29 (1984) (published after his death in 1983), where he states that:

"My guess is that nuclear weapons will be used sometime in the next hundred years, but that their use is much more likely to be small and limited than widespread and unconstrained [emphasis added]. . . No one can guarantee that [a nuclear war can be reliably limited]."

See also: Louis Henkin, "How Nations Behave" 47-48 (2d ed. 1979):

"[O]ne nuclear aggression by a major power might render meaningless all the observances of all norms and obligations by all the nations of the world."


"[T]he danger of nuclear catastrophe remains a social fact that will persist for the indefinite future. This fact poses the issue of human decline - quite literally, of human survival - in stark terms[.]"
catastrophe $P_c$ is calculated from the formula $(1 - P_c)^{50} = .5$, yielding $P_c = .014$. Although we will calculate a constant annual probability of catastrophe as a benchmark, there were clearly variations over time, such as during the dramatically heightened tensions of the Cuban Missile Crisis.\(^{541}\) Earlier (see page 46), we derived the formula for the relative improvement in non-catastrophic utility needed to compensate for a probabilistic threat of an unrecoverable catastrophe:

$$\frac{U_{t+1}}{U_t} > \frac{1}{1-P_c}.$$ 

For $P_c = .014$, this means that $U_{t+1} / U_t$ must exceed 1.014, or an annual growth of about 1 ½%. Assume that utility is proportional to economic welfare, which implies risk-neutrality and therefore understates the significance of the threat of a large-scale nuclear attack. In that case, if the long-term potential for real economic growth is around 3%, then this threat can be seen to offset about half of that potential.

Alternatively, the benchmark heuristic can be recast to ask: what probability of catastrophe $P_c$ would completely offset the growth in real per capita GNP? Consider the case of the United States over the period 1950 to 1990, during which a Soviet Union possessed a devastating nuclear capability.\(^{542}\) Over that period, per capita GNP grew from 9,398 to 19,670

\(^{541}\)The extension of this analysis to include such variations over time is straightforward, but in general assuming constancy could underestimate the cumulative threat.

\(^{542}\)If 1950 were considered to be a premature date for the acquisition by the Soviet Union of the capacity to destroy the United States, the subsequent analysis would be little changed by using the forty year interval starting in 1955. E.g., "By the middle fifties the simple view of U.S. strategic superiority was replaced in much of the literature by another equally simple one. In this model, the Soviets had created a deterrent which countered and negated our deterrent, thus giving rise to an automatic, symmetrical, and reliable balance of terror." Kahn (1962), supra note 540 at 104. Indeed, by 1954 not only fission bombs but also thermonuclear fusion bombs were available to both superpowers. P.M.S. Blackett, "Steps Toward Disarmament", in Richard Falk, Saul Mendlovitz, "The Strategy of World Order: Disarmament and Economic Development" 16 (1966).
in constant (1987) dollars,\textsuperscript{543} for a compound growth rate of approximately 2%. Once again assume that utility is proportional to per capita real GNP, which disregards the non-economic component of utility; it also implies risk neutrality which will result in understating the significance of the threat. Then the entire improvement in utility would have been offset if the probability of catastrophe $P_c$ derived from the equation $1.02 = \frac{1}{1 - P_c}$ were exceeded. I.e., if $P_c > .02$, then the United States would have failed to achieve sustainable development after taking the risk of large-scale nuclear attack into account.

The plausibility of having incurred a risk of $P_c = .02$, given that the attack did not occur, can be characterized by calculating that: 1) given $P_c = .02$, the probability of surviving the 40 year period would be $(1 - .02)^{40} = .45$, which seems high enough not to reject that level of $P_c$ out of hand; and 2) given a Bayesian analysis of two possible alternatives, $P_c = .02$ or $P_c = 0$, with benchmark prior probabilities of .5 each,\textsuperscript{544} there is a posterior probability of about .3 that $P_c = .02$, given survival for the 40 year period.\textsuperscript{545} I.e., there is a posterior probability of about one third that the threat more than offset real economic growth over the period, resulting in a failure to achieve sustainable development.

This conclusion could be strengthened if the ongoing \textit{improvement} criterion of sustainable development necessitated a significant improvement each period, corresponding to the "fat indifference curves" of social choice theory or the "just noticeable difference" of psychology. If a benchmark improvement of 1\% per year were adopted as the minimum threshold of improvement, then the above calculation would be modified so that a probability of


\textsuperscript{544} This is an example of "second-order" probability distributions, or a probability distribution of a parameter in a probability distribution. See generally Colin Camerer, Martin Weber, "Recent Developments in Modeling Preferences: Uncertainty and Ambiguity", 5(4) Journal of Risk and Uncertainty 325-70 (1992).

\textsuperscript{545} The posterior probability that $P_c = .02$, leading to a failure to achieve sustainable development, is given by:

$$P_c = .5 (1 - .02)^{40} / [ .5 (1 - .02)^{40} + .5 (1) ] = .31 .$$
catastrophe $P_c = .01$ would preclude sustainable development. In that case, the probability of having survived the 40 year period becomes .67, and the posterior probability of having failed to achieve sustainable development increases to about 0.4.

The degree of sensitivity of the Bayesian analysis to its assumptions can be demonstrated by changing our assumption from a two-alternative world to a three-alternative world: $P_c \in \{ 0, .01, .02 \}$. Again assume benchmark equal prior probabilities (of 1/3), and assume that $P_c = .01$ is the threshold risk which precludes sustainable development over the 40-year period. In this case, the posterior probability of failing sustainable development rises to about 0.5. In other words, under these assumptions, the threat of large-scale nuclear attack was, as likely as not, great enough to preclude sustainable development over the post-War period despite sustained real economic growth.

It is also possible to incorporate risk aversion into a simple Bayesian model. Consider a utility function of the form $I^\alpha$, where $I$ is the real per capita GNP, and $(1 - \alpha)$ is the (constant) Arrow-Pratt relative risk aversion ($RRA = -[U''/U] I$). Transforming the equation relating $P_c$ and the required growth in utility (see page 227), and substituting $(1.02)^\alpha$ for $U_{c}/U$ gives a threshold $P_c = 1 - .98^\alpha$ for precluding sustainable development. Consider a situation where we don't know whether the probability of the threat is $P_c$ or 0. However, we have "prior beliefs" that there is a probability of $P_{HI}$ that the probability of the threat is equal to $P_c$, and a probability of $P_{LO} = 1 - P_{HI}$ that it is 0, or at least negligible relative to $P_c$. Having survived 40 years without the catastrophe will lead us to update our belief about the risk we had incurred (see Figure 17(a)).

The formula for the Bayesian estimate of the probability that the nuclear threat precluded sustainable development ($P_f$) is given by:

$$P_f = P_{HI} \left(1 - P_c\right)^{40} / \left[ P_{HI} \left(1 - P_c\right)^{40} + \left(1 - P_{HI}\right)1 \right].$$

By substituting $P_c = 1 - .98^\alpha$ into this expression and dividing by $P_{HI}$ we obtain:

$$P_f = .98^{40^\alpha} / \left[ .98^{40^\alpha} - 1 + 1/P_{HI} \right].$$
This value of $P_r$ is tabulated for a selection of various levels of relative risk aversion $(1 - \alpha)$ and prior probabilities $P_{HI}$ in Figure 17(b).

**Figure 17: Estimate of Probability that The Bomb Precluded Sustainable Development**

<table>
<thead>
<tr>
<th>$P_{LO}$</th>
<th>$P_{HI}$</th>
<th>-- Posterior Probability --</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P_e=0$</td>
<td>$P_e = 1 - .98^a$</td>
<td>[ .07 \quad .24 \quad .42 \quad .63 ]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>RRA .4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[ .06 \quad .21 \quad .38 \quad .59 ]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1- $\alpha$) .2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[ .06 \quad .18 \quad .34 \quad .55 ]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[ .04 \quad .16 \quad .31 \quad .51 ]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[ .1 \quad .3 \quad .5 \quad .7 ]</td>
</tr>
</tbody>
</table>

$a$ No attack (history) | Large-scale nuclear attack (counterfactual)

Even considering the imprecision inherent in this series of heuristic benchmarks, it seems appropriate to infer that the threat itself of large-scale nuclear attack, based on the posterior probabilities in this table, could plausibly have precluded sustainable development during the Cold War. Substitution of a relatively non-confrontational relationship for the previous sustained facedown reduces this risk; however, the severe destabilization of a society which is
in possession of tens of thousands of nuclear warheads qualitatively increases the risk.\textsuperscript{546} Therefore, it seems reasonable to adopt the perspective that the issue continues to warrant a very high priority in the policy formulation of the relevant governments. If so, can the preceding historical analysis be adapted to support current policy makers attempting to achieve sustainable development?

In order to adapt the analysis for the formulation of current policy, assume again the existence of a von Neumann-Morgenstern utility function:

\[
EU_t = P_{ok}(t) U_t ; \\
EU_{t+1} = P_{ok}(t+1) U_{t+1} ;
\]

where \(P_{ok}(t)\) is the probability of no catastrophe by time "t", \(U_t\) is the expected utility conditional upon non-occurrence of the catastrophe, and utility in the case of a catastrophic attack is normalized to zero.

\textsuperscript{546} According to the International Institute for Strategic Studies:

"The actions of the Russian government in the latter part of 1994 have seriously jeopardized the possibility of Russia evolving into a stable democratic nation. It badly mishandled economic affairs which led to a collapse of the rouble, and then it launched a disastrous military intervention in Chechnya. Civil control of the military forces seems to have been weakened. . . . It is important for the West . . . that Russia does not descend into chaos, or revert to authoritarian rule. Moscow's bumbling effort to bring Chechnya under its control has highlighted the extraordinary deterioration of what was once a highly professional, solidly trained and effectively armed force. Yet Russia still maintains a powerful, and possibly threatening, nuclear capability."


However, IISS goes on to claim:

"The Strategic Rocket Forces, responsible for maintaining and protecting missiles, are among the few units in the Russian military not affected by a loss of prestige and a deterioration in their cohesion." Id. at 18.

A recent cross-section of fourteen suggestions for the setting of the "Doomsday Clock" of the Bulletin of the Atomic Scientists found six suggestions within ten minutes of "midnight", another six within the last half hour, and two "outliers" about two hours from midnight.

Assume: 1) a minimum threshold development \( D_{\text{min}} \) in expected utility;
2) \( P_{\alpha}(t+1) = (1 - P_c) \cdot P_{\alpha}(t) \); and
3) \( U_t \propto I_t^\alpha \) where \( I_t \) is equal to the generalized real per capita expected Hicksian income (see footnote 19 and accompanying text above).

We can re-arrange terms to find the criterion of achieving sustainable development between period "t" and "t+1" as follows:

\[
(1 - P_c) \left( \frac{I_{t+1}}{I_t} \right)^\alpha \geq D_{\text{min}}
\]

This expression can be better understood by tabulating (see Figure 18) the percentage growth in expected utility derived from the left hand side as a function of:
1) the percentage probability of the catastrophe \( 100 \cdot P_c \),
2) the relative risk aversion \( 1 - \alpha \), and
3) the percentage growth in real per capita expected income \( 100 \cdot \left( \frac{I_{t+1}}{I_t} - 1 \right) \):

**Figure 18: Growth in Expected Utility as Function of:**

*Growth in Hicksian Income, Probability of Catastrophe and Risk Aversion*

<table>
<thead>
<tr>
<th>Percentage probability of catastrophe</th>
<th>0.5</th>
<th>0.4</th>
<th>0.3</th>
<th>0.2</th>
<th>0.1</th>
<th>0.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>½%</td>
<td>0.5</td>
<td>0.7</td>
<td>0.9</td>
<td>1.1</td>
<td>1.3</td>
<td>1.6</td>
</tr>
<tr>
<td>1%</td>
<td>0.5</td>
<td>0.8</td>
<td>1.1</td>
<td>1.4</td>
<td>1.7</td>
<td>2.0</td>
</tr>
<tr>
<td>2%</td>
<td>-1.0</td>
<td>-1.2</td>
<td>-1.3</td>
<td>-1.2</td>
<td>-1.1</td>
<td>-1.0</td>
</tr>
</tbody>
</table>

\[
\begin{array}{cccccc}
\text{Percentage Growth in Real Per Capita Hicksian Income} \\
1\% & 2\% & 3\% & 1\% & 2\% & 3\% \\
0.5 & 1.0 & 2.0 & -1.0 & -0.9 & -0.8 \\
0.4 & 0.7 & 1.8 & -0.8 & -0.7 & -0.6 \\
0.3 & 0.9 & 2.1 & -0.6 & -0.5 & -0.4 \\
0.2 & 1.1 & 2.4 & -0.4 & -0.3 & -0.2 \\
0.1 & 1.3 & 2.7 & -0.2 & -0.1 & -0.0 \\
0.0 & 1.5 & 3.0 & 0.0 & 0.1 & 0.2 \\
\end{array}
\]

232
If the percentage growth in expected utility in the table exceeds the percentage minimum threshold of development ($D_{min}$ in %), then sustainable development is achieved for this time period. Entries which fail this test for $D_{min} = 1\%$ are depicted as hatched, while entries which fail even a test for $D_{min} = 0\%$ are also depicted in bold. As can be seen, a significant number of combinations of these parameter selections are inconsistent with sustainable development. Indeed, even a probability of catastrophe as low as $P_c = .001$ could still preclude sustainable development, given relative risk aversion of .5, real growth of 2%, and a minimum threshold of development of 1%.

The peoples of the world have been painfully aware of the connection between war and sustainable development, and they have articulated this connection increasingly explicitly as the terminology of sustainable development has evolved. In the United Nations Charter of 1945, peoples of the world were "determined to save succeeding generations from the scourge of war". The Stockholm Declaration of 1972 specifically stated: "Man and his environment must be spared the effects of nuclear weapons and all other means of mass destruction". And the most explicit statement of all is in the Rio Declaration of 1992, which proclaims: "Warfare is inherently destructive of sustainable development". On a more positive note, according to UN Special Rapporteur Cristescu: "[I]nternational peace and security create the possibility of sustained development at all levels."

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547 Supra p. 143.


549 Supra p. 148.

550 Supra, footnote 237.
This analysis of the threat of a large-scale nuclear attack demonstrates that sustainable development *directly* involves even classical national security issues of the highest priority. National security has also been reconceptualized to explicitly include global environmental risks.⁵⁵¹ Taken together, the direct connection between sustainable development and classical national security issues, and the reconceptualization of national security to explicitly include a broader range of societal risks, reinforce the wisdom displayed by the peoples of the world in placing sustainable development at the top of the international agenda.

2. Global Climate Change:

Stratospheric Ozone Depletion and Global Warming

a) Physical Science

i) Stratospheric Ozone Depletion

Atmospheric ozone is important to mankind. At the surface of the earth, tropospheric ozone is a constituent of photochemical smog and is a dangerous pollutant to breathe. However, at altitudes above 10km, stratospheric ozone is an important shield. It efficiently absorbs dangerous solar ultraviolet radiation which can cause skin cancer and threaten ecosystems, in a range of wavelengths (200-300 nm) where the atmosphere is otherwise practically transparent.\textsuperscript{552} The issue for global climate change is the danger of stratospheric ozone depletion, in particular due to anthropogenic causes such as emissions of chlorofluorocarbons used for purposes such as refrigerants and solvents.

The starting point for understanding stratospheric ozone chemistry is the Chapman mechanism:\textsuperscript{553}

\[
\begin{align*}
O_2 + h\nu & \rightarrow O + O \\
O + O_2 & \rightarrow O_3 \\
O_3 + h\nu & \rightarrow O_2 + O \\
O + O_3 & \rightarrow O_2 + O_2
\end{align*}
\]

\textsuperscript{552}This discussion closely follows that of Mario J. Molina, Luisa T. Molina, "Stratospheric Ozone", in "The Science of Global Change" (1992).

The first two reactions produce ozone by photolysis of molecular oxygen (O₂), where the photon hv has wavelength shorter than 220 nm. The last two reactions destroy ozone, leading to a dynamic balance. However, observations indicate that stratospheric ozone concentrations are below what the Chapman mechanism alone would produce.

Ozone can be reduced below the concentrations predicted by the Chapman cycle by means of catalytic destruction cycles involving nitrogen oxides554 or chlorine555.

\[
\begin{align*}
\text{NO}_2 + \text{O} & \rightarrow \text{NO} + \text{O}_3 \\
\text{NO} + \text{O}_3 & \rightarrow \text{NO}_2 + \text{O}_2 \\
\text{Cl} + \text{O}_3 & \rightarrow \text{ClO} + \text{O}_2 \\
\text{ClO} + \text{O} & \rightarrow \text{Cl} + \text{O}_2
\end{align*}
\]

The net result for each cycle is:

\[
\text{O} + \text{O}_3 \rightarrow \text{O}_2 + \text{O}_2
\]

These reaction pairs are catalytic cycles, in that the catalysts NO₂ or Cl⁻ are returned to their original form, which means each molecule can destroy a large number of ozone molecules. There are natural sources of both stratospheric nitrogen oxides and chlorine: mainly methyl chloride (CH₃Cl) and nitrous oxide (N₂O) which have biological origins and are sufficiently stable to reach the stratosphere. Eventually, NO₂ and Cl⁻ are themselves transformed into relatively inert "reservoirs" such as HNO₃ or HCl.


Chlorofluorocarbons, which were invented in 1928, increase the stratospheric concentration of ozone-destroying stratospheric chlorine. They are extremely stable, so that they cumulate in the troposphere until they eventually reach the stratosphere, predominantly by convection such as thunderstorms protruding into the stratosphere. In the stratosphere, chlorofluorocarbons undergo photodecomposition and release chlorine atoms which can participate in the ozone destruction cycle.

The situation over the polar regions is special. Convection of ozone from lower latitudes replaces the Chapman mechanism as the dominant source of stratospheric ozone there, because the oblique angle of incidence of solar radiation reduces the intensity of ultraviolet radiation. Furthermore, the rates of the conventional non-polar catalytic destruction cycles are very low in polar regions due to low concentrations of atomic oxygen and low temperatures, so a different explanation of ozone destruction must be sought.

Extremely low Antarctic temperatures (below -90°C) during the winter and spring result in polar stratospheric clouds of ice formed from, e.g., water, nitric acid and hydrochloric acid. These ice clouds provide a reaction surface for reservoir species to efficiently combine:

\[
\begin{align*}
\text{HCl} + \text{ClONO}_2 & \rightarrow \text{Cl}_2 + \text{HNO}_3 \\
\text{HCl} + \text{HOCl} & \rightarrow \text{Cl}_2 + \text{H}_2\text{O}
\end{align*}
\]

---


The significance of these reactions is that ample reservoir species (HCl, ClONO₂, HOCl) combine to form gaseous chlorine (Cl₂), which readily yields atomic chlorine by photolysis in the visible and near-ultraviolet spectrum, where the solar flux is intense enough to compensate even for the oblique polar angle of incidence.\footnote{J.C. Farman, B.G. Gardiner, J.D. Shankin, "Large Losses of Total Ozone in Antarctic Reveal Seasonal ClOₓ / NOₓ Interaction", 315 Nature 207-10 (1985); R.S. Stolarski, A.J. Krueger, M.R. Schoeberl, R.D. McPeters, P.A. Newman, J.C. Alpert, "Nimbus 7 Satellite Measurements of the Springtime Antarctic Ozone Decrease", 322 Nature 808-11 (1986); Susan Solomon, Rolando R. Garcia, F. Sherwood Roland, Donald J. Wuebbles, "On the Depletion of Antarctic Ozone", 321 Nature 755-58 (1986).}

The atomic chlorine destroys ozone, but not by the non-polar catalytic destruction cycles which depend on atomic oxygen, since its polar concentration is too low. Alternative cycles have been proposed, which rely on ClO and intermediate species such as dichlorine peroxide (ClOOCl)\footnote{L.T. Molina, M.J. Molina, "Production of Cl₂O₂ From Self-Reaction of the ClO Radical", 91 Journal of Physical Chemistry 433-36 (1987); Stanley P. Sander, Randall R. Fridl, Yuk L. Yung, "Rate of Formation of the ClO Dimer in the Polar Stratosphere: Implications for Ozone Loss", 245 Science 1095-98 (1989).} or bromine.\footnote{Michael B. McElroy, Ross J. Salawitch, Steven C. Wofsy, Jennifer A. Logan, "Reductions of Antarctic Ozone Due to Synergistic Interactions of Chlorine and Bromine", 321 Nature 759-62 (1986); Michael B. McElroy, Ross J. Salawitch, Steven C. Wofsy, "Antarctic O₃: Chemical Mechanisms for the Spring Decrease", 13(12) Geophysical Research Letters 1296-99 (1986).} Interestingly, NO₂, which participates in ozone destruction cycles at non-polar latitudes, scavenges ClO and would extinguish these alternative cycles, except that the ice clouds scavenge the NO₂ itself.\footnote{An excellent summary of the science of Antarctic ozone depletion is Susan Solomon, "The Mystery of the Antarctic Ozone 'Hole'", 26(1) Reviews of Geophysics 131-48 (1988).}

There are various types of uncertainty in our understanding of the science of stratospheric ozone depletion. As noted earlier, rate constants themselves are not known exactly, especially over the full range of natural conditions for all reaction paths of potential interest.
Atmospheric residence times of some compounds are insufficiently understood. The actual mechanisms of some cycles are not fully understood, especially in areas such as the mixed phase (solid-gas) reactions on and in polar stratospheric clouds. More importantly, we may be unaware of some significant reactions and cycles. In addition, the extremely complex interaction of atmospheric chemistry with other meteorological processes such as convection or weather systems is not fully understood. In fact, our models remain limited by the quality of observations and the processing power of computers. Typically, 2-dimensional or even 1-dimensional computer models are used because of the complexity of the simulations.

Despite these uncertainties, we have a high degree of confidence in our qualitative understanding of important behavior modes of the integrated system. In particular, there are very strong logical and observational links between anthropogenic chlorofluorocarbon emissions, tropospheric concentrations, stratospheric migration and stratospheric ozone depletion. It is precisely this reasonable, if incomplete, understanding which forms a solid foundation for policy formulation in the context of bounded rationality.

ii) Global Warming

The temperature of the earth continually changes, on all time scales, by a large set of complex, interactive processes. One process with major implications for the temperature of the earth is the greenhouse effect, whereby certain gases in the atmosphere partially trap long-wave radiation emitted by the earth. The issue of global warming relates to the concern that anthropogenic emissions of greenhouse gases such as carbon dioxide will heat the earth so much that human welfare and ecosystems will be adversely affected.

The atmospheric physics of the greenhouse effect is summarized in the simplified depiction of Figure 19. At the most fundamental level, all physical bodies emit electromagnetic radiation. The rate of emission, in terms of energy per unit area per time, is given by:

\[ E = \sigma T^4, \]

where \( \sigma \) is the Stephan-Boltzman constant and \( T \) is the absolute temperature in degrees Kelvin. The temperature also determines the spectrum of wavelengths of the emitted
electromagnetic radiation. In particular, the peak wavelength $\lambda_{m}$ is given by Wien's Displacement Law:

$$\lambda_{m} T = 2.898 \times 10^6,$$

where $T$ is once again the absolute temperature in degrees Kelvin, and $\lambda_{m}$ is the peak wavelength in nanometers (nm).\textsuperscript{562}

Figure 19: Global Warming Pictorial

The surface of the sun has a temperature of about 6000K, with a peak wavelength at 500nm, which is rather naturally in the middle of the visible spectrum. The surface of the earth has a temperature of about 300K, so that its peak emitted wavelength is about 10,000nm (or 10μ), in the infrared region of the spectrum. In Figure 19, the relatively short-wavelength emissions are designated by dashed lines. Solar radiation can be either scattered (including reflection) or absorbed by terrestrial objects such as clouds, the atmosphere and the surface of the earth. The relatively long-wavelength emissions of the terrestrial objects are depicted by solid lines.

As Figure 19 indicates, some of the radiation is absorbed by and therefore heats the surface of the earth. The earth then emits long-wavelength radiation which is partially absorbed by greenhouse gases or clouds in the atmosphere. This in turn heats the atmosphere, which itself

emits long-wavelength radiation. Part of this long-wave radiation is directed back down so as to trap some of the energy, a process referred to as "radiative forcing" of the temperature. If not for this greenhouse effect, the earth would be about 33°C cooler than it is. Therefore, the global warming discussion revolves around potentially adverse intensification of a process which is already an integral part of earth's climate.\(^{563}\)

These radiative processes are just one component of earth's climate. Heat is transferred away from the earth's surface by convective air motion. The conventional model holds that heat is then transferred from the equator to the poles by means of large-scale Hadley cells.

There is a sobering range of major uncertainties about the earth's climate. As recently as 1974, it was a cooling trend which was referred to as "the climate change".\(^{564}\) Uncertainty intervals for different compounds which contribute to the radiative forcing effect are portrayed in Figure 20 from the 1994 IPCC report.

\(^{563}\)The estimate of the temperature differential from the baseline greenhouse effect, and parts of the following discussion, are drawn from "Radiative Forcing of Climate Change: The 1994 Report of the Scientific Assessment Working Group of IPCC (Summary for Policymakers)" (1994), and George W. Rathjens, "Energy and Climate Change", in Jessica Tuchman Mathews (ed.) "Preserving the Global Environment", 155-85.

\(^{564}\)Central Intelligence Agency, "A Study of Climatological Research as it Pertains to Intelligence Problems" (August 1974).
As can be seen, confidence is characterized as no better than "low" for fully five of the six categories. The confidence range for indirect tropospheric aerosols, by which is meant "clouds", should probably even extend above the zero axis. This is because of the possibility that preferential cloud formation in certain regions (e.g., high latitude) or times (e.g., nocturnal) could cause the classic greenhouse effect of clouds to exceed the effect of their albedo (the percentage of solar radiation which they reflect). If global warming heated...
northern tundras, trapped methane from biological sources could be released as part of an unstable positive feedback loop. Interestingly, the most important greenhouse gas is water vapor, which is subject to extreme variability even on relatively short time scales, but is not even included on the chart or in the IPCC report summary.  

There are also severe uncertainties associated with computer models designed to simulate earth's climate. In particular, there are major uncertainties in the predictions of global circulation models with respect to the transfer of heat from the equator to the poles. Indeed, several important processes such as cloud formation, convection of moisture and hydrological processes take place on a scale smaller than the resolution of global circulation models. Major correction factors known as "flux adjustments" are necessary to prevent the models from failing to reproduce even current climate conditions, and there is no assurance that these correction factors would apply to different situations such as increased loading of greenhouse gases. There is an attempt to explicitly characterize the uncertainty, for instance by quoting a range of an equilibrium temperature increase of 1.5°C to 4.5°C if the concentration of carbon dioxide were to double from its pre-industrial level. However, this range is essentially a qualitative judgment of experts rather than a true probability distribution function.


570Id.
Perhaps one of the most critical, but least understood, parts of the global warming picture is the role of the ocean, which is "the flywheel of the climate engine". The upper three meters of the ocean can store as much heat as the entire atmosphere, therefore the ocean can act as a massive thermal buffer. On the other hand, there is too little information about whether warming the ocean could disrupt its patterns of circulation with possibly severe implications for regional climates. It has even been estimated that the range of temperature rises associated with a doubling of carbon dioxide could result in sea level rises of up to six meters, through a combination of thermal expansion and especially the melting of the unstable West Antarctic ice sheet.

As can be seen, the fundamental uncertainty about the mechanisms underlying the probability of global warming is qualitatively more severe than the uncertainty about stratospheric ozone depletion. Another contrast is that there seems to be a greater danger in global warming of largely irreversible shifts to qualitatively different system modes, such as triggering a different climate regime.

571 The following discussion draws on Lee-Lueng Fu, "The Ocean and Climate: Observations from Space", Engineering and Science - California Institute of Technology (Spring 1995).

572 However, even on this count if stratospheric ozone depletion were unchecked, the stratosphere itself could be in jeopardy since the heating associated with ozone's absorption of solar radiation creates the tropopause, which is the boundary between the troposphere and stratosphere.
b) Social Science
i) Economics
Suppose that emissions of chlorofluorocarbons and greenhouse gases are considered to be "pollution", because of their potential to cause stratospheric ozone depletion and global warming respectively. The classic economic model balances the aggregate net present value of the marginal benefit of reductions against the aggregate net present value of the marginal cost of reductions, using a reference level such as a baseline projection of the status quo.

Consider Figure 21, which portrays the individual and aggregate marginal benefit and marginal cost of pollutant reduction. For heuristic clarity, we assume $N$ homogenous individuals, each of whom has a linearly increasing marginal cost and a linearly decreasing marginal benefit as a function of reductions. The aggregate marginal benefit line is the vertical sum of the individual marginal benefit lines (since benefits for a given reduction are additive), while the aggregate marginal cost line is the horizontal sum of the individual marginal cost lines (since reductions for a given marginal cost are additive).

![Figure 21: Benefit - Cost Analysis of Pollution Reduction](image)
It can be shown: 1) the optimum aggregate reduction of pollution is \((\alpha_c - \alpha_c/N) / (\beta_b + \beta_c/N^2)\) [labelled "ideal" on Figure 21]; 2) if each individual reduced by their personal optimum, given that the other (homogenous) individuals would reduce the same amount, then the "voluntary contributions equilibrium"\(^{573}\) would reduce pollution by \((\alpha_b - \alpha_c) / (\beta_b + \beta_c/N)\) [not labelled on Figure 21, but between "too little" and "ideal"]; and 3) if a single individual knew that nobody else would make reductions, then it would be optimal for that individual to reduce by \((\alpha_b - \alpha_c) / (\beta_b + \beta_c)\) [labelled "too little" on Figure 21].

The progressively smaller than optimal pollution reductions as cooperation decreases is an example of the tragedy of the commons,\(^{574}\) worsening as marginal cost increases. The solution for this dilemma is some form of binding commitment such as coercive domestic law or international convention.

In recognition of the significance of this issue, Cline begins a series of prescriptions for estimations of the benefits (and presumably costs) of reductions with the stipulation that the estimates be prepared separately for each actor in the negotiating framework.\(^{575}\) He then goes on to recommend that estimates of the net benefit of reductions be prepared by category of effect; at different points in time; taking adaptation into account; in comparison to the baseline policies; using time discounting; scaled by gross domestic product; using different welfare weights for different countries; and taking risk aversion into account.

This classic approach to the optimization of pollution reduction goes on to stipulate some form of time discounting to estimate the net present value of marginal benefits and marginal costs. Discounting is taken to embrace both a smaller utility for future consumption due to intrinsic impatience or a risk of death or extinction, and also the effect of diminishing


\(^{575}\)William R. Cline, "The Economics of Global Warming" (1992).
marginal utility in a presumably wealthier future. Discount rates have also been allowed to be nonstationary, so that lower rates can be used for the more distant future. For societal issues involving global stock pollutants and incomplete markets, social rates of time preference are used rather than market rates.\(^{576}\)

Classical benefit-cost analysis of issues such as global warming is subject to major uncertainties. Different assumptions can lead to opposite conclusions. For example, Cline estimates the benefit-cost ratio of aggressive action to abate global warming as 0.41 for the IPCC lower-bound warming projection, 0.74 for the best guess and 1.52 for the upper-bound. Using nominal weights of different scenarios to incorporate risk aversion, he estimates a weighted benefit-cost ratio to be 1.26, and therefore concludes that aggressive abatement is warranted.

In contrast, Nordhaus finds aggressive abatement polices (ranging from stabilizing emissions to stabilizing the climate) to be economically inferior to no controls. Interestingly, his top-ranked policy is geoengineering, a highly uncertain policy involving significant intentional intervention into climate processes to partly offset any anthropogenic greenhouse effect.\(^{577}\)

This classical economic approach is distinctly incremental. However, one of the dangers of stratospheric ozone depletion and especially global warming is the threat of some sort of catastrophe. Suppose that the probability of a catastrophe \(P_c\) is a decreasing function of reductions "R", and that the resulting utilities are \(U_c\) and \(U_{OK}\) for the catastrophe and non-catastrophe outcomes respectively (see Figure 22).


\(^{577}\)William D. Nordhaus, "Managing the Global Commons: The Economics of Climate Change" (1994).
Then the expected utility as a function of reductions $U(R)$, abstracting away timing considerations, would be:

$$U(R) = [1 - P_e(R)] U_{OK} + P_e(R) U_c - C(R),$$

where $C(R)$ is the decrement to utility due to the cost of reductions $R$. To optimize the reductions, we set the derivative of this expression to zero:

$$U'(R) = -P_e'(R) U_{OK} + P_e'(R) U_c - MC(R) = 0,$$

where $MC(R) = C'(R)$ is the marginal cost of reductions $R$. Then by rearranging we obtain:

$$MB(R) = -P_e'(R) [U_{OK} - U_c] = MC(R),$$

were $MB(R)$ is the marginal benefit of reductions $R$, and the negative sign reflects the fact that the probability $P_e$ of the catastrophe decreases with reductions $R$. 

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A still more sophisticated approach could take into account the option value of delaying the elimination of emissions. Following Dixit and Pindyck, suppose a pollutant stock is given by:

\[ \frac{dM}{dt} = E(t) - \gamma M(t), \]

where \( E \) is the normalized emission rate and \( \gamma \) is the rate of decay. Suppose further that the cost of the pollution is \( \Theta M \), where \( \Theta \) is a stochastic variable which follows geometric Brownian motion to reflect unpredictable changes in society. Then an optimal policy would defer reductions longer if there is more uncertainty, a greater discount rate or faster natural removal. On the other hand, if the original problem is worse because emissions are higher, reductions would be accelerated.\(^{578}\) All these economic analyses provide mental models which capture different aspects of stratospheric ozone depletion and global warming, although none of their assumptions holds rigorously.

\textbf{ii) International Agreements}

Framework conventions have been used for both stratospheric ozone depletion and global warming. In this approach a basic convention is adopted which includes broadly acceptable principles, in the expectation that later protocols will add more detailed obligations.\(^{579}\)

In 1985, the framework Vienna Convention established a general obligation on the parties to cooperate in addressing the issue of stratospheric ozone depletion.\(^{580}\) The Montreal Protocol of 1987 stipulated a production freeze for five chlorofluorocarbons (CFC 11, 12, 13, 114, 115) and three halons, phasing into a reduction from 1986 levels of 50% by 1999. The stricter London Revisions to the Montreal Protocol in 1990 required a phaseout of those compounds and ten others by 2000, with additional phaseouts extending to 2040. The

\(^{578}\)Avinash K. Dixit, Robert S. Pindyck, "Investment Under Uncertainty" (1994).

\(^{579}\)Kiss and Shelton, supra note 364 at 53 and 124-32 in the 1994 Supplement.

London Revisions also created a Multilateral Fund of voluntary contributions to developing countries to induce their participation. It began operation on an interim basis even before the London Revisions came into force, and has non-unanimous voting provisions. 581 Even stricter "Copenhagen Amendments" were subsequently instituted in 1992.

The interplay between science and diplomacy on the issue of stratospheric ozone depletion is considered an environmental success story. The paper by Molina and Rowland in 1974 is widely credited with identifying the problem. The scientific community progressively increased its understanding, which together with public opinion overcame both political inertia and industry reluctance to implement production phaseouts.

With respect to global warming, in 1988 the United Nations General Assembly requested the World Meteorological Society and the United Nations Environment Program to establish the Intergovernmental Panel on Climate Change (IPCC), to coordinate assessments of the problem. 582 The IPCC has established three working groups - on science, impacts and response strategies - which continue to meet and prepare periodic assessments. At the recommendation of the IPCC, the United Nations General Assembly established the Intergovernmental Negotiating Committee (INC) in 1990, in order to negotiate a Framework Convention on Climate Change (FCCC).

In the negotiations, countries polarized into three constituencies: the G-77 developing nations, the United States, and the rest of the developed world. The developing nations further split into small island states, heavily forested states, and oil producers. The United States held out against the inclusion of binding timetables for greenhouse gas reductions or

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581 So far, $226 million has been collected against pledges cumulating to $750 million. Hilary F. French, "Making Environmental Treaties Work", Scientific American 94, 97 (December 1994).

specific funding support for developing countries.

The Framework Convention on Climate Change announced at the UNCED conference articulates an objective to stabilize greenhouse gases at a level which will "prevent dangerous anthropogenic interference with the climate system" (Article 2). It goes on to require inventories of emissions and sinks, and the "promotion" of policies to abate global warming. A new principle calls for "common but differentiated responsibility" (Article 3(1)), with developed counties taking the lead. There is an absence of specific commitments which has been characterized by some as disappointing.583 However, the Conference of the Parties has broad powers to continue to administer the Convention.

iii) Impacts

Global warming has the potential to affect the world system in ways which significantly affect human welfare. Effects of global warming on sea level, freshwater resources, weather systems and food production will be discussed below.584

Global warming can raise the sea level by melting ice sheets and by thermal expansion. One range of "best estimate" expectations of total sea level rise before the year 2100 is from 20cm to 1m, with the extreme range being from 0 to 3.7m. The most obvious impact of sea level rise is flooding of coastal areas and island states. However, there are large uncertainties in projections for such flooding, because there can be complex dynamic feedback loops. As just


584 In this section on impacts, and the next sections on mitigation and adaptation, global warming and other tropospheric climate changes will be discussed since they constitute issues of acute uncertainty with a particularly wide range of reasonable policy responses. This section follows the presentation in Irving M. Mintzer, "Confronting Climate Change: Risks, Implications and Responses" 97-162 (1992).
one example, alterations in local weather systems can affect upstream soil erosion and sedimentation rates for coastal basins. Therefore, it is important to formulate integrated assessments which incorporate the natural, and human, dynamic feedback responses.

Global and regional hydrologic cycles are also affected dramatically by global warming. It increases global precipitation by 3-15%, because of increased evaporation. This would result in generally moister regional climates, but model projections have not achieved detailed agreement. However, changes in patterns of water runoff and an increased risk of storms and floods appear likely. Of particular significance, changes in regional freshwater resources can have national security implications with the potential to destabilize geopolitically volatile areas.

Weather systems are mesoscale phenomena and therefore subject to particular uncertainty in the context of global warming projections. Nevertheless, it is plausible to expect that more weather extremes will be associated with global warming. This could have not only economic impacts, but geopolitical effects such as refugees escaping weather-related disasters.

The greatest risks to agriculture from global warming are due directly to the elevated temperatures, and indirectly due to drought or floods. Elevated temperatures increase evapotranspiration which at times would not be compensated for by increased local precipitation, leading to dryness in vegetation. Regional monsoon patterns and food production potential would change. Geographical growing regions would migrate poleward. In addition, higher concentrations of carbon dioxide would directly promote vegetation growth.
iv) Mitigation and Adaptation

Mitigation in the context of global warming can be defined as reduction of greenhouse gas emissions or geo-engineering to moderate any temperature increases. Mitigation can be evaluated by benefit-cost analysis, subject to substantial uncertainty due to deviations of real-world behavior from model assumptions. A wide range of mitigation options are available, some of which will be discussed below.

The building sector uses more electricity than any other sector. The oil embargo and subsequent price increases induced large efficiency gains. However, very significant efficiency opportunities remain, typically with a positive net present value. This same characterization hold true for the industrial sector. In addition, manufacturers which directly emit greenhouse gases can contribute to mitigation by increased conservation and by substitution of compounds with less impact.

The transportation sector accounts for most of the petroleum consumption and about 1/3 of United States carbon dioxide emissions. Fuel efficiency trended sharply upward until the mid-1980's, with a slower rise after then. Technological improvement in transportation efficiency is an ongoing process, but sometimes meets consumer resistance to change or undervaluation of the capitalized benefit.

Energy suppliers can also mitigate global warming by efficiency gains. Another approach is direct carbon dioxide separation, recovery, fixation, and utilization or disposal. Still another option is an increased emphasis on renewable energy such as hydropower, wind, geothermal and solar energy. Finally, integrated systems such as combined heat and power can achieve dramatic net efficiency gains by making use of unavoidable thermodynamic heat losses resulting from electricity generation.

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Reductions in deforestation can also mitigate global warming. Geo-engineering options include positive afforestation, iron fertilization of the ocean, and increasing the planetary albedo by space mirrors, space dust or stratospheric dust. Finally, perhaps the most direct mitigation option is population control.

With respect to adaptation, the first set of measures focuses on coastal zone management.\textsuperscript{585} One option is to \textit{abandon} inundated or threatened coastal areas. Alternatively, \textit{accommodation} involves continuing to use coastal areas which are at greater risk of flooding, but without taking measures to reduce the flooding. In addition, emergency flood shelters, elevated buildings or bridges, conversion to aquaculture and water-tolerant or salt-tolerant crops are included in accommodation. Finally, \textit{protection} connotes engineering either "soft" approaches such as vegetation or dunes or "hard" approaches such as seawalls or dikes.

Another set of adaptation measures involves resource use and management. The development and transfer of research and technology are able to make better use of resources. One example of this is to maximize sustainable yields of resource bases. Of particular significance, increasing the flexibility and responsiveness of resource use and management enhances options which can prove invaluable in the context of rapid climate change.

c) Manifestations

i) Stratospheric Ozone Depletion
There is a high correlation between the total amount of chlorofluorocarbons produced and current atmospheric concentrations. In order to take into account the relative effectiveness of different chlorofluorocarbons in destroying stratospheric ozone, an index of Ozone-Depleting Potential has been estimated using CFC-11 as a reference.

The secular decline in non-polar stratospheric ozone concentrations can be seen in Figure 23.

Figure 23: Stratospheric Ozone Decrease - History\textsuperscript{587}

\begin{center}
\begin{tikzpicture}
\begin{axis}[
    width=\textwidth,
    height=\textwidth/1.5,
    scale only axis,
    xmin=1980, xmax=1994,
    ymin=-6, ymax=0,
    ytick={-6,-4,-2,0},
    yticklabels={-6,-4,-2,0},
    xlabel=Year,
    ylabel=Percent Deviation from Monthly Average,
    title=Global Ozone Trend (60°S–60°N),
]
\end{axis}
\end{tikzpicture}
\end{center}

The corresponding impact in the Antarctic spring can be seen in Figure 24.

**Figure 24: Antarctic Ozone Hole**

The result of these declines in stratospheric ozone is a corresponding increase in potentially harmful ultraviolet radiation reaching the surface of the earth (see Figure 25).

**Figure 25: Ultraviolet Radiation vs. Stratospheric Ozone**

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The success story of international cooperation which built upon the foundation of scientific knowledge about chlorofluorocarbon impact on stratospheric ozone\textsuperscript{590} is illustrated in the next two figures. Figure 26(a) shows how world production of chlorofluorocarbons has plummeted, while Figure 26(b) shows a corresponding decline in consumption in major regions - with the notable exception of China.

\textbf{Figure 26}\textsuperscript{591}

\begin{figure}[h]
\centering
\begin{subfigure}{0.45\textwidth}
\centering
\includegraphics[width=\textwidth]{CFC_Production.png}
\caption{(a) CFC Production - History}
\end{subfigure} \hspace{0.05\textwidth}
\begin{subfigure}{0.45\textwidth}
\centering
\includegraphics[width=\textwidth]{CFC_Consumption.png}
\caption{(b) CFC Consumption - History}
\end{subfigure}
\end{figure}

\textsuperscript{590}See supra, pp. 192, 235, 249.

\textsuperscript{591}From Megan Ryan, "CFC Production Plummeting", in Lester R. Brown, Nicholas Lenssen, Hal Kane, "Vital Signs 1995: The Trends that are Shaping our Future" 63 (Worldwatch Institute, 1995).
Projections of stratospheric chlorine concentrations reflecting alternative paths ranging from no controls all the way to the 1992 Copenhagen Amendments are shown in Figure 27, and emphasize the large effect these agreements are expected to have.

Figure 27: Chlorine Concentrations - History and Alternative Projections

![Graph showing chlorine concentrations over time with various projections including Continued Growth, Montreal Protocol, 1990 Amendments, and 1992 Amendments.](source: DuPont)

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592From Hilary F. French, "Environmental Treaties Grow in Number", in Lester R. Brown, Nicholas Lenssen, Hai Kane, "Vital Signs 1995: The Trends that are Shaping our Future", 91 (Worldwatch Institute, 1995).
ii) Global Warming

The classic record of the increase in CO₂ concentrations is derived from observations at Mauna Loa (see Figure 28).

Figure 28: CO₂ Concentrations - History

This figure, depicting "one of the most important data sets ever collected", shows an annual variation due to vegetation seasons superimposed on a very steady secular increase attributed to anthropogenic emissions.

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593 Handout at the "Summer School for Earth Sciences: Processes of Global Change", conducted by Jet Propulsion Laboratory, California Institute of Technology (July 21, 1995).

594 Daniel J. McCleese, at the "Summer School for Earth Sciences: Processes of Global Change", conducted by the Jet Propulsion Laboratory at the California Institute of Technology (July 21, 1995).
Methane follows carbon dioxide in importance as a greenhouse gas. Figure 29 clearly demonstrates its increase over time.

Figure 29: Methane Concentrations - History

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The current status of greenhouse gases is depicted in Figure 30.

**Figure 30: Greenhouse Gases - Current Status**

<table>
<thead>
<tr>
<th></th>
<th>CO₂</th>
<th>CH₄</th>
<th>N₂O</th>
<th>CFC-12 (a CFC substitute)</th>
<th>HCFC-22 (a CFC substitute)</th>
<th>CF₄ (a perfluorocarbon)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-industrial</td>
<td>280 ppmv</td>
<td>700 ppbv</td>
<td>275 ppbv</td>
<td>zero</td>
<td>zero</td>
<td>zero</td>
</tr>
<tr>
<td>Concentration</td>
<td>355 ppmv</td>
<td>1714 ppbv</td>
<td>311 ppbv</td>
<td>503 pptv</td>
<td>105 pptv</td>
<td>70 pptv</td>
</tr>
<tr>
<td>in 1992</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recent rate of</td>
<td>1.5 ppmv/yr</td>
<td>13 ppbv/yr</td>
<td>0.75 ppbv/yr</td>
<td>18-20 pptv/yr</td>
<td>7-8 pptv/yr</td>
<td>1.1-1.3 pptv/yr</td>
</tr>
<tr>
<td>concentration</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>change per year</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(over 1900s)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Atmospheric</td>
<td>(50-200)</td>
<td>(12-17)¹</td>
<td>120</td>
<td>102</td>
<td>13.3</td>
<td>50000</td>
</tr>
<tr>
<td>lifetime (years)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* No single lifetime for CO₂ can be defined because of the different rates of uptake by different sink processes

† This has been defined as an adjustment time which takes into account the indirect effect of methane on its own lifetime.

1 pptv = 1 part per trillion (million million) by volume

Analogous to the Ozone-Depleting Potential index, an index of Global Warming Potential has been estimated for different greenhouse gases. The Global Warming Potential is a function of primary and indirect effects, and depends on the planning horizon since different compounds have different residence times. For example, the one century Global Warming Potential of methane is 24.5, so that it will cause 24.5 times as great a temperature increase in 100 years as the same mass of CO₂. Nitrous oxide, the next most significant greenhouse gas, has a one century Global Warming Potential of 320, but is present in smaller concentrations. The Global Warming Potential of chlorofluorocarbons ranges from 4000 to nearly 12000. On the other hand, the class of hydro-chlorofluorocarbons designed to replace them has lower Global Warming Potentials ranging from 73 to 2000 due in part to much shorter residence times in the atmosphere.

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The temperature record seems to indicate a secular warming trend (see Figure 31).

**Figure 31: Global Temperature - History**

This apparent trend is broadly consistent with the hypothesis that greenhouse gases from anthropogenic sources are inducing global warming. However, changes on the time scale of a few decades do not show a strong correlation. For example, there was a decline in Northern Hemisphere temperatures from the 1940's until the early 1970's, when CO₂ concentrations continued to increase. Furthermore, during the past 50 years, warming has been more prominent in the tropics than the Arctic, which is opposite the prediction of global circulation models. Indeed, the warming trend seems to be primarily due to an increase in nighttime minimum temperatures, which is unlikely to result just from a direct radiative effect of

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597 Handouts at the "Summer School for Earth Sciences: Processes of Global Change", conducted by Jet Propulsion Laboratory, California Institute of Technology (July 21, 1995).

598 For this and the following observations, see George Kukla, Thomas Karl, "Nighttime Warming and the Greenhouse Effect", 27(8) *Environmental Science and Technology* 1468-74 (1993).
greenhouse gases. In sum, there are reasonable people who believe that it is premature to conclude that a process of anthropogenic global warming has already begun.599

Projections of future CO$_2$ concentrations can be seen in Figure 32.

**Figure 32: CO$_2$ Concentrations - Projections**

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600 From IPCC, "Radiative Forcing of Climate Change: The 1994 Report of the Scientific Assessment Working Group of IPCC: Summary for Policymakers" 14 (1994), captioned as: "(a) Prescribed anthropogenic emissions of CO$_2$ (from fossil fuel use, deforestation and cement production) for the IS92 Scenarios; (b) CO$_2$ concentrations resulting from the IS92 emissions Scenarios calculated using the 'Bern' model, a mid-range carbon cycle model (a range of results from different models is indicated by the shaded area of the IS92a curve)..."
Finally, a set of scenarios for future warming is presented in Figure 33.

**Figure 33: Global Temperature - Projections**

Rather than attempt to predict how fast trace gases will build up, GISS researchers devised three scenarios, each characterized by different rates of increase. Under Scenario B, which assumes the most plausible rates, global temperatures will have risen by more than 2°F by 2025 (0 represents the 1958 average temperature).

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d) Consistency of Policy Sets with Sustainable Development

The issue of global climate change is vastly complex, necessitating the adaptive heuristic approach envisioned by bounded rationality. This discussion will focus on global warming as a policy challenge which is subject to particularly grave complexity and uncertainty. One way to evaluate the consistency of global climate change policies with sustainable development is presented in the simplified Figure 34.

**Figure 34: Evaluation of Global Warming Policy Subset**

1. Create Linked Models
2. Execute Models for Alternative Policy Strategies
3. Evaluate Model Projections

First, models are created representing our knowledge of the various systems related to global climate change. Alternative policy strategies are generated. The models are executed by assuming the alternative policy strategies. Finally, the model projections are evaluated to determine whether the alternative policy strategies result in the ongoing improvement required by sustainable development.

This figure is simplified in that the different steps will not generally be so neatly compartmentalized, and will be performed largely in parallel with bidirectional feedback loops.
between each pair of steps, rather than simple being executed serially. With that in mind, each of the steps will be discussed in turn.

i) **Creation of Linked Models**

Global climate change relates to just about every component of the world system. It is necessary to identify its primary interactions, such as with population and energy usage, and generate hierarchical multi-disciplinary, and multi-modal models of those variables and their interaction with global climate change. The reference to multi-modal models is intended to make explicit that in addition to computer software models comprised of hierarchical sets of formal algorithms, it is necessary to incorporate other modes such as wetware models comprised of expertise and judgment.

Incorporating expertise and judgment is particularly essential when addressing issues subject to varying degrees of non-probabilistic uncertainty. However, to the extent possible it is important to explicitly incorporate the dimension of uncertainty even in algorithmic submodels. This will be particularly challenging with respect to joint uncertainties embedded within a very complex system.

Powerful modelling initiatives have already begun. The MIT Joint Program on the Science and Policy of Global Change is integrating an economic model with an efficient two-dimensional statistical-dynamical model of the climate system. Nordhaus has developed...

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602See, e.g., Kevins E. Trenberth (ed.), "Climate System Modelling" (1992). The linked nature of the models will be further discussed under the topic of advances in modelling technology in section (iv) below.


604The climate model has been adopted for a real land-ocean distribution from the Stone-Yao model developed at the Goddard Institute for Space Studies. Andrei P. Sokolov, Peter H. Stone, "Description and Validation of the MIT Version of the GISS 2-D Model", MIT Joint Program on the Science and Policy of Global Change Report No. 2 (June 1995).
DICE as a general economic model of global warming. MERGE has been presented as a sophisticated model to evaluate regional and global effects of greenhouse gas reduction policies, and includes submodels for abatement costs, climate, and damage assessment. ICAM-1 is an integrated model framework which incorporates geoengineering policies and an explicit propagation of the effects of parameter uncertainty. Multiple models can be logically linked even after execution by a combined meta-analysis of their projections.

ii) Execution of Models for Alternative Policy Strategies

The value of the models is in their ability to project the consequences of alternative policy strategies. Policy strategies are taken to mean policy set function paths, which specify a set of policies based upon the course of events. Indeed, much of the policy argument about global warming may be premised on the unhelpful notion that we must adopt an unchanging policy, rather than a policy strategy which responds to current and future information. In the spirit of bounded rationality, some adaptive "search algorithm" is used to identify promising candidate policy strategies for evaluation.

A broad range of policies has been proposed to deal with global warming, including regulation, taxation, permits and geoengineering. One alternative is to design a mechanism with the right incentive properties for states to report their beliefs about their abatement costs and damage assessments, assign abatement responsibilities and transfer payments based on those reports, and subject noncompliance to some effective enforcement mechanism.


iii) Evaluation of Model Projections
The evaluation of projections of the world system over the appropriate time horizon, with special reference to global climate change, can reach one of two major conclusions. First, a catastrophic scenario might dominate the projections and by itself preclude sustainable development either unarguably (e.g., a runaway feedback loop which rendered Earth as uninhabitable as Mars, on a time scale shorter than any extra-planetary capability), or arguably (e.g., a rise in ocean levels which wreaked havoc with island nations and coastal populations). Otherwise, the projected effects of global climate change need to be considered along with projections of the rest of the world system to determine whether a policy set is consistent with sustainable development.

iv) Global Inclusiveness of Expertise and Public Opinion
The key dimension of each of the three stages - creating models, executing them for alternative policy strategies, and evaluating projections - is inclusiveness of expertise and public opinion. Indeed, such inclusiveness is mandated by the legitimacy constraint on the constructed social preference relation. The procedural rationality constraint on an issue such as global climate change can hardly be fulfilled without including as broad and diverse a range of expertise as possible. Likewise, the equity constraint of access to information and participation by those affected mandates the inclusion of informed public opinion from around the world.

To actually achieve such global inclusiveness of expertise and public opinion, a number of steps can be taken. Modelling technology can be extended in the direction of compatible modularity with standardized interfaces. To model global climate change in an integrated fashion, models of different components of the world system such as geophysics or economics need to be able to efficiently access and provide spatio-temporal projections of different variables such as monthly temperatures or energy usage. This can be achieved by standardized interfaces to accomplish translations such a spatio-temporal interpolation or integration to achieve common space-time grids. Special attention needs to be given to explicit definitions of variables, identification of assumptions and characterization of
uncertainties. With this approach particular submodels could invoke alternative projections of variables which it considers exogenous, in order to robustly make its own projections based on a diverse range of environments. It should eventually be possible, for particular initial conditions and a given policy strategy, to use Monte-Carlo techniques to repeatedly invoke different combinations of submodels which have passed threshold validation tests,\(^{608}\) in order to generate particularly robust sets of projections with rich probabilistic information.

One set of threshold questions to ask of models during their validation is:

"What assumptions and data were used in producing model output? How well does the model perform: what is the accuracy of the model output? Is the model appropriately sensitive to the inputs being varied? Has the model been analyzed by someone other than the model authors? Is documentation adequate for the users' needs?"\(^{609}\)

The set of models, as extended by the capabilities of the experts and public who create and execute them and evaluate their projections, constitutes an adaptive knowledge base. The Monte-Carlo approach to integrating different combinations of submodels can be substantially enhanced by new software technology being patented by MIT.\(^{610}\) This technology empowers a knowledge-building community to adaptively evolve a knowledge base as a function of ongoing evaluations of its components, such as assumptions, submodels and policy strategies.

The potential for global inclusiveness in this process is dramatically enhanced by modern communication networks in general, and by the Internet in particular. This inclusiveness can be extended in two ways. Higher communication bandwidths and more powerful computers

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\(^{608}\)For example, the Atmospheric Model Intercomparison Project (AMIP) is designed to validate participating global circulation models by means of standardized simulations of the 10-year period 1979-88. Supra note 603 at 9.

\(^{609}\)These are selected and rearranged questions from Vincent P. Barabba, "Values Incorporated in Models", in William A. Wallace (ed.), "Ethics in Modeling" 153 (1994).


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can yield a progressively more sophisticated process. In addition, societies without access to such high technology can be deliberately included, in part by offline capabilities such as are inherently designed into the adaptive knowledge base software technology described above.

Money and politics both play a role in an inclusive process to evaluate the consistency of global climate change policy strategies with sustainable development. Many current and potential future experts, along with much of the global public, lack the resources to effectively participate in this process. Innovative funding programs can make financial and other resources available to subsidize such participation on the part of individuals, non-governmental organizations and government agencies. The result of this entire process is to promote the development of informed citizens and organizations able to more effectively participate in the essentially political decision of a policy strategy with respect to global climate change.

e) Implementation of Coordinated Policy Sets

The coordination of policy sets in the face of a global commons raises difficult issues. This section first discusses international policy coordination from a game theoretic perspective. Next, the connection between sanctions and trade law is explored. The difficult question of the legitimacy of sanctions not based on formal authority is discussed. The role of institutions in dispute avoidance and resolution is considered. Finally, Agenda 21 as promulgated by UNCED is portrayed as a focally attractive core component of an initial set of coordinated policy strategies.

i) Game Theoretic Perspectives

A significant issue is whether and how states can be expected to achieve international coordination in the pursuit of sustainable development. This issue is particularly stark where there is a global commons aspect, such as with stratospheric ozone depletion or global warming. Game theory can provide valuable perspectives if not complete or unique answers (see p. 211).
Recall first that policy strategies involve plans for reacting to different possible courses of events, much like the notion of strategies in game theory. By the same token, coordinated policy strategies involve contingent plans, so that the process of negotiation need not focus on predicting what will happen, but rather can focus on how to react to different alternatives. Of course, the process of planning how to react under various plausible circumstances connotes an element of forecasting. However, negotiating coordinated policy strategies has the potential to deflate the obstacle of conflicting forecasts and thereby enhance the prospects for successful negotiation. In addition, it is possible that the advantages of negotiating coordinated policy strategies in the international arena can awaken governments to the value of policy strategies in the domestic policy arena as well.

Another game theoretic perspective adopts state sovereignty as a starting point, and attempts to find an arrangement which not only achieves optimal emission reductions, but is in the "core". In this sense, the "core" of a game is a proposal that no individual state or even coalition of states could unilaterally improve upon. Chander and Tulkens perform just such a "cooperative game theory analysis" for transboundary pollution. This approach is termed "cooperative" game theory because it requires core solutions to be stable equilibria relative to any possible subset, or coalition, of states which were to cooperate among themselves. The model assumptions imply the existence of known, unique optimal emissions for each state. The sum over all states of abatement and damage costs is then minimized. Chander and Tulkens go on to identify a formula for allocating this total cost among states, and this formula is in the core, in the sense that no state or coalition of states is unilaterally motivated not to go along. "Transferable utility", such as payments from states who would be damaged

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611 See, generally, Lawrence Susskind, "Environmental Diplomacy: Negotiating More Effective Global Agreements" 80-81 (1994). However, Susskind seems to oversell contingent agreements, which neither eliminate the "least common denominator syndrome" nor diminish the need to agree on the most effective policy response, given some prospective state of the world.

the most to states who can abate most cheaply, is a key element of this model.

It is worth recalling some of the assumptions about this model, which of necessity sacrifices a degree of realism for analytical tractability. The analysis revolves around flow pollutants as opposed to stock pollutants like greenhouse gases. However, the cost and damage functions could be interpreted as the present discounted value of the sum of incremental costs associated with current emissions, to adapt the analysis to stock pollutants. Other assumptions include convex cost and damage functions, ambient pollution as a linearly additive function of emissions, and a damage function which is linear over ambient pollution.

Several additional assumptions underlying the model even more severely limit its applicability to global negotiations. First, the model assumes that the abatement and damage costs are known with certainty, whereas they are actually characterized by extreme uncertainty for global warming. Second, in order to calculate a "characteristic function" (which ascribes to each possible subset of states a "value" for the outcome unilaterally achievable by such a coalition) the model assumes that non-coalition states all act individually. This has intuitive appeal for coalitions lacking only relatively few states, but fails to capture potential strategic behavior of the rest of the world given a "coalition" comprised of one or a few states. Third, the fundamental premise of the model is nineteenth century sovereignty, in effect endowing each state with an absolute "property right" to damage the global environment as much as it chooses. The model then determines abatement and transfer payments irrespective of historical emissions, economic capacity or other factors which may be relevant to a legitimate outcome.

A different approach is to acknowledge the necessarily political decisions about the legitimate allocation of burdens, and to demonstrate how those decisions can be implemented as a Nash equilibrium by making use of the repeated nature of the game. The global commons is a

\[^{613}\] A Nash equilibrium can be thought of as a set of strategies for all the participants, such that no participant has an incentive to unilaterally deviate from its strategy.

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public good which can result in a prisoner's dilemma where each individual state is motivated not to cooperate, yielding a "bad" Nash equilibrium. However, an alternative "good" Nash equilibrium might be achieved by credibly threatening to exact a penalty which is larger than the incentive not to cooperate.

Suppose the outcome of the political process is for state "i" to achieve abatement "a_i" and to be reimbursed amount "t_i". The payoff matrix for this state vis-a-vis the rest of the world considered as an aggregate (not a coalition) is:

<table>
<thead>
<tr>
<th></th>
<th>Cooperate</th>
<th>Don't Cooperate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooperate</td>
<td>0</td>
<td>-b_i(a_i) - t_i</td>
</tr>
<tr>
<td>State &quot;i&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Don't Cooperate</td>
<td>c_i(a_i) - b_i(a_i) - t_i</td>
<td>c_i(a_i) - b_i(a_i) - b(a_i) - t_i</td>
</tr>
</tbody>
</table>

where: c_i(a_i) is the cost to state "i" of planned abatement "a_i" (i.e., above and beyond what it would plan if it did not cooperate);
t_i is the monetary equivalent of a transfer to (or from, if negative) state "i", contingent on its compliance;\(^{614}\)
b_i(a_i) is the benefit to state "i" of its planned abatement "a_i";
b_i(a_j) is the benefit to state "i" of the abatement planned for the rest of the world "a_j";
benefits for state "i" of planned abatements for it and for the rest of the world are assumed to be additively separable;
costs, benefits and transfers for state "i" are assumed to be additively separable; and
the outcome of the "cooperate-cooperate" cell is normalized to zero.

\(^{614}\)Note that there may be important opportunities to benefit transferee states by means of non-monetary concessions (e.g., licenses for certain categories of patents on advantageous terms, a significant component of one form of "technology transfer"). In such cases, the cost to a transferor state may either be significantly less than the benefit to the transferee state, or even be an outright benefit for the transferor state as well. However, it can be difficult to segregate non-financial concessions in particular, and perhaps even financial transfers, from what would have been extended anyway (e.g., enforcing the "new and additional sources of funds" committed to developing countries in recent environmental conventions).
In this matrix, "cooperate" signifies complying with a political agreement about abatements and transfers, "don't cooperate" in the second row signifies abating only as much as justified for state "i" itself and refusing to make any planned transfer, and "don't cooperate" in the second column signifies the same thing for each individual state in the rest of the world.

Since abatement is a public good, with marginal cost from initial levels presumably less than the sum of all states' marginal benefit at optimal levels, it would be advantageous to agree on additional abatement. Further, the excess \( c_i(a_i) \) of the cost of globally optimal abatement over "non-cooperative" abatement will presumably exceed the corresponding excess benefit \( b_i(a_i) \). Therefore, \( c_i(a_i) - b_i(a_i) > 0 \) and all states who receive \( t_i < c_i(a_i) - b_i(a_i) \) will be motivated to not cooperate. Since this includes all states who are planned to make payments \( (t_i < 0) \), and assuming transfers are subject to a balanced budget, then no state would receive any transfer even if it did cooperate, resulting in an equilibrium where all states fail to cooperate.

This "bad" Nash equilibrium can be overcome by "punishing" a state which fails to cooperate by an amount \( p_i \) which exceeds \( c_i(a_i) - b_i(a_i) - t_i \), inclusive of timing effects. (As a theoretical but counterproductive example, a "trigger strategy" might contemplate as punishment a Nash equilibrium which is worse than compliance would have been for a would-be shirker, such as the original "bad" Nash equilibrium if the shirker's discount rate is not too high.) This results in a "good" Nash equilibrium in which all states are motivated to comply with their planned abatements and transfers. The equilibrium can be "subgame perfect", in the sense that the threat of enforcement is credible, if for example the punishment sufficiently advantages the enforcers or if failing to cooperate in enforcement is itself punishable in a repeated regress.

It may be helpful to discuss the political process designed to plan the abatements and transfers, although it would be unrealistic and inappropriate to attempt to prescribe a detailed process. The agenda could reasonably include the past record of states, such as previous degradation of a commons resource. From a more positive perspective, the record could include contributions to relevant scientific research or policy analysis, access to assets such as
computers or satellites, and the stringency of and compliance with past abatement commitments. The agenda could also incorporate current factors such as strength of preferences or the ability to afford abatement, which might have the quite controversial effect of stronger economies subsidizing weaker economies on a secular or even cyclical basis.

A transparent, inclusive and adaptive expert process is necessary to identify and evaluate the effectiveness of different policy alternatives, model the costs to different states of different policies, and model the benefits to different states of different outcomes. The intermediate result would be a set of policy menus for states to choose from, either by direct implementation or by "joint implementation" with other states. Joint implementation could benefit from a clearinghouse operation, perhaps performed by the Global Environmental Facility, and perhaps involving politically attractive non-financial flows such as technology transfer. While challenging, this political process to coordinate state policies with respect to the global commons can achieve an outcome in the interest of all states, and arguably could be implied by states' legal duty under international law to pursue sustainable development.

States in dereliction of any duty to participate in formulating or complying with the abatement and transfer plans could be subject to a corresponding reaction from the community of nations in defense of its interests. In particular, a transparent, inclusive and adaptive expert process would estimate the aggregate costs imposed by, and individual benefits sought by, a shirker. Contingency plans to recoup the presumably greater costs would then be developed, for example the selective targeting of trade with sanctions or protectionism by proxy states who would redistribute gains and be reimbursed for any loss or retaliation. Presumably, given two alternative possible sets of sanctions with the same cost to a shirker, the set with greater gain to non-shirkers should be preferred. If the costs imposed by the shirker could be recouped without confiscating the entire benefit of shirking, then whether or not to impose still greater sanctions to confiscate the entire benefit of shirking would correspond to selecting between a "benefit of the bargain" or "restitution" conceptual basis for "damages" (though of course this situation would not have arisen if the policy coordination had achieved a "Pareto-efficient" outcome).
The uncertainty associated with enforcement by plans which were not specified originally could effectively contribute to deterrence. Further, such contingency plans might not need to actually be implemented if making them more concrete itself overcame recalcitrance. In other words, if defiance by a state of its legal duty to the community of nations provokes an appropriate combination of political delegitimization, economic enforcement and other pressure, then states might be less motivated to attempt to cloak themselves in nineteenth century concepts of sovereignty while jeopardizing the global environment.

ii) Trade Law: GATT and the Uruguay Round

The viability of economic sanctions in particular is dependent in part on trade law such as the General Agreement on Tariffs and Trade (GATT).\textsuperscript{615} There are at least three ways that the traditional GATT provisions might be interpreted as sanctioning reactions against a party (non-parties enjoy no privileges under GATT) which shirked its responsibility regarding cooperation for sustainable development, e.g. by "overpolluting" a global commons.

First, Article XX explicitly exempts from non-discriminatory "most-favored-nation treatment" two situations of potential relevance:

1) measures "necessary to protect human, animal or plant life or health" - which could be directly applicable in the cases of CFCs causing stratospheric ozone depletion or greenhouse gases causing global warming; and

2) measures "relating to the conservation of exhaustible natural resources if such measures are made effective in conjunction with restrictions on domestic production or consumption" - which could be directly applicable in the sense that the capacity of the atmosphere to act as a "sink" for CFCs or greenhouse gases is an exhaustible natural resource, with respect to which there could be a coordinated system of restrictions.

Second, Article III specifies non-discrimination against imported products with respect to

\textsuperscript{615} General Agreement on Tariffs and Trade (GATT) (Oct. 30, 1947, with revisions), as excerpted in Guruswamy, supra note 460 at 1125.
taxation and regulation respectively as follows:

1) Imported products "shall not be subject, directly or indirectly, to internal taxes or other internal charges of any kind in excess of those applied, directly or indirectly, to like domestic products." Therefore, for example, if domestic law were to assess a tax based on the carbon, energy, global-warming-potential, or ozone-depletion-potential content of a product in coordination with other countries, imports of a shirker might not be shielded from a corresponding tax.

2) Imported products "shall be accorded treatment no less favourable than that accorded to like products of national origin in respect of all laws, regulations and requirements affecting their internal offering for sale, purchase, transportation, distribution or use." Therefore, for example, if sustainability restrictions were domestically placed on the sale or use of a product in coordination with other countries, imports of a shirker might not be shielded from corresponding restrictions.\(^{616}\)

Third, and more generally, if a basic premise underlying GATT is the overall reduction of barriers to trade,\(^{617}\) and if a failure to coordinate for sustainable development presents a long-term barrier to trade, then a case might be made to either interpret or amend GATT to allow effective countermeasures. In the world of Schultz:

"The globalization of the world's economies is paralleled by the increasingly global nature of environmental problems. This is true in terms of the effects of these problems (e.g., climate change and ozone depletion), and also because dealing with these problems will require international cooperation. In view of the significant role it will play in the world economy, this global response will, in part, include reforming the rules of the international trading system."\(^{618}\)

\(^{616}\)See the Superfund Tax Case, Report of the Panel, GATT Doc BISD/345/16T (June 17, 1987); but see Mexican Tuna Case, GATT Doc DS21/R (Sep. 3, 1991) [cites from Sands, supra note 2 at 398], where "the United States banned the import of tuna caught by Mexican fisherman without proper regard for dolphins. This ban was ruled incompatible with the G.A.T.T." Henkin, supra note 59 at 1392.

\(^{617}\)See, e.g., Rich, supra note 419 at 307.

Schultz goes on to analyze the results of the Uruguay Round extension to GATT, completed in December 1993, which: 1) included a preambular goal of "optimal use of the world's resources in accordance with the objective of sustainable development"; 619 2) established, under the auspices of the newly created World Trade Organization (WTO), a Committee on Trade and Environment; 620 3) retained "the current GATT rules regarding national and most-favored-nation treatment"; 621 and 4) adopted an additional principle of international treatment whereby recognized international standards for legitimate objectives, including environmental protection, are rebuttably presumed to be legitimate. 622 Schultz's overall assessment of the Uruguay Round is:

"Policy makers do not really know whether the Uruguay Round will be good or bad for the world environment. All that is known is that the Round will be good for the world economy." 623

iii) "Reciprocal-Entitlement-Violations"

The foundation in international law of sanctions for noncompliance with the collective duty to pursue sustainable development resurrects the issue of the nature of international law itself. 624 Considering the more difficult case in which GATT did not formally authorize sanctions, is there any legal theory according to which retaliation against shirkers might still be legitimate? According to D'Amato's analysis of the meaning of international law:

619 Id. at 425.

620 Id.

621 Id. at 427.

622 Id.

623 Id. at 432. Of course, economic development is itself a component of sustainable development, along with the environment. See also, Jack Garvey, "Trade Law and Quality of Life - Dispute Resolution under the NAFTA Side Accords on Labor and the Environment", 89 American Journal of International Law 439 (1995).

624 The basic discussion on international law as "really law" can be found supra, pp. 69ff.
"As a construct of international law, a nation is nothing more nor less than a bundle of entitlements, of which the most important ones define and secure its boundaries on a map . . .

The simple conclusion follows that a nation is coextensive with its international legal entitlements.

This conclusion in turn illustrates why, as a matter of its very identity, a state should act in such a manner as to preserve its entitlements."625

Further, while international law can really "be law" even without enforcement,626 enforcement in international law analogous to enforcement in domestic law does exist.627 Thus, if a state contravenes international law by violating some entitlement,628 then it can be subject to a tit-for-tat violation of one (or more) of its own entitlements, and perhaps not the same one.629 D'Amato relates how the United States, with the acquiescence of the world community, retaliated against Iran's violation of the U.S. entitlement to diplomatic immunity (i.e., the "Iranian hostage crisis" of 1979) by freezing thirteen billion dollars of Iranian deposits and effectively confiscating the interest.630 D'Amato summarizes his thesis as follows:

626 D'Amato provides two lines of argument in support of the proposition that international law can really "be law" even without enforcement. First, in domestic law, there is no coercive enforcement available against the state when it is a party to litigation (e.g., in constitutional claims or criminal prosecutions). Second, the critical distinction between:
   a) a legal right, its justiciability and even the existence of a remedy, and
   b) the ability to enforce the remedy as premised on constitutional jurisdiction, was the foundation underlying Marshall's reasoning in Marbury v. Madison, arguably the most influential case in the jurisprudence of the United States. Id. at 4-5, citing Marbury v. Madison, 5 U.S. (1 Cranch) 137 (1803).
627 Id. at 13-25.
628 D'Amato defines an entitlement as a right recognized by international law, whether inhering in a state (e.g., territorial integrity), an individual (e.g., a human right), or, presumably, a people (e.g., self-determination). Id. at 14, 146ff.
629 Id. at 21-25.
630 Id. at 23-24, 166ff.
"International law is enforced by . . . reciprocal-entitlement-violation. The violation may be of the same entitlement or, more likely nowadays, of a different entitlement. . . .

In this sense, international law is a very realistic component of the picture that political scientists try to draw of how nations behave."\textsuperscript{631}

While it is possible for "reciprocal-entitlement-violation" to spiral out of control,\textsuperscript{632} the prevailing effect is more toward collective interest and stability because all states "have an interest in preserving [the system of] entitlements per se".\textsuperscript{633} In this regard, the pursuit of sustainable development is a duty of each state by virtue of the norm of self-determination. Further, to the extent that this duty is an \textit{erga omnes} norm of international law,\textsuperscript{634} the pursuit

\textsuperscript{631}Id. at 25-26.

\textsuperscript{632}Id. at 15-16, 24-25.

\textsuperscript{633}Id. at 21, 153ff.

\textsuperscript{634} "Common interests shared by the international community may be protected as obligations \textit{erga omnes}. In the case of \textit{Barcelona Traction, Light and Power Company, Limited} the International Court of Justice recognized the distinction between reciprocal and regulatory norms:

\begin{quote}
[A]n essential distinction should be drawn between the obligations of a State towards the international community as a whole, and those arising vis-a-vis another State in the field of diplomatic protection. By their very nature the former are the concern of all States. In view of the importance of the rights involved, all States can be held to have a legal interest in their protection; they are obligations \textit{erga omnes}.
\end{quote}

The Court included as obligations \textit{erga omnes} international legal norms against aggression and human rights protections against genocide, slavery and racial discrimination. The core interest in such obligations is protecting the international community as a whole. This factor, plus the absence of reciprocity characterizes much of international environmental law. Thus, to the extent there exist codified norms and customary standards in the environmental field these may be viewed as containing obligations \textit{erga omnes}.

Kiss et al, supra note 364 at 16-17.

"The Restatement (Third) [of the Foreign Relations Law of the United States, §902] also accepted the category of \textit{erga omnes} obligations. It included in that category customary law obligations in respect of human rights and protection of
by states of sustainable development is also an entitlement of each state, and perhaps one of
the most valuable of all entitlements considering the modern array of global threats to national
welfare. In this sense, appropriately disciplined "reciprocal-entitlement-violations", by the
community of nations and against shirkers jeopardizing the collective pursuit of sustainable
development, can help stabilize expectations and facilitate a "virtuous" sub-game perfect
equilibrium of coordinated policies.

iv) Institutionalizing Dispute Avoidance and Resolution

Of course, there are real advantages to institutionalizing the process of dispute avoidance and
resolution in general, and with respect to sustainable development in particular. In the words
of President Singh of the International Court of Justice:

"[I]t is necessary to strongly support the recommendation of [the World
Commission on Environment and Development] regarding the strengthening of
the existing machinery for dispute settlement provided by the two international
institutions functioning in the Peace Palace at The Hague. The first is ICJ and
the other is the Permanent Court of Arbitration. They both stand for dispute
settlement by peaceful means invoking the rule of law.

It is indeed gratifying to note that ICJ has observed recently that its doors are
always open to welcome consideration of any request for settlement of
environmental disputes by invoking either its special chamber of jurisdiction or
adjudication by the whole court, whichever method the parties preferred.

Furthermore, the Permanent Court of Arbitration will also welcome the idea of
maintaining an additional list of experts, both legal and scientific specialists on
the subject of environment, for the purpose of helping settlement of
environmental disputes by the method of arbitration if the parties chose to
select that method. The aforesaid proposal to make full use of the existing
international machinery for peaceful judicial settlement to include environmental

the environment . . . Recognition of erga omnes obligations has consequences
beyond judicial proceedings. States considered to have a legal interest in
vindicating important community or collective interests may assert that interest
in relevant non-judicial arenas such as international organs. Or, more important,
they may take counter-measures unilaterally or jointly against offending states."
Henkin et al., supra note 59 at 556-57. See also supra, p. 82.
disputes as well is to be welcomed and merits a mention in the present context."635

Methods to avoid or settle disputes in the field of sustainable development, including recourse to the International Court of Justice as suggested above, were further set out in Agenda 21:

Agenda 21, Chapter 39D: "Disputes in the field of sustainable development"636

In the area of avoidance and settlement of disputes, States should further study and consider methods to broaden and make more effective the range of techniques available at present. . . This may include mechanisms and procedures for the exchange of data and information, notification and consultation regarding situations that might lead to disputes with other States in the field of sustainable development and for effective peaceful means of dispute settlement in accordance with the Charter of the United Nations, including, where appropriate, recourse to the International Court of Justice, and their inclusion in treaties relating to sustainable development.

v) Agenda 21 as a Focally Attractive Initial Set of Coordinated Policy Strategies

Finally, it should be emphasized that an initial agenda by which states can proceed to fulfill their duty to pursue sustainable development already exists, in the form of some 350 multilateral and 1,000 bilateral environmental treaties,637 in addition to the instruments produced at the United Nations Conference on Environment and Development:

"At UNCED in 1992 a Framework Convention on Climate Change [31 ILM 851] was opened for signature. The objective of the signatories was the stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. A Biodiversity Treaty [31 ILM 822] was also opened for signature, with the objective of protecting endangered species and ensuring the equitable sharing of the benefits flowing from the earth's biological diversity.

Three important soft-law agreements were also concluded: the Rio Declaration on Environment and Development [31 ILM 876]; the Statement of Forest Principles [31 ILM 882]; and Agenda 21. None of these is legally binding, but


636As quoted in Sands, supra note 2 at 336.

they do reflect the consensus views of states. Not only do they serve now as guidelines for national, regional and international action, but they also provide a basis for establishing the international legal framework to achieve sustainable development.\textsuperscript{638}

UN Special Rapporteur Ksentini summarized Agenda 21 as follows:

"The Conference adopted a comprehensive programme of action known as 'Agenda 21' in the form of a plan for implementation in the various areas relating to sustainable development of the Earth. As pointed out by the Conference, the programme areas that constitute Agenda 21 are described in terms of the basis for action, objectives, activities and means of implementation. Agenda 21 is a dynamic programme. It will be carried out by the various actors according to the different situations, capacities and priorities of countries and regions in full respect of all the principles contained in the Rio Declaration on Environment and Development. It could evolve over time in the light of changing needs and circumstances. This process marks the beginning of a new global partnership for sustainable development.

Agenda 21] covers such diverse areas as international cooperation to accelerate sustainable development in developing countries and related domestic policies; combating poverty; changing consumption patterns; protection and promotion of human health conditions; promoting a sustainable pattern of human settlements; integration of environment and development in decision-making; protecting the atmosphere; combating deforestation; combating desertification; protection of the ocean and all kinds of seas; protection of freshwater resources; environmentally sound management of toxic chemicals and hazardous and radioactive wastes, including the prevention of illegal international traffic in such wastes; strengthening the role of major groups such as women, youth, indigenous peoples and non-governmental organizations."\textsuperscript{639}

The vigorous implementation and further development of Agenda 21 is thus able to serve as a focally attractive core component of coordinated policy strategies by which states can proceed to fulfill their duty to pursue sustainable development.


3. Case Studies: Summary and Comparative Analysis

The brief case studies of a large comet, viral mutation, and large-scale nuclear attack share a threat of triggering an unrecoverable catastrophe. Therefore, it is reasonable to ask how large is the risk that they could by themselves preclude sustainable development without reference to any other aspects of the world system. With probabilistic uncertainty in the form of a constant, statistically independent periodic chance of catastrophe, it is possible to calculate the ongoing increase in utility necessary to achieve sustainable development. This necessary increase in non-catastrophic utility proved to be relatively small for the large comet. In the case of non-probabilistic uncertainty such as in the case of a viral mutation, projections made on the basis of procedural rationality are evaluated for ongoing improvement over the appropriate time horizon to qualitatively determine whether a given policy set is consistent with sustainable development. For the case of a large-scale nuclear attack, subject to non-probabilistic uncertainty, benchmark calculations making heuristic use of the analytical techniques of probabilistic uncertainty indicate that the threat could plausibly by itself preclude sustainable development, and therefore warrants high priority policy consideration.

The case study on global climate change deals with an issue for which non-probabilistic uncertainty dominates, like the case of the viral mutation. However, in contrast to the comet and viral mutation, global climate change interacts very strongly with the rest of the world system. These case studies can be subjectively located in "Interconnectedness - Uncertainty" space to illustrate these comparisons (see Figure 35). The interconnectedness dimension of this figure can be thought of as an answer to the question: how extensive are the links between a particular threat (e.g., global warming) and the rest of the world system, which must be understood for effective policy analysis?
The uncertainty dimension of this figure actually comprises two potentially independent aspects of uncertainty: 1) *type* of uncertainty (probabilistic vs. non-probabilistic), and 2) *magnitude* of uncertainty (low vs. high). It is conceptually possible for probabilistic uncertainty to be of a high magnitude (e.g., a small sample size yields an estimate with very large standard errors) and for non-probabilistic uncertainty to be of a low magnitude (e.g., not being sure which of two Gaussian distributions with the same small standard deviation but slightly different means should be used). However, these potentially independent dimensions are represented together, since for the policy issues presented here they are strongly correlated.

These issues can also be differentiated on a temporal basis, by asking about their relevant time horizon and the potential rapidity of serious effects (see Figure 36). With respect to the horizontal dimension of this figure, the significance of the "relevant time horizon" is that threats whose onset is likely to be deferred, such as a large comet, require less urgent policy consideration. As to the vertical dimension, threats with rapid serious effects such as a large-scale nuclear attack severely limit effective policy reactions after the event. In contrast, the
issues with potentially slower effects, such as global climate change, may provide an opportunity to effectively modulate policy reactions even after initial onset of the catastrophe.

**Figure 36: Temporal Dimensions of Policy Issues**

<table>
<thead>
<tr>
<th>Potential rapidity of serious effects (years)</th>
<th>Global</th>
<th>Climate Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Viral mutation</th>
<th>Nuclear Attack</th>
<th>Comet</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
<td>100</td>
</tr>
<tr>
<td>1000</td>
<td>10,000</td>
<td></td>
</tr>
</tbody>
</table>

Relevant Time Horizon (years) →

The case study on global warming was used to develop a process by which a policy issue with extensive interconnections and major uncertainty could be integrated into an evaluation of the consistency of a policy set with sustainable development. This process consisted essentially of three stages: creation of linked models, execution of those models for alternative policy strategies, and the evaluation of the model projections - with global inclusiveness of expert and public opinion throughout the process. In effect, this spells out the heuristic, adaptive behavior of the procedural rationality called for in the context of bounded rationality.
The lessons from these policy case studies, which broadly span the relevant two-dimensional space of interconnectedness and uncertainty, can be combined to derive a general "process" to evaluate whether a given policy set is consistent with sustainable development:

*Organize* information about the world;

*Identify* alternative plausible policy strategies;

*Project* future states of the world over the time horizon, using a combination of expert forecasts, computer models and judgement;

*Evaluate* the projections for ongoing improvement, by comparing successive states of the world.

These steps are subjected to equitable procedural rationality, inclusive of expert and public opinion. In particular, rules of thumb such as the capital maintenance paradigm can be valuable heuristic tools to aid in the evaluation process.

Four particularly significant implications of this analysis are:

1. This systems / social choice process does not constitute a mechanism to select among alternative government policy sets, policy strategies, or social preference relations. Rather, such choices are the province of the political process, which can enforce the requirement on policy sets of consistency with sustainable development.

2. In general it is only complete policy sets whose consistency with sustainable development can be evaluated. While individual policies or policy subsets relating to threats of unrecoverable catastrophes could by themselves preclude sustainable development and be *inconsistent* with it, only complete policy sets can be characterized as *consistent* with it.

3. The standards which have been enunciated are clear, but qualitative. Correspondingly, the issue of a state's compliance with its duty under international law to pursue sustainable development must ultimately be resolved by interpretive processes, whether political or judicial, domestic or international.
4. The consistency of a particular state's proposed policy set with sustainable development can be a function of other states' current and future policy sets. As an extreme example, the prospect of a large-scale nuclear attack could render all possible policy sets of a target state inconsistent with its sustainable development. At the other extreme, routine economic activity of every state affects global climate change. Consistent with this interdependence, the pursuit of sustainable development is both an individual and a collective responsibility of states. Where coordination of policy sets is important for the pursuit of sustainable development, as in the case of global climate change, domestic constituencies and the international community are in a position to judge the degree of good faith coordination by individual states. Individual violators can be subjected to both domestic and international pressure. If there is a collective failure by states to fulfill their responsibility under international law to pursue sustainable development, they can likewise be subjected to collective political pressure, with differentiation as appropriate, by the democratic process.640

V. Conclusion

This dissertation has analyzed the existence of a duty of states to pursue sustainable development. The three main parts have been the legal argument, a systems / social choice definition of sustainable development, and a series of case studies.

The legal argument for the pursuit of sustainable development as a duty of states derives from self-determination, as reinforced by human rights. Self-determination is shown to be a binding norm of international law, although inconsistent state conduct remains a severe problem. The law of self-determination is also characterized as an international trust, with all peoples as beneficiaries and all states as trustees. This legal paradigm could serve the interest of the world community, as concepts of sovereignty adjust to new global threats.

The core concept of self-determination is the right of peoples to determine their future. This embraces sustainable development as one possible choice. Furthermore, peoples have actually chosen to pursue sustainable development, as demonstrated at the United Nations Conference on the Environment and Development in 1992. The result is a duty of states to pursue sustainable development.

The definition of sustainable development itself is based on systems and social choice theory. It can be summarized as "ongoing improvement of the world system, according to a legitimately constructed social preference relation". This definition does not provide a selection mechanism among alternative policy choices, but is a "litmus test" by which to evaluate the consistency of a proposed policy set with sustainable development.
Case studies on the threat of an unrecoverable catastrophe involved a large comet, a viral mutation and a large-scale nuclear attack. These were analyzed using non-probabilistic uncertainty for the viral mutation, and probabilistic uncertainty for the other two, albeit only to establish heuristic benchmarks in the case of a large-scale nuclear attack. The threat of a large comet seems to be a relatively small issue in the context of a significantly improving world system, while the threat of a large-scale nuclear attack could plausibly have precluded post-war sustainable development despite real economic growth.

The global climate change case study included stratospheric ozone depletion and global warming. Because of the large, complex nature of these issues, which have a myriad of connections with the rest of the world system, the focus was on discussing the kind of modelling and evaluation processes which could be appropriate.

The net result of these case studies is that operationalizing the pursuit of sustainable development involves learning about the world, searching for promising policy strategies, projecting their consequences, and evaluating those projections.

Finally, the connection between sustainable development and the political process is deep and bidirectional. The political process can impact on sustainable development, in the senses that: 1) meaningful access to information, and an opportunity for effective participation in decisions by those affected, are vital dimensions of sustainable development; and 2) an argument in the political arena, that the failure to pursue sustainable development serves to delegitimize a state or government, can be a particularly powerful enforcement mechanism.

Sustainable development may also powerfully impact the political process in turn, because its substantive significance looms large in multiple dimensions of political issue space, and can be powerfully leveraged even further by framing and agenda manipulation.
Glossary

Abatement. The reduction of a threat by means of a policy. For example, a carbon tax might be used to reduce the threat of global warming.

Adaptation. Reacting to a state of the world system. For example, progressive relocation inland along coastal areas could be an adaptation to sea level rise caused by global warming.

Arrow's Theorem. This theorem from social choice theory proves that the only possible Arrowian social choice function (mapping individual preferences onto a societal preference) is a dictatorship, given four seemingly innocuous assumptions: 1) universal domain (the mapping covers all possible individual preferences), 2) rationalizability (the social preference relation is reflexive, complete and transitive), 3) independence of irrelevant alternatives (individual preferences over unavailable alternatives do not affect the social preference relation), and 4) Pareto optimality (if all individuals prefer one outcome to another, the social preference relation will also).

Benefit-cost Analysis. An economic decision-making criterion which compares the net present value of the benefits and the costs of a proposed action.

Bounded Rationality. A paradigm in which people are faced with a complex world, but have limited information and processing capacity.

Capital. The capacity for future welfare.

Extensive Capital. Capital which results in relatively large increases in environmental degradation when the scale of production is increased; in particular, capital with the potential for negative incremental Hicksian income during the planning horizon (i.e., full internalization of environmental degradation could result in negative incremental income).

Intensive Capital. Capital which results in relatively small increases in environmental degradation when the scale of production is increased.

Complete Information. Absence of uncertainty concerning any material information, both present and future.

Equity. In the legitimacy constraint on the social preference relation of the systems / social choice definition of sustainable development, equity includes access to information and an opportunity to participate in decisions for those affected.

Global Warming. Anthropogenic enhancement of the greenhouse effect.
Greenhouse Effect. Absorption of longwave infrared terrestrial radiation by atmospheric gases such as CO₂, trapping energy in the terrestrial system and causing higher temperatures.

Hicksian Income. Amount of consumption which would leave society as well off at the end of a period as at the beginning.

Internalization of Environmental Degradation. Ensuring that the producers and consumers in economic activity which degrades the environment bear the resulting cost to society.

Legitimacy Constraint. With respect to the social preference relation of the systems / social choice definition of sustainable development, a combination of rationality and equity.

Optimization. Achievement of, or the attempt to achieve, the "best" possible outcome.

Policy. A specific government program or plan, usually dealing with a particular issue.

Policy Subset. Policies which are related to one another in some way. For example, they may be related by dealing with a particular issue such as global warming, or they may all be of the same type such as taxation policies. Policy subsets can be both overlapping and hierarchical. For example, policy subsets dealing with global warming and stratospheric ozone depletion overlap, and are included in the policy subset dealing with global climate change.

Policy Set. All the policies with the capacity to affect human welfare, for a particular time period. In the case of complete information, a future policy set which is "eligible" for projecting ongoing improvement (to justify a proposed current policy set) is one which is no more difficult to adopt than the proposed current policy set.

Policy Set Function. A function which maps accessible observations of the world system up to the particular time period onto the set of feasible policy sets.

Policy Strategy, or Policy Set Function Path. A temporal sequence of policy set functions. An "eligible" policy strategy is one for which current binding commitments to its individual component policy set functions, given commitments to all the rest, would be no more difficult than adopting the proposed current policy set.


Rationality. In the legitimacy constraint on the social preference relation of the systems / social choice definition of sustainable development, rationality corresponds to procedural rationality.

Procedural Rationality. In the context of bounded rationality, heuristic adaptation to achieve a satisfactory outcome, including investing an appropriate amount of resources to effectively formulate and evaluate alternative policy strategies.
Satisficing. In the context of bounded rationality, realistic achievement of an aspiration level rather than unrealistic optimization.

Self-Determination. The right of peoples under international law to determine their future, e.g., to freely pursue their political, economic, social and cultural development.

Social Preference Relation. A preference relation whose ranking of pairs of alternatives is on behalf of society.

Eligible Social Preference Relation. A social preference relation which is both feasible and legitimate.

Feasible Social Preference Relation. A social preference relation for which the construction is both affordable and logistically practical.

Legitimate Social Preference Relation. A social preference relation which is both rational and equitable.

Stratospheric Ozone Depletion. Decrease of ozone in the stratosphere due to anthropogenic emissions of CFCs or other compounds, resulting in a greater intensity of ultraviolet radiation reaching the surface of the earth.

Substitutability. Ability to use one item in place of another. E.g., an ability to substitute technological advances for natural resources.

Sustainable Development. Ongoing improvement of the world system over some time horizon, according to a legitimately constructed social preference relation.

Consistency of a Policy Set with Sustainable Development (with respect to an initial state of the world system, an eligible social preference relation, and a time horizon). The existence of an eligible policy strategy which would result in ongoing improvement of the world system over the time horizon, according to the eligible social preference relation.

Tragedy of the Commons. Overuse of a commons resource because the cost to an individual user fails to include part of the true social cost.

Uncertainty - Probabilistic. Characterization of alternative possible states of the world by a probability distribution function.

Uncertainty - Non-probabilistic. Inability to characterize all alternative possible states of the world by a probability distribution function.
Appendix 1: Justification of Focus on Overall Policy Set

The focus of this analysis is on the consistency of an overall policy set with sustainable development, as opposed to the consistency of individual policies with sustainable development. This is because the effect that an individual policy \( p_0 \) has on satisfying the sustainable development constraint of ongoing improvement in general depends on the rest of the policy set and its evolution over time, referred to as the strategy set \( P \).\(^1\)

If the welfare effect of a policy \( p_0 \) and its evolution over time "\( p \)" is not separable from the welfare effect of the balance of the policy strategy \( P \), then it is immediately apparent that the effect of \( p \) on satisfying sustainable development can depend upon \( P \). However, this dependence of the effect on satisfying sustainable development of an individual policy \( p \) on the balance of the policy strategy \( P \) obtains even in the case of separability of welfare effects. Perhaps the most stark heuristic demonstration involves the case of additively separable utilities with complete information.

\(^1\)The separate issue, not considered in this analysis, as to whether or not to implement a particular policy, can perhaps be best addressed by portfolio analysis. From that perspective, a feasible policy set is a feasible portfolio of individual policies, and can be evaluated in the context of their interaction and (in the case of uncertainty and risk aversion) the cross-correlation of their impacts.
In the case of additively separable utilities with complete information:

\[ U(P_t^+) = U(P_t) + U(p_t), \]

where \( p = \{p_0, p_1, \ldots, p_T\} \) is the evolution over time of an individual policy;

\( P = \{P_0, P_1, \ldots, P_T\} \) is the sequence of policy sets which constitutes the strategy set without \( p \);

\( P^+ = \{P_0^+, P_1^+, \ldots, P_T^+\} \) is the sequence of policy sets which constitutes the strategy set \( P \) as augmented by \( p \);

\( U(\cdot) \) is the von Neumann Morgenstern utility of the argument (\( \cdot \)), where the argument can be taken to be the individual policy or the policy set rather than a state of the world, due to complete information and separability.

**Theorem.** In the case of complete information and additively separable utilities for the evolution of a non-constant individual policy \( p \) and the balance of the policy strategy \( P \), the effect of \( p \) on satisfying the constraint of sustainable development is in general dependent on the balance of the policy strategy \( P \).

**Proof.** The proof will proceed by showing that any individual policy over time, \( p \), can have different effects on satisfying sustainable development depending on the remaining policy strategy \( P \). Two cases of individual policy instruments will be considered in turn: those with non-monotonic \( U(p_t) \) and monotonic \( U(p_t) \).
Case I: Non-monotonic $U(p_t)$.

Assume a particular "non-monotonic" $U(p_t)$, in the sense that $U(p_t)$ is neither non-decreasing nor non-increasing, so that it includes both a one-interval increase and decrease over the relevant time horizon.

a) It is possible to choose a time such that:

$$U(p_{t+1}) - U(p_t) < 0.$$  

Consider a remaining policy strategy $P$ which is consistent with sustainable development before augmenting it with $p$. The ongoing improvement criterion holds between $t$ and $t+1$, so that:

$$U(P_{t+1}) - U(P_t) > 0.$$  

Further specify $P$ such that:

$$|U(P_{t+1}) - U(P_t)| < |U(p_{t+1}) - U(p_t)|.$$  

This is always possible, for example with an additional appropriate-sized wastage between $t$ and $t + 1$, given sufficient continuity of utility.
Then the change of utility of the combined policy strategy $P^+$ is:

$$U(P^+_{t+1}) - U(P^+_t) = [U(P_{t+1}) + U(p_{t+1})] - [U(P_t) + U(p_t)]$$

$$= [U(P_{t+1}) - U(P_t)] + [U(p_{t+1}) - U(p_t)] < 0.$$ 

where the first step obtains from additive separability, the second step by rearranging terms, and the final step results from the inequality above. This reduction in utility means that we have constructed a balance of a policy strategy $P$ which is consistent with sustainable development by itself, but is not consistent with sustainable development when combined with the given evolution over time of policy instrument $p$.

b) For the converse result, consider a remaining policy strategy $P$ such that:

$$U(P_t) = -U(p_t) + \epsilon t, \quad 0 \leq t \leq T,$$

where $\epsilon$ can be specified as:

$$0 < \epsilon < MAX[U(p_{t+1}) - U(p_t)], \quad 0 \leq t < T,$$

since $U(p)$ is not non-increasing. By construction, $\epsilon$ is too small to change the sign of the greatest inter-period increase of $p$, which corresponds to the greatest inter-period decrease of $P$. Therefore, $U(P)$ is not monotonically increasing, so that $P$ is not consistent with sustainable
development.

The utility of the composite strategy \( P^+ \) is then:

\[
U(P_{t+1}^+) = U(P_t) + U(p_t) = \epsilon t, \quad 0 \leq t < T,
\]

\[
U(P_{t+1}^+) - U(P_t^+) = \epsilon > 0, \quad 0 \leq t < T.
\]

Therefore, while the remaining policy strategy \( P \) is not consistent with sustainable development by itself, it is consistent with sustainable development when combined with the given evolution over time of policy instrument \( p \).

c) As an example where the consistency with sustainable development of the balance of the policy strategy is not changed by including the evolution over time of policy instrument \( p \), consider a remaining policy strategy \( P \) such that:

\[
|U(P_{t+1}) - U(P_t)| > |U(p_{t+1}) - U(p_t)|, \quad 0 \leq t < T;
\]

i.e., the magnitude of the change in utility of \( P \) exceeds the magnitude of the change in utility of \( p \) over the relevant time interval. This implies that:

\[
SIGN[U(P_{t+1}^+) - U(P_t^+)] = SIGN[U(P_{t+1}) - U(P_t)],
\]
and that the consistency with sustainable development of the remaining policy set $P$ is _unchanged_ by including the evolution over time of policy instrument $p$.

Case I (non-monotonic $U(p_t)$) summary: We have shown that given _any_ policy instrument $p$ over time for which $U(p_t)$ is non-monotonic, remaining policy strategies can be displayed which are made consistent with sustainable development by augmentation with $p$, made inconsistent with sustainable development by augmentation with $p$, or whose consistency with sustainable development is left unchanged by augmentation with $p$.

Case II: Monotonic $U(p_t)$.

Assume a particular "monotonic" $U(p_t)$, in the sense that $U(p_t)$ is either non-decreasing or non-increasing.

a) For non-decreasing $U(p)$, a remaining policy which is consistent with sustainable development implies:

$$U(P_{t+1}) - U(P_t) > 0, \quad 0 \leq t < T,$$

so that for the composite policy strategy:

$$U(P_{t+1}^+) - U(P_t^+) = [U(P_{t+1}) + U(p_{t+1})] - [U(P_t) + U(p_t)]$$

$$= [U(P_{t+1}) - U(P_t)] + [U(p_{t+1}) - U(p_t)],$$
where the first term is greater than zero (by construction) and the second term is greater than or equal to zero (by assumption). Therefore, the composite policy strategy remains consistent with sustainable development.

However, if the remaining policy strategy is not consistent with sustainable development, the composite policy strategy may or may not be consistent with sustainable development, depending on whether:

\[
U(p_{t+1}) - U(p_t) > |U(P_{t+1}) - U(P_t)| \quad \forall \, t \in [0, T - 1] \text{ s.t. } U(P_{t+1}) < U(P_t).
\]

b) For non-increasing \(U(p)\), a remaining policy strategy which is not consistent with sustainable development results in a composite policy strategy which remains not consistent with sustainable development, using the same logic as in (a).

However, if the remaining policy strategy is consistent with sustainable development, the composite policy may or may not be consistent with sustainable development, using the same logic as in (a).

Case II (monotonic \(U(p_t)\)) summary: We have shown that given any policy instrument \(p\) over time for which \(U(p_t)\) is monotonic, remaining policy strategies \(P\) can be displayed whose consistency with sustainable development is left unchanged by augmentation with \(p\), which are made consistent with sustainable development (if \(U(p_t)\) is non-decreasing), or which are made
inconsistent with sustainable development (if $U(p_t)$ is non-increasing).

Combining the two cases, we have shown that given any policy instrument $p$ over time, remaining policy strategies can be displayed which are made consistent with, inconsistent with, or left unchanged with respect to sustainable development - with the sole exception that if a monotonic policy instrument changes the consistency with respect to sustainable development of a remaining policy strategy it can only be in the direction of its monotonicity. Therefore, the effect of a policy instrument on satisfying the constraint of sustainable development is general dependent on the balance of the policy strategy. Q.E.D.

The next theorem shows, somewhat counterintuitively, that a policy instrument with uniformly positive and improving welfare effects can be inferior to a policy instrument with negative welfare except for a single time period, if judged on the basis of consistency with sustainable development when augmenting a remaining policy strategy.
Theorem. Consider two policy instruments over time: 1) \( p^{\text{pulse}} \) with a positive welfare effect for only a single time \( t+1 \), but with a negative welfare effect at all other times,\(^2\) and 2) \( p^{\text{monotonic}} \), with a uniformly positive welfare effect and monotonic improvement. Depending on \( U(p^{\text{pulse}}_t) \), \( U(p^{\text{monotonic}}_t) \) and \( U(P_t) \), where \( P_t \) is the component at time \( t \) of the remaining policy strategy, there are conditions for which the composite policy strategy \( P + p^{\text{pulse}} \) can be consistent with sustainable development while the composite policy strategy \( P + p^{\text{monotonic}} \) is not consistent with sustainable development.

Proof. Assume: 1) Complete information and additively separable utility;
2) \( P \) is consistent with sustainable development except for a utility decline between \( t \) and \( t+1 \);
3) \( U(p^{\text{pulse}}) = -\epsilon \) except at time \( t+1 \), where:

\[
U(p^{\text{pulse}}_{t+1}) - (-\epsilon) > U(P_{t+1}) - U(P_t),
\]

4) \( U(P_{t+1}), U(P_{t+2}) \) are such that

\[
| - \epsilon - U(p^{\text{pulse}}_{t+1}) | < U(P_{t+2}) - U(P_{t+1}).
\]

Then by construction the composite strategy \( P + p^{\text{pulse}} \) is consistent with sustainable development.

\(^2\)Note that this theorem could also be formulated for a \( p^{\text{pulse}} \) with negative welfare effects at all times.
development. Assume further that:

\[ U(p_{t+1}^{\text{monotonic}}) - U(p_t^{\text{monotonic}}) < |U(P_{t+1}) - U(P_t)|. \]

Then by construction the composite strategy \( P + p^{\text{monotonic}} \) is not consistent with sustainable development. Therefore, augmenting a policy strategy with an individual policy over time with negative welfare effects except for a single period can be consistent with sustainable development, even while augmenting that policy strategy with an individual policy with monotonically increasing and uniformly positive welfare effects can be inconsistent with sustainable development. Q.E.D.

**Summary of Both Theorems**

The gist of these theorems is that the effect of a particular policy instrument over time on achieving sustainable development is dependent on the rest of the policy strategy, even in the case of additively separable utility. This is analogous to the conclusions of finance theory, according to which an asset or project can be valued only in the context of remaining available assets or projects.\(^3\) Therefore, an analysis of sustainable development which focuses on the overall policy set is justifiable and appropriate.

\(^3\)This explains, for example, how in the context of risk aversion, an asset with a negative expected value (such as the purchase of an insurance policy), can be valued above an asset with certain positive value (such as cash). However, the conclusion here does not depend on risk aversion, and in that sense is more general than the analogous conclusion of finance theory.
Appendix 2: When is the Sustainable Development Constraint Binding?

Consider an optimization program which maximizes the present discounted value of an infinite stream of interim utility, perhaps subject to a constraint of sustainable development. A constraint of sustainable development over the same infinite time horizon corresponds to monotonically increasing interim utility. Interim utility is assumed to be a Cobb-Douglas-like function of interim consumption and capital (i.e., the existence value of capital is explicitly included). Consumption is the control variable. The question is, under what conditions (i.e., discount rates, growth rates and parameters of the interim utility function) is the sustainable development constraint binding? In particular, can we identify in some sense who would be “for” and “against” sustainable development, based on the parameters in their utility function and the return to capital?

This optimization program can be formulated as:

$$\max \int_0^\infty \exp(-rt)u(K, C) \ dt,$$

subject to:

1) $u(K, C) = K^{\alpha_K}C^{\alpha_C}$ [with $0 < \alpha_C, \alpha_K < 1$]

2) $K' = gK - C$

3) $K(0) = K_0$

4) $C > 0; \ K > 0.$
Note that $C = gK - K'$, and perform the change of variable:

$$\chi = \frac{C}{gK},$$

in which case the constraint of positive consumption corresponds to $\chi$ positive. Note that $\chi$ can be interpreted as consumption in units of contemporaneous Hicksian income, so that $\chi < 1$ corresponds to increasing capital.

Under this change of variable, the rate of change of capital and the interim utility can be expressed as:

$$K' = gK - C = gK - gK\chi = gK(1 - \chi),$$

$$u(K', C) = K^\alpha (gK\chi)^{\alpha_c} = g^{\alpha_c} K^\alpha \chi^{\alpha_c},$$

where $\alpha \equiv \alpha_K + \alpha_C$.

The optimization program can then be expressed as:

$$\max \int_0^\infty \exp(-rt)(g^{\alpha_c} K^\alpha \chi^{\alpha_c}) \, dt,$$

subject to:

1) $K' = gK(1 - \chi)$

2) $K(0) = K_0$

3) $K > 0, \chi > 0$.  

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Using calculus of variations, the Hamiltonian formulation for this problem is:

\[ H \equiv \exp(-rt)g^{ac}K^a\chi^{ac} + \lambda[gK(1 - \chi)] \]

\[ H_x : \frac{\partial H}{\partial x} = 0 = \exp(-rt)g^{ac}K^a\alpha_c\chi^{ac-1} - \lambda gK \]

\[ H_K : \frac{\partial H}{\partial K} = -\lambda' = \alpha \exp(-rt)g^{ac}\chi^{ac}K^{a-1} + \lambda g(1 - \chi) \]

\[ H_\lambda : \frac{\partial H}{\partial \lambda} = K' = gK(1 - \chi). \]

From \( H_x \) we obtain:

\[ \lambda = \frac{\alpha_c \exp(-rt)g^{ac}K^a\chi^{ac-1}}{gK} = \alpha_c g^{ac-1} \exp(-rt)K^{a-1}\chi^{ac-1} \Rightarrow \]

\[ \lambda' = \alpha_c g^{ac-1} [\exp(-rt)K^{a-1}(\alpha_c - 1)\chi^{ac-2}\chi' + \chi^{ac-1}(\alpha - 1)K^{a-2}K' - r \exp(-rt)K^{a-1}\chi^{ac-1}] \]

Substituting \( \lambda \) and \( \lambda' \) into \( H_K \), and using \( H_\lambda \) to replace \( K' \) with \( gK(1 - \chi) \), we obtain:

\[ -\alpha_c g^{ac-1} \exp(-rt)\left[ (\alpha_c - 1)K^{a-1}\chi^{ac-2}\chi' + (\alpha - 1)\chi^{ac-1}K^{a-2}gK(1 - \chi) - rK^{a-1}\chi^{ac-1} \right] \]

\[ = \alpha g^{ac} \exp(-rt)\chi^{ac}K^{a-1} + [\alpha_c g^{ac-1} \exp(-rt)K^{a-1}\chi^{ac-1}]g(1 - \chi). \]

To simplify, divide by \( \exp(-rt)g^{ac-1}K^{a-1}\chi^{ac-2} \):

\[ -\frac{\alpha_c}{g} [(\alpha_c - 1)\chi' + (\alpha - 1)g\chi(1 - \chi) - r\chi] = \alpha \chi^2 + \alpha_c \chi(1 - \chi). \]

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Using standard format and continuing the simplification process yields:

\[
\chi' \left[ \frac{\alpha_C(1 - \alpha_C)}{g} \right] + \chi(1 - \chi)[\alpha_C(1 - \alpha) - \alpha_C] - \chi^2[\alpha] + \chi \left[ \frac{\alpha_C r}{g} \right] = 0
\]

\[
\chi' \left[ \frac{\alpha_C(1 - \alpha_C)}{g} \right] - \chi^2[\alpha(1 - \alpha_C)] + \chi \left[ \alpha_C \left( \frac{r}{g} - \alpha \right) \right] = 0.
\]

Transposing the \(\chi^2\), \(\chi\) terms and multiplying by \(g/[\alpha_C(1 - \alpha_C)]\) yields:

\[
\chi' = \chi^2 \left[ \frac{\alpha}{\alpha_C} g \right] - \chi \left[ \frac{r - \alpha g}{1 - \alpha_C} \right]
\]

\[
\frac{d\chi}{\left( \frac{\alpha g - r}{1 - \alpha_C} \right) \chi + \left( \frac{\alpha g}{\alpha_C} \right) \chi^2} = dt
\]

This differential equation is in the standard form:

\[
\frac{d\chi}{a + b\chi + c\chi^2} = dt
\]

where \(a = 0;\)

\(b = -(r - \alpha g)/(1 - \alpha_C) = -(r - \alpha g)/(1 - \alpha_C);\)

\(c = \alpha g/\alpha_C;\) and

\(4ac - b^2 = -b^2 < 0\) (we will assume \(r > \alpha g\), as discussed below).
This can be integrated to obtain:

\[
\frac{1}{b} \log \left( \frac{2c\chi}{2c\chi + 2b} \right) = t + \gamma_1,
\]

where \( \gamma_1 \) is the constant of integration. Then:

\[
\left( \frac{c\chi}{c\chi + b} \right)^t = \exp(\gamma_1) \exp(t) \Rightarrow
\]

\[
\frac{c\chi}{c\chi + b} = \exp(b\gamma_1) \exp(bt) = \gamma \exp(bt),
\]

\[
\gamma = \exp(b\gamma_1) = \frac{c\chi_0}{c\chi_0 + b}.
\]

It is then possible to solve for \( \chi \) as follows:

\[
c\chi = (c\chi + b)\gamma \exp(bt)
\]

\[
c\chi[1 - \gamma \exp(bt)] = b\gamma \exp(bt)
\]

\[
\chi = \left( \frac{b\gamma}{c} \right) \left[ \frac{\exp(bt)}{1 - \gamma \exp(bt)} \right]
\]

\[
\chi = \left( \frac{b\chi_0}{c\chi_0 + b} \right) \left( \frac{\exp(bt)}{1 - \gamma \exp(bt)} \right).
\]
Consumption being positive implies:

\[ \chi > 0 \Rightarrow \left( \frac{b\chi_0}{c\chi_0 + b} \right) \left( \frac{1}{1 - \gamma \exp(bt)} \right) > 0. \]

Because the first term is a constant, the second term cannot change sign over time. At time \( t = \infty \), if we assume \( b > 0 \), we know:

\[ \text{SIGN}(\chi) = \text{SIGN}(c\chi_0 + b) \text{SIGN}(-\gamma) = + \Rightarrow \]

\[ \text{SIGN}(c\chi_0 + b) [-\text{SIGN}(c\chi_0 + b)] = + \Rightarrow \]

\[ b = -c\chi_0 < 0. \]

This contradicts the assumption that \( b > 0 \), so we must have \( b \leq 0 \). If consumption is strictly positive then \( b \neq 0 \), and the requirement that the sign of the second term in parentheses not change between \( t = 0 \) and \( t = \infty \) implies:

\[ \text{SIGN}(1 - \gamma) = \text{SIGN}(1 - 0) = + \Rightarrow \gamma < 1. \]

This result, combined with the constraint \( b < 0 \) leads to:

\[ b < -c\chi_0 \Rightarrow \chi_0 < \chi_0^{\text{max}} = -\frac{b}{c} = \left( \frac{\alpha_C}{1 - \alpha_C} \right) \left( \frac{r}{\alpha g} - 1 \right) = \left( \frac{\alpha_C/\alpha}{1 - \alpha_C} \right) \left( \frac{r}{g} - \alpha \right). \]
In this case, it is possible to rewrite our expression for $\chi$ as:

$$\chi = \chi_0^{\max} \left[ \frac{-\gamma \exp(bt)}{1 - \gamma \exp(bt)} \right] = \chi_0^{\max} \left[ \frac{1}{1 - \frac{1}{\gamma} \exp(-bt)} \right].$$

In order to find $K(t)$, recall that $K' = gK(1 - \chi)$. Then:

$$\left( \frac{1}{g} \right) \frac{dK}{K} = (1 - \chi) \, dt = \left\{ 1 - \left( \frac{b\gamma}{c} \right) \left[ \frac{\exp(bt)}{1 - \gamma \exp(bt)} \right] \right\} \, dt.$$ 

This can be integrated to obtain:

$$\left( \frac{1}{g} \right) \log(K) = t - \left( \frac{b\gamma}{c} \right) \left( \frac{-1}{b\gamma} \right) \log [1 - \gamma \exp(bt)] + \gamma_2$$

$$= t + \left( \frac{1}{c} \right) \log [1 - \gamma \exp(bt)] + \gamma_2 \Rightarrow$$

$$\log K = gt + \log [1 - \gamma \exp(bt)]^{\frac{\gamma}{c}} + \gamma_2 \Rightarrow$$

$$K = \exp(\gamma_2) \exp(gt) [1 - \gamma \exp(bt)]^{\frac{\gamma}{c}},$$

where $\pi_c \equiv \frac{ac}{a} = \frac{g}{c}$. At time $t=0$, we obtain:

$$K_0 = \exp(\gamma_2)(1 - \gamma)^{\pi_c} \Rightarrow \exp(\gamma_2) = \frac{K_0}{(1 - \gamma)^{\pi_c}}$$

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Therefore, the solution for $K$ becomes:

$$K = K_0 \exp(gt) \left( \frac{1 - \gamma \exp(bt)}{1 - \gamma} \right)^{\pi_e}.$$ 

Recalling the original expressions for utility: $U = K^{\alpha_K} C^{\alpha_C}$, and consumption: $C = gK\chi$, and substituting for the closed-form solutions of $K$ and $\chi$, we obtain:

$$U = g^{\alpha_C} K_0^{\alpha} \exp(\alpha gt) \left[ \frac{1 - \gamma \exp(bt)}{1 - \gamma} \right]^{\alpha_C} (\chi_0^{\max})^{\alpha_C} \left[ \frac{-\gamma \exp(bt)}{\gamma \exp(bt) - 1} \right]^{\alpha_C}$$

$$= (g\chi_0^{\max})^{\alpha_C} K_0^{\alpha} \left( \frac{-\gamma}{1 - \gamma} \right)^{\alpha_C} \exp(\alpha gt) \exp(\alpha_C bt)$$

$$= \left[ (g\chi_0^{\max})^{\alpha_C} \left( \frac{-\gamma}{1 - \gamma} \right)^{\alpha_C} K_0^{\alpha} \right] \exp \left[ (\alpha g + \alpha_C b)t \right]$$

$$= U_0 \exp \left[ (\alpha g + \alpha_C b) t \right].$$

The ongoing improvement condition for sustainable development translates to $U' > 0$, which will be true if

$$\alpha g + \alpha_C b > 0.$$ 

This expression can be simplified as follows:

$$\alpha g + \alpha_C b = \alpha g + \left( \frac{\alpha g - r}{1 - \alpha_C} \right)$$
\[
= g \left[ \alpha + \alpha \left( \frac{\alpha_c}{1 - \alpha_c} \right) \right] - r \left[ \frac{\alpha_c}{1 - \alpha_c} \right] \\
= \frac{g\alpha - r\alpha_c}{1 - \alpha_c} > 0 \iff r < \left( \frac{\alpha}{\alpha_c} \right) g.
\]

Therefore, the condition for sustainable development can be written as:

\[
U' > 0 \iff (g\alpha - r\alpha_c > 0) \iff \left[ r < \left( \frac{\alpha}{\alpha_c} \right) g \right].
\]

Substituting for the closed form solution of utility into the maximization problem we next obtain:

\[
\max \int_0^\infty e^{-rt} U(t) \, dt = U_0 \int_0^\infty e^{-rt} \exp \left[ (\alpha g + \alpha_c b) t \right] \, dt \\
= U_0 \int_0^\infty \exp \left[ - \left( \frac{r - \alpha g}{1 - \alpha_c} \right) t \right] \, dt \\
= \left( \frac{1 - \alpha_c}{r - \alpha g} \right) U_0.
\]

The problem is then to maximize \( U_0 = K_0^\alpha K_0^{\alpha_c} \). Since initial capital \( K_0 \) is a given parameter, this leads to maximizing initial consumption \( C_0 \), subject to the constraint of positive consumption, so that:

\[
\left[ \chi_0 \rightarrow \chi_0^{\text{max}} = - \frac{b}{c} \right] \Rightarrow \left[ \frac{1}{\gamma} \rightarrow 0 \right].
\]

The closed form solution for capital \( K \) can be written as:

\[
K = K_0 \exp(gt) \left( \frac{\exp(bt) - \frac{1}{\gamma}}{1 - \frac{1}{\gamma}} \right)^{\alpha_c}.
\]
Substituting $\frac{1}{\gamma} = 0$ from above leads to:

$$K = K_0 \exp \left[ (g + \pi_c b) t \right],$$

$$K = K_0 \exp \left[ \left( \frac{g (1 - \alpha_c) + \pi_c \alpha g - \pi_c r}{1 - \alpha_c} \right) t \right],$$

$$K = K_0 \exp \left[ - \left( \frac{\pi_c r - g}{1 - \alpha_c} \right) t \right].$$

Then the condition for increasing capital,

$$K' > 0 \iff (\alpha_c r < \alpha g) \iff \left( r < \frac{g}{\pi_c} \right) \iff (U' > 0),$$

is equivalent to the condition for sustainable development.

This condition for sustainable development, $r < \frac{g}{\pi_c}$, or $g > \pi_c r$, can be interpreted as the following constraints on each parameter (taking as fixed the other parameters):

1) the discount rate parameter $r$ in the utility function be sufficiently small, i.e. that the effective time horizon implicit in the optimization program be sufficiently long;

2) the growth rate $g$ be sufficiently large, i.e. that productivity of capital is high enough;

3) the proportion of consumption in the Cobb-Douglas-like interim utility function over consumption and capital, $\pi_c$, be sufficiently small, i.e. that preferences sufficiently weight the existence value of capital.
If the optimization program is considered to be defined over \( \{r, g, \pi_c\} \) parameter-space, then regions of the projection of this space onto \( \{r, g\} \) space and \( \{r, \pi_c\} \) space can be labelled according to whether the sustainable development constraint is binding or not (see Figure 37). At the level of individual actors in a society, Figure 37 portrays whether an optimization program based on an actor’s "ideal point" in these two projections, without an explicit sustainable development constraint, would nonetheless be consistent with sustainable development. I.e., for a given productivity of capital, the ideal optimization program of actors with sufficiently short time horizons, who place small enough value on capital per se, would not be consistent with sustainable development unless they introduce it as an independent binding constraint.

On the other hand, the ideal optimization programs of actors with sufficiently long time horizons, who place high enough value on capital per se, would be consistent with sustainable development even if they did not introduce it as an independent binding constraint. In this restricted sense, the model categorizes actors who would be "for" and "against" sustainable development, according to the parameters in their utility functions, given the productivity of capital.
Figure 37. Preference-Productivity Parameters Incorporating Sustainable Development

(a) Sustainable development: binding constraint

(b) Sustainable development: non-binding constraint

\[ \pi_c = \frac{\alpha_c}{\alpha} \]

This appendix will discuss a simple model for which an attempt to increase capital indefinitely, in an attempt to evoke a “sustainable development” constraint” from the “capital maintenance paradigm”, could violate a variety of feasibility constraints unless there is a transition to “intensive development” rather than “extensive growth”.

Consider a system whose behavior is portrayed by Figure 38. In the top graph of Figure 38, net economic product internalizes environmental degradation only to the extent of today’s standards\(^4\) and is a monotonically increasing function of economic (or industrial) capital \(K\) (and linear above \(K_c\)). Non-internalized environmental degradation is also a monotonically increasing function of economic (or industrial) capital, and is assumed to be piecewise linear, with a steeper slope above \(K_{msy}\).\(^5\) Hicksian income \(Y_H\), or the excess of net economic product over non-internalized environmental degradation, is portrayed in the bottom graph of Figure 38. As can be seen, Hicksian Income is negative below some critical threshold \(K_c\); it rises

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\(^4\)Today’s standards are assumed to allocate a calculable amount, perhaps a constant proportion of gross economic output, to (only) partly offset environment degradation. See Appendix 4 for a more textured discussion about the potential political constituency for not fully internalizing environmental degradation.

\(^5\)The total value of non-internalized environmental degradation can be considered as the sum of the values that individuals ascribe to it. The increase in value of non-internalized environmental degradation as economic capital increases can result from two different effects: increasing quantity of non-internalized environmental degradation; and imputing to environmental degradation a higher “price” relative to economic output as they both increase. The piecewise linearity assumption, and the assumption of a linear relation between net economic product and economic capital, will be used for illustrative purposes in this model over the full relevant range of capital; of course, linearity would be a far more realistic assumption if the analysis which follows in this and the next appendix were interpreted as a local analysis with linear slopes interpreted as local derivatives, perhaps in the context of progressively more complete information and iterative policy adjustments.
linearly between critical capital $K_c$ and the capital $K_{msy}$ at maximum sustainable output $Y_H^{msy}$; but then it falls to 0 at $K_\Omega$.

The transition at $K_{msy}$ can be thought of as an idealized change of state of the world system if industrial pressures on the global ecosystem exceed some critical threshold, so that additional industrial capital reduces Hicksian income. The situation at $K_\Omega$ can be interpreted as overloading the global ecosystem so severely that net economic product amounts in its entirety to cannibalization of natural capital. In other words, if environmental degradation were to be fully internalized into the cost of production, the physical amount of industrial capital which is valued at $K_\Omega$ based on the extent of today’s internalization of environmental degradation would have a market value equal to zero. Alternatively, the assumptions embedded in this model imply that if environmental degradation were fully internalized into net economic product, then growth in industrial capital beyond the point represented by $K_{msy}$ on Figure 38 would decrease total (i.e. industrial plus natural) capital and would be economically infeasible, at least in the sense that the marginal return to capital would become negative. Of course, this highlights the possibility that wealth-holders (in the sense of owners of the industrial capital) could be motivated to attempt to politically block further internalization of environmental degradation, even if scientific evidence were to indicate that industrial capital already exceeded $K_{msy}$. This could have the effect of prolonging a redistribution of wealth to themselves from the general public as stakeholders in the natural capital inherent in the global commons.\footnote{See Appendix 4 for a model characterizing the constituencies for and against further internalization of environmental degradation.}
Note that Figure 38, with its bound on Hicksian income and the discontinuity in its derivative with respect to economic capital, is not intended to represent a precisely accurate model of behavior of the world system. Such a conclusion, and the converse assumption typical in neoclassical economics - that it is feasible for aggregate capital to increase infinitely - are beyond the competence of the discipline of economics to evaluate by itself.\(^7\) Rather, this model

\(^7\)The divergence of opinions on this subject is illustrated by quotations from two highly respected authorities, Lester Brown of the Worldwatch Institute, and Nobel laureate MIT economist Robert Solow.

According to Lester Brown:

"The pace of change in our world is speeding up, accelerating to the point where it threatens to overwhelm the management capacity of political leaders. This acceleration of history comes not only from advancing technology, but also from unprecedented world population growth, even faster economic growth, and the increasingly frequent collisions between expanding human demands and the limits of the earth's natural systems."

"These spiraling human demands for resources are beginning to outgrow the capacity of the earth's natural systems. As this happens, the global economy is damaging the foundation on which it rests. Evidence of the damage to the earth's ecological infrastructure takes the form of collapsing fisheries, falling water tables, shrinking forests, eroding soils, dying lakes, crop-withering heat waves, and disappearing species."


This contrasts, at least in part, with the view of Robert Solow, who responded to the questions "Are there any limits to economic growth? Are we going to run Spaceship Earth out of fuel?" as follows:

"Finding a route to sustainable growth or sustainable development or even to a sustainable state will not be easy. First of all, I think the various scenarios in which the world economy runs out of resources and then falls into a tailspin are neither valid nor helpful. My reading is that they are poor science and poor economics. We are more likely to experience rising costs of fuel and materials than to run out. We simply cannot know what tastes and technology will be like 50 or 100 years from now.

There are, however, plenty of things that people and policy should be concerned with now. Ensure that environmental costs are reckoned into economic decision making. Impose the taxes or regulations that are needed for efficient long-run use of fish stocks and other renewable resources. Subsidize scientific and technological research that can find or create new materials and energy sources. Help and induce poor countries to control their populations. I really don't think that Doomsday scenarios move us in these directions." Robert M. Solow, as interviewed in Michael Parkin, "Economics" 3-4 (2d ed. 1994).

The division of at least some opinions on this subject has run deep since "Limits to Growth" was published in 1972, as noted by Richard Falk:

"A rather furious debate has ensued over whether present growth dynamics are poisoning the planet at an unacceptably dangerous rate or are depleting scarce resources in an exceedingly shortsighted fashion." "A Study of Future Worlds" 398 (1975).

Consider also the following eloquent exposition of one perspective of Indigenous peoples:

"Western thinking ... looks at the world in terms of what can be done today to satisfy the growing wants and
is presented as a hypothetical thought experiment, in order to explore the possible implications of unrestrained growth of economic capital and to set the stage for the analysis of the political dynamics in Appendix 4.
Figure 38. Output v. Capital in a World with Bounded Hicksian Income
Consider system behavior in the range $K_c < K < K_{\text{f}}$, where net economic product $Y_{\text{nep}}$ and Hicksian income $Y_H$ are approximated by linear and piecewise-linear functions respectively of economic capital $K$: $Y_{\text{nep}} = \alpha + \beta K$; $Y_H = a'_d + b'_d K$ (in the “growth region”)

$K_c < K < K_{\text{msy}}$); $Y_H = a'_d + b'_d K$ (in the “deterioration region” $K_{\text{msy}} < K < K_{\text{f}}$). Assume consumption $C$ is a constant proportion of net economic product: $C = (1 - s)Y_{\text{nep}}$, where “$s$” is the savings rate.\footnote{Note that consumption and savings are a function of net economic product, which: 1) through its discount rate determines economic capital, and 2) underlies economic decisions. Note also the distinction between this model where consumption is at first assumed to be a constant proportion of output, and the model discussed in Appendix 2 where consumption was a control variable unconstrained over time.} Then:

$$K' = sY_{\text{nep}} = s(\alpha + \beta K);$$

$$K' - s\beta K = s\alpha.$$

A solution for capital $K$ can be found as:

$$K(t) = K_h(t) + K_p(t),$$

where $K_h$ is the solution for the homogenous version (if $\alpha s = 0$), and $K_p$ is a “particular” function for nonzero $\alpha$. To obtain the solution to the homogenous version, form the characteristic polynomial equation:

$$[P_1(\lambda) = \lambda - s\beta = 0] \Rightarrow [\lambda = s\beta].$$

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Then the solution to the homogenous version is:

\[ K_h(t) = \gamma_1 \exp [s\beta t]. \]

The particular function is obtained from \( K_h \) and \( s\alpha \) as follows:

\[ K_p = \exp [s\beta t] \int \frac{s\alpha}{\exp [s\beta t]} \, dt = \exp [s\beta t] \exp [-s\beta t] \frac{s\alpha}{s\beta} = -\frac{\alpha}{\beta}. \]

Combining the homogenous and particular solutions to form the complete set of solutions yields:

\[ K = K_h + K_p = \gamma_1 \exp [s\beta t] - \frac{\alpha}{\beta}. \]

The constant \( \gamma_1 \) can be found from the initial condition for capital as follows:

\[ [K(0) = \gamma_1 - \frac{\alpha}{\beta}] \Rightarrow [\gamma_1 = \left(K_0 + \frac{\alpha}{\beta}\right)]. \]

Substituting for \( \gamma_1 \) yields the general solution over a linear interval as:

\[ K = \left(K_0 + \frac{\alpha}{\beta}\right) \exp [s\beta t] - \frac{\alpha}{\beta} = K_X + (K_0 - K_X) \exp (s\beta t); \]

\[ K' = s (\alpha + \beta K_0) \exp (s\beta t) = sY_{nvo} \exp (s\beta t), \]

where \( K_X \) is the intercept on the economic capital axis of the extrapolation of the linear
segment of net economic product (not labelled on Figure 38).

Consumption can be calculated as:

\[ C(t) = (1 - s)Y_{nep} = (1 - s)Y_{nepo} \exp(s\beta t); \]

\[ C' (t) = (1 - s)(s)\beta Y_{nepo} \exp(s\beta t); \]

so that consumption is exponentially increasing, with an initial value maximized by \( s = 0 \), and an initial rate of increase proportional to \( \beta \) and maximized by \( s = .5 \). Assuming we start in the "growth region" where \( K < K_{msy} \), the time \( t_{msy} \) when \( K_{msy} \) is reached is:

\[ t_{msy} = \frac{1}{s\beta} \log \left( \frac{K_{msy} - K_X}{K_0 - K_X} \right), \]

and is reached sooner for higher savings ("\( s \"), \( \frac{dY_{msy}}{dK} ("\beta") \), and initial economic capital ("\( K_0 \")).

As can be seen, economic capital increases exponentially throughout the range of this model, and will only stop growing if some feasibility constraint becomes binding. We will examine four possible feasibility constraints, and calculate the times at which they would be violated.

The first possible feasibility constraint is that Hicksian income \( Y_H \) exceed some minimum \( Y_H^{min} \). Assume that initially this constraint is satisfied. Then it will be violated at some point in
the "deterioration region" where:

\[ Y_H = a'_d + b'_d K < Y_H^{\text{min}}. \]

Substituting for economic capital yields:

\[ a'_d + b'_d [K_X + (K_0 - K_X) \exp(s \beta t)] < Y_H^{\text{min}} \]

\[ \Rightarrow (K_0 - K_X) \exp(s \beta t) > \frac{Y_H^{\text{min}} - a'_d}{b'_d} - K_X. \]

The critical time after which Hicksian income falls below \( Y_H^{\text{min}} \), denoted by \( T_{Y_H^{\text{min}}} \), is then:

\[ T_{Y_H^{\text{min}}} = \frac{1}{s \beta} \log \left( \left( \frac{1}{K_0 - K_X} \right) \left[ \frac{Y_H^{\text{min}} - a'_d}{b'_d} - K_X \right] \right) \]

\[ = \frac{1}{s \beta} \log \left[ \frac{\left( \frac{Y_H^{\text{min}}}{b'_d} + K_\Omega \right) - K_X}{K_0 - K_X} \right]. \]

The second possible feasibility constraint is that total capital exceed some minimum \( K_T^{\text{min}} \).

Total capital can be written as economic capital less cumulative non-internalized environmental degradation (assuming constant relative prices):

\[ K_T(t) = K(t) - \int_0^t Y_{\text{nied}}(\tau) d\tau, \]

\(^9\)Note however the possibility of temporarily maintaining even a negative Hicksian income as long as the "reservoir" of natural capital is large enough to withstand the depletion necessary to support consumption.
Suppose that due to lags in population dynamics, an inadequate understanding of the impact of economic activity on the environment, or even maladaptive politics (see Appendix 4), we were to find ourselves in the "deterioration" interval. Instead of increasing capital as before, what would be the result of a policy which increased consumption to drive capital to the value $K_{msy}$ at time $T_{max}$? This can be thought of as progressively "cannibalizing" capital, or failing to allocate resources to offset its depreciation. In particular, suppose the consumption path is given by:

$$C = C_0 \exp(g_c t), 0 \leq t \leq T_{max}.$$  

The first observation to make is that the consumption path is increasing over time horizon $T_{max}$. In that case, interim utility will also be rising over that horizon, if for example it depends positively and solely on consumption by means of a stationary functional form. This would be consistent with sustainable development over time horizon $T_{max}$ if the growth rate of consumption $g_c$ exceeded any minimum threshold for it, or if $g_c C_0$ exceeded any minimum threshold of improvement $C'_{min}$.

The path of capital is found similarly to the case of constant savings:

$$K' = (\alpha + \beta K) - C(t),$$

$$K' - \beta K = \alpha - C(t).$$

We will find the general solution as the sum of the solution to the homogenous differential
equation and a particular function, \( K = K_h + K_p \), as before.

The solution of the homogenous equation is:

\[
K_h = \gamma_2 \exp(\beta t).
\]

The particular function is found as:

\[
K_p(t) = e^{\beta t} \int \frac{\alpha - C(t)}{e^{\beta t}} dt
\]

\[
= e^{\beta t} \int \frac{\alpha - C_0 \exp(g_c t)}{e^{\beta t}} dt
\]

\[
= e^{\beta t} \left[ \int \alpha e^{-\beta t} dt - \int C_0 e^{(g_c - \beta)t} dt \right]
\]

\[
= \frac{\alpha e^{\beta t} e^{-\beta t}}{-\beta} - C_0 \frac{e^{\beta t} e^{(g_c - \beta)t}}{g_c} = K_X - \frac{C_0}{g_c - \beta} e^{(g_c t)}
\]

Recall that \( K = K_h + K_p \), so that:

\[
K = \gamma_2 \exp(\beta t) + K_X - \frac{C_0}{g_c - \beta} \exp(g_c t).
\]

\[
K(0) = \gamma_2 + K_X - \frac{C_0}{g_c - \beta} \Rightarrow \gamma_2 = (K_0 - K_X) + \frac{C_0}{g_c - \beta}.
\]

\[
K = K_X + \left[ K_0 - K_X + \frac{C_0}{g_c - \beta} \right] \exp(\beta t) - \left[ \frac{C_0}{g_c - \beta} \right] \exp(g_c t).
\]

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Suppose we decide to drive capital back to \( K_{msy} \) at time \( T_{\text{max}} \). Then:

\[
K_{msy} = K_X + \left[ K_0 - K_X - \frac{C_0}{g_c - \beta} \right] \exp(3T_{\text{max}}) - \left[ \frac{C_0}{g_c - 3} \right] \exp(g_cT_{\text{max}}),
\]

which implicitly determines the required growth rate of consumption \( g_c \) as a function of time horizon \( T_{\text{max}} \), when consumption will have increased to \( C_0 \exp(g_cT_{\text{max}}) \). Note that the choice of a time horizon \( T_{\text{max}} \) may be bounded above, by means of one or more feasibility constraints like those discussed earlier. However, it is insufficient at time \( T_{\text{max}} \) simply to reduce consumption to Hicksian income \( Y_{H}^{msy} \), since that would be below net economic product \( Y_{\text{nep}}^{msy} \) and economic capital would grow once again. Therefore, the policy prescription would be to fully internalize environmental degradation, and set \( C = Y_{H}^{msy} \), so that economic capital would be maintained at the level corresponding to maximum Hicksian income \( Y_{H}^{msy} \). If environmental degradation were fully integrated sooner than \( T_{\text{max}} \), the positive return to decreasing industrial capital toward the amount associated with maximum Hicksian income \( Y_{H}^{msy} \) would presumably induce just such a reduction.

While the consumption-capital pair \((C, K) = (Y_{H}^{msy}, K_{msy})\) is an equilibrium after full internalization, it is worth discussing the nature of its stability. Given a constant consumption \( C = Y_{H}^{msy} \), the equilibrium is stable with respect to a positive perturbation of capital (since it would be less productive leading to \( K' < 0 \)), but is not stable with respect to a negative perturbation of capital (since it would again be less productive, reinforcing the decline in capital). Conversely, given capital \( K = K_{msy} \), a positive perturbation of consumption (e.g., a
“mistake” in implementing the “MSY equilibrium” strategy) leads to a decline in capital which would continue, while a negative perturbation of consumption leads to an increase in capital to a new and slightly worse equilibrium in the “deterioration” interval. Therefore, the “MSY equilibrium” is relatively insensitive to excursions into the “deterioration” interval, but it is important that excursions backwards into the growth interval be recognized by appropriate feedback and offset by a suitable increase in savings.

The capital in this model which inflicts such a heavy toll in the “deterioration” region could be characterized as “extensive” in the thermodynamic sense. Chemical factories might be a classic example. An alternative form of economic activity which might avoid such effects over the time scales of interest by remaining in the “growth” region could be characterized as “intensive” in the thermodynamic sense. Art, literature or electronic networking might be good examples.

Suppose we desire to transition away from “extensive” capital in order to extend the horizon of sustainability beyond $T_{\text{max}}$ (after which consumption from “extensive” economic product remains constant, violating any minimum threshold consumption increase $C'_{\text{min}}$ greater than zero). We have already shown that in the growth region, with a constant rate of savings $s^i$:

$$C^{i'}(t) = \left(1 - s^i\right) s^i \beta^i \gamma^i_{\text{neq}} \exp\left(s^i \beta^i t\right),$$

where superscript “i” denotes the “intensive” sector (which remains in the “growth” region). If
the "intensive" sector is additively separable from the "extensive" sector. Then a choice of $s^i$ which leads to a rate of increase in "intensive" consumption $C^i$ at time $T_{max}$ of $C'_{min}$, i.e., which satisfies the following condition:

$$C^i (T_{max}) = (1 - s^i) s^i \beta^i Y_{nepo} \exp (s^i \beta^i T_{max}) > C'_{min}.$$ 

would suffice to maintain the increase in consumption above threshold $C'_{min}$ beyond horizon $T_{max}$ into the indefinite future. Alternatively, a minimum threshold growth rate of consumption could be compared to $s^i \beta^i$ to evaluate whether it was being met. (Note that at $T_{max}$, the consumption policy designed to drive "extensive" capital to $K_{msy}$ called for a shift of "extensive" economic consumption from $C_0 \exp (g_c T_{max})$ to $Y_H^{msy}$, which would result in a drop in consumption at that point in time). While $C^i$ considered as a function of $s^i$ is maximized at time $t = 0$ for $s^i = .5$, it can be shown that $C^i$ is maximized at time $t = T_{max}$ for intensive savings equal to:

$$s^i = \frac{(\beta^i T_{max} - 2) + \sqrt{(\beta^i T_{max})^2 + 4}}{2 \beta^i T_{max}}.$$

If this is insufficient to satisfy the inequality above, then more accelerated intensive development might be possible to a degree by diverting resources from the "extensive" sector (e.g., from the planned increase in consumption) to investment in the intensive sector. For example, environmental degradation can be internalized in the "extensive" sector by a tax which is used to subsidize the intensive sector.
Appendix 4: Sustainable Development and the Democratic Process in a World with Bounded Hicksian Income

Consider once again the model of a world with bounded Hicksian income, as set out in Appendix 3. Recall that environmental degradation is not fully internalized, and growth in capital $K$ beyond $K_{m^*}$ decreases Hicksian income. The conclusion in Appendix 3 was that unrestrained growth of capital above $K_{m^*}$ would eventually violate plausible feasibility constraints. Furthermore, the elimination of externalities (sometimes referred to as the "polluter pays principle") would be necessary to avoid at least one of those feasibility constraints, and is at any rate generally considered to be a prime policy lever to avoid uneconomic environmental degradation. Therefore, in this appendix, we will address the issue: Under what circumstances would a democratic process choose to fully internalize environmental degradation and to maintain capital at $K_{m^*}$?

Assume a perfectly homogenous electorate, except for variations in "economic wealth" or economic capital, whose value will be dependent on the degree of internalization of environmental degradation. Total capital (i.e., the sum of the value placed on natural capital and the share of economic wealth) is assumed to be the sole argument in the voters' utility function, since our focus here is on tradeoffs between natural and economic capital and redistribution issues associated with externalities, rather than the intertemporal interplay between capital and consumption. We assume that each voter has the same utility function, or

---

10 We assume for the purpose of this analysis that capital is "extensive", in the sense discussed in Appendix 3.
alternatively that there is no market in either externalized environmental degradation or in votes. In that case, an individual’s total wealth can be written as:

\[ \kappa_T^\theta = \omega \left( \frac{K^\theta}{N} \right) - (1 - \theta) \left( \frac{K_{end}}{N} \right). \]

where 1) \( \kappa_T^\theta \) is an individual’s total capital, parametrized by the degree of further internalization \( \theta \) of environmental degradation, where \( \theta = 0 \) denotes the status quo (which is assumed to represent incomplete internalization);

2) \( \omega \left( \frac{K^\theta}{N} \right) \) is an individual’s economic capital, with \( K^\theta \) being total economic capital parameterized by \( \theta \), \( N \) being the total number of individuals, and \( \omega \) being an individual’s ownership of economic capital in units of average economic capital;

3) \( (1 - \theta) \left( \frac{K_{end}}{N} \right) \) is an individual’s value for environmental degradation not already internalized into economic capital, where \( K_{end} \) is the capitalized value of “external natural degradation”; and

4) the process of further internalizing environmental degradation is assumed to reduce economic capital by the same amount that it offset environmental degradation.\(^{11}\)

\(^{11}\)As examples, consider: 1) a tax on economic output equal to non-internalized environmental degradation, which is redistributed equally to all individuals, and 2) regulations requiring that, as part of the production process, an amount equal to a portion of non-internalized environmental degradation be successfully invested in improving the environment to that extent.
Internalization of Environmental Degradation

Economic capital parametrized by $\theta$ can be written as:

$$K^\theta = K - \theta K_{end}.$$ 

where $K$ is the value of economic capital based on the original degree of internalization.

In that case, we can rewrite the total capital of an individual as:

$$\kappa_T^\theta = \omega \left( \frac{K - \theta K_{end}}{N} \right) - (1 - \theta) \frac{K_{end}}{N}$$

$$= \omega (\kappa - \theta \kappa_{end}) - (1 - \theta) \kappa_{end},$$

where $\kappa = \frac{K}{N}$; $\kappa_{end} = \frac{K_{end}}{N}$.

In order to determine whether a given individual would prefer greater internalization of environmental degradation, we can differentiate their total capital with respect to $\theta$ as follows:

$$\frac{\partial \kappa_T^\theta}{\partial \theta} = -\omega \kappa_{end} + \kappa_{end} = (1 - \omega) \kappa_{end}.$$

By assumption, $\kappa_{end} > 0$, so the condition for a positive differential of total capital with
respect to $\theta$ is:

$$\left[ \frac{\partial \kappa_T^\theta}{\partial \theta} > 0 \right] \iff [\omega < 1 = \omega_0].$$

In other words, the constituency for further internalization is everyone with less than average economic wealth.\(^\text{12}\)

Therefore, if the single issue of whether to increase the internalization of environmental degradation were put to a vote, and if the wealth distribution were skewed positively,\(^\text{13}\) then the outcome of the vote would be to increase internalization.

Recall that the assumption of homogeneity (except for wealth) included equal valuation for environmental degradation relative to economic output. It can be expected that this assumption will not in general be true, for example at extreme low values of wealth near the subsistence level. If an individual values environmental degradation at an amount equal to $\pi$ times its average valuation, it is easy to show that the condition for a positive differential of total capital with respect to $\theta$ becomes:

$$\left[ \frac{\partial \kappa_T^\theta}{\partial \theta} > 0 \right] \iff [(\pi - \omega) > 0].$$

\(^\text{12}\)Note the insensitivity of this conclusion to risk aversion. I.e., if utility is any monotonically increasing function of total wealth, the constituency for further internalization remains the same. Note also that if further internalization reduces economic capital less than it reduces environmental degradation (which is plausible, e.g., if more realistic pricing results in greater total capital), then it can be shown that the constituency for further internalization would increase (although it would remain non-unanimous, at least for an incremental increase in internalization).

\(^\text{13}\)A positively skewed distribution of wealth, for which the average wealth is greater than the median wealth, has been characterized as "always true of actual wealth distributions". John Roemer, "Why the Poor Do Not Expropriate the Rich in Democracies: A New Argument" (draft, Jan. 1996).
Note that we assume here that internalization of environmental degradation takes the form of environmental restoration, and exclude the case of fiscal redistribution to the general citizenry out of net economic product. In this case, the outcome of a single-issue vote on internalization would be determined by the sign of the median value of $\pi - \omega$, which could in general be either positive or negative.$^{14}$

Assume that $\pi$ is an increasing function of $\omega$, so that an individual with greater wealth places a higher relative value on environmental amenities. Consider a stylized categorization of voters, where:

1) below some threshold $\omega_L$, $\pi$ is smaller than even the relatively low wealth $\omega$ (i.e., environmental amenities are valued less that economic output, despite the low degree of economic participation, perhaps in the extreme because of the need to focus on short-term subsistence);

2) above some threshold $\omega_H$, $\pi$ is once again smaller than $\omega$, because wealth is such a high multiple of the average that it exceeds even the relatively large value placed on environmental amenities (i.e., if externalized environmental degradation is considered a redistribution from the general citizenry to those with above average wealth, then above $\omega_H$ the effect of this redistribution is large enough to exceed even a stronger preference for environmental amenities); and

3) between $\omega_L$ and $\omega_H$, $\pi$ exceeds $\omega$, i.e. any individuals in this category with below average

$^{14}$We have already seen that for typical wealth distributions, if $\pi$ is equal to 1 for all individuals, then the vote would call for more internalization. As an example of the opposite outcome, consider the situation where $\pi = 0$ for 51% of the voters (e.g., those with the lowest wealth).
wealth do not place such an increased value on economic output that it matters more to them than the redistribution of their share of natural capital to those wealthier-than-average, and any individuals in this category with above average wealth do not benefit from redistribution associated with externalization enough to offset the above-average value to them of environmental amenities.

Figure 39a depicts this relationship between relative valuation of the environment ($\pi$), and relative wealth ($\omega$). In order to determine whether a single-issue vote would increase internalization in this case, it is necessary to determine the percentage of voters with wealth between $\omega_L$ and $\omega_H$. A sample cumulative frequency distribution of wealth is shown in Figure 39b, along with two possible combinations of threshold pairs ($\omega_L, \omega_H$).

In this figure, for the threshold pair ($\omega_L^{ext}, \omega_H^{ext}$), the intermediate category of voters is a minority so that the outcome would be even less internalization than before. In contrast, the threshold pair ($\omega_L^{int}, \omega_H^{int}$) results in a majority in favor of more internalization. Of course, the frequency distribution of wealth should be restricted to voters actually participating in an election in order to predict an actual outcome, in which case a stylized fact of decreased participation by the very poorest members of the electorate might reduce the opposition to further internalization. On the other hand, to the extent that members of the group with wealth above $\omega_H$ use their resources to affect the outcome of an election, the prospects for further internalization could diminish.

15Note, however, the possibility that if the participation in economic output is too low for the very poor, it could fall below even a stylized, relatively low valuation of environmental degradation.
Figure 39. Constituencies on Internalization of Environmental Degradation

Based on Wealth and Valuation of the Environment

(a)

(b)
Trajectory of Capital

Consider now the second "control variable" in the model: the trajectory of capital.

Substituting the annuity value of the rate of environmental degradation, \( \frac{a+bK}{r} \), for \( K_{end} \) in our earlier equation for total capital parametrized by \( \theta \) yields:

\[
N_{K_T} = \omega \left[ K - \theta \left( \frac{a + bK}{r} \right) \right] - (1 - \theta) \left( \frac{a + bK}{r} \right)
\]

\[
= \left[ -\omega \frac{a}{r} - (1 - \theta) \frac{a}{r} \right] + \left[ \omega - \theta \omega \frac{b}{r} - (1 - \theta) \frac{b}{r} \right] K
\]

\[
= \frac{a}{r} \left[ \theta (1 - \omega) - 1 \right] + \left[ \omega \left( 1 - \theta \frac{b}{r} \right) - (1 - \theta) \frac{b}{r} \right] K,
\]

where \( r \) is the discount rate for non-internalized environmental degradation.

In this case, the differential of total capital with respect to \( \kappa \) is seen to be:

\[
\frac{\partial N_{K_T}}{\partial \kappa} = \omega \left( 1 - \theta \frac{b}{r} \right) - (1 - \theta) \frac{b}{r}.
\]

Therefore, the condition for a positive differential of total capital with respect to \( \kappa \) is:

\[
\left[ \frac{\partial N_{K_T}}{\partial \kappa} > 0 \right] \iff \left[ \omega \left( 1 - \theta \frac{b}{r} \right) > (1 - \theta) \frac{b}{r} \right]
\]

\[16\] See the model in Appendix 3.

\[17\] Note that we have assumed in the second line below that \( \frac{b}{r} < \frac{1}{2} \), which will be true in the growth region given the assumption discussed in footnote 19 below. If it were not to hold in the deterioration region, then there would be a unanimous constituency for a trajectory of capital toward \( \kappa_{m.e} \).
\[ \iff \omega > \frac{(1 - \theta) \frac{b}{r}}{1 - \theta \frac{b}{r}} \equiv \omega_\kappa. \]

Consider first the case of unchanged internalization of environmental degradation, i.e. \( \theta = 0 \):

\[
\left[ \frac{\partial \kappa^*_r}{\partial \kappa} > 0 \right] \iff \omega > \frac{b}{r}.
\]

In this case of no further internalization, the constituency for further growth is everyone with wealth at least \( \frac{b}{r} \) times the average wealth.\(^{18}\) On the assumption that the discount rate for non-internalized environmental degradation \( r \) equals the marginal return to economic capital \( \beta \),\(^{19}\) from Figure 38 in Appendix 3 we can see that the ratio \( \frac{b}{r} \) is less than one in the "growth" region, but greater than one in the "deterioration" region:

\[ \frac{b_2}{r} < 1 < \frac{b_d}{r}. \]

\(^{18}\) We assume here that utility is a monotonically increasing function of total wealth, and ask whether an increase in economic wealth would be preferred despite the associated increase in environmental degradation. In that case, note once again the insensitivity of this conclusion to risk aversion.

\(^{19}\) This assumption, which will be maintained throughout this appendix, can be motivated by an intermediate assumption that the discount rate for non-internalized environmental degradation equals the discount rate for net economic product, and noting from Figure 38 in Appendix 3 that the discount rate for net economic product (equal to net economic product divided by economic capital, which for this model interestingly increases - i.e. foreshortens the economic planning horizon - with increasing economic capital) will more closely approximate the marginal return to economic capital: 1) as economic capital increases, or 2) for a smaller deviation of behavior below critical economic capital \( K_{c} \). At any rate, our conclusions will be relatively insensitive to the precise fulfillment of this assumption, which is only used to argue whether \( \frac{b}{r} \) is greater or less than 1 to characterize the choice of a median voter.

If the discount rate for non-internalized environmental degradation were lower than the marginal return to economic capital, this would mean a longer perspective toward and a higher weight accorded to non-internalized environmental degradation, and the constituency in favor of not increasing capital beyond \( K_{max} \) would also increase. The endogenization of preference parameters such as the discount rate for non-internalized environmental degradation (e.g., by education about the importance of longer perspectives) could play a crucial role in the political process.
Assume once again that the median wealth is below the average wealth. Then in the "deterioration" region, the constituency for still higher levels of capital are those individuals for whom:

\[ \omega > \frac{b_d}{r} > 1, \]

which will be an even smaller minority of wealthy individuals than lost the earlier corresponding vote against internalization. In other words, in this model, a distinct majority would prefer to decrease capital toward \( K_{msy} \), if it became known that we found ourselves in the "deterioration" region.

Suppose, conversely, that we are in the "growth" region. Then, a single-issue vote over the trajectory of capital would call for increasing capital if:

\[ \omega_m > \frac{b_g}{r}. \]

By assumption, \( \frac{b_g}{r} \) is less than 1, and if it is sufficiently small then a majority would prefer to see capital grow. On the other hand, if median wealth is too low, i.e. below \( \frac{b_x}{r} \), then a majority would presumably prefer an overhaul of a system which degrades their natural capital more than the net economic product is worth to them (i.e., even with capital growth, they become worse off). Indeed, if \( \omega < \frac{b_x}{r} \) for even a sufficiently activist minority, then an unstable situation could exist with respect to the economic system, resulting in the extreme in "wealth expropriation", "land reform" or "revolution".
The condition for a stable equilibrium at $K_{msy}$ in this model is thus seen to be:

$$\frac{b_g}{r} < \omega_m < \frac{b_d}{r}.$$ 

In other words, if median wealth (in units of average wealth) is both high enough, i.e. above $\frac{b_d}{r} < 1$, so that the median voter sufficiently participates in the production of wealth (which occurs partially at the expense of the environment), and low enough, i.e. below $\frac{b_d}{r} < 1$, which is satisfied for a positively skewed wealth distribution, then a fully informed democratic process would choose a trajectory of capital converging on $K_{msy}$.

Consider now the case where environmental degradation is to be fully internalized, i.e. $\theta = 1$. Then

$$\left[ \frac{\partial \kappa_{\theta=1}}{\partial \kappa} > 0 \right] \iff \left[ \omega \left( 1 - \frac{b}{r} \right) > 0 \right] \iff \left[ \frac{b}{r} < 1 \right].$$

If $\frac{b}{r} < 1$, as in the growth region, then the choice to increase capital toward $K_{msy}$ would be unanimous. Conversely, if $\frac{b}{r} > 1$, as in the “deterioration” region, the choice to decrease capital toward $K_{msy}$ would also be unanimous. Therefore, in accord with intuitive expectations, in the context of full internalization of environmental degradation, the fully informed democratic choice would be a trajectory of capital toward $K_{msy}$, which would be the unanimous ideal point.

A misperception, such as an erroneous belief that $\frac{b}{r}$ were less than 1 ("we think we’re in the growth region") when actually $\frac{b}{r}$ is greater than 1 ("but we’re actually in the deterioration

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region"), could lead to a consensus to continue to grow capital. It is precisely this type of hazard which the procedural rationality component of the legitimacy constraint on the social preference relation in the systems/social choice definition of sustainable development is designed to avoid.

If, as in the issue of internalization of environmental degradation, we relax the assumption of uniform preferences over natural capital (and assume that internalization takes the form of restoring environmental amenities), then the condition for a positive differential of wealth with respect to capital becomes:

\[
\left[ \frac{\partial K_T}{\partial \kappa} > 0 \right] \implies \omega \left( 1 - \frac{\theta b}{r} \right) - (1 - \theta) \pi \frac{b}{r},
\]

where \( \pi \) is once again the relative valuation of environmental impacts. As can be seen, this does not affect our conclusion in the case of full internalization.
In the other extreme of no further internalization, with $\theta = 0$, this condition becomes:

$$\left[ \frac{\partial \kappa^2_r}{\partial \kappa} > 0 \right] \iff \frac{\omega}{\pi} > \frac{b}{r}.$$  

While, in general, this condition may or may not be satisfied, we do know that the median of $\frac{\omega}{\pi}$ will exceed one for exactly the same joint distributions of $\omega$ and $\pi$ for which the median of $\pi - \omega$ is less than zero. Therefore, if the constituency against further internalization had been in the majority, then there will also be a majority for more capital in the “growth” region (where $\frac{b}{r} < 1$). Likewise, if the constituency for further internalization had been in the majority, there will also be a majority for decreasing capital in the “deterioration” region (where $\frac{b}{r} > 1$).

Recall that the choice as to full internalization of environmental degradation found individuals divided according to whether $\omega$ was greater or less than 1 (at least in the simplified case of uniform environmental preferences), with the median voter having $\omega_m < 1$ and preferring to maximize $\theta$ (where the maximum is assumed to be 1). Recall likewise (in the case of uniform environmental preferences), the choice as to reducing capital to $K_{mxy}$ if it were to become known that $K > K_{mxy}$, found individuals divided according to whether $\omega$ was greater or less than $\frac{b_d}{r} > 1$, with the median voter having wealth of $\omega < 1 < \frac{b_d}{r}$ and preferring to decrease $K$ to $K_{mxy}$. A summary of the preference of individuals with respect to internalization and the trajectory of capital is portrayed in Figure 40.
If the choice were less simple than a fully informed, transparent, single-issue vote, then the possibilities arise that: 1) the constituency against internalization of environmental degradation, i.e. individuals with above average wealth, might prevent its increase (or even engineer a decrease to reduce existing internalization or, in the extreme, arrange subsidization of environmental degradation); or

2) the constituency against reducing $K$ to $K_{msy}$, i.e. individuals for whom $\omega > \frac{b_K}{r} > 1$, might prevent the decrease of $K$ to $K_{msy}$ (or even engineer its continued increase with still further diminishing Hicksian income).

This model indicates the possible motivation for a wealthy stratum, small plutocracy, or even dictator to anti-democratically “hijack” the decisions over internalizing environmental degradation or growing capital beyond $K_{msy}$.\(^{20}\) In the extreme, this could amount to the usurpation of proceeds from “wantonly” developing the natural resources of a country. Therefore, this model provides some support for the perspective that real democracy can reinforce the pursuit of sustainable development, as eloquently emphasized by the Secretary General of the United Nations: “One thing is certain: there can be no sustainable development without promoting democracy and, thus, without respect for human rights.”\(^{21}\)

\(^{20}\)Consider the following warning by indigenous authors that this danger can be very real even a democratic society, if that society has become complacent: “Western institutions which are built upon representative democracy and the free market and which make incremental decisions aimed at increasing wealth of the people, the corporations and the state, have played a significant role in the shortsightedness of people’s responsibility to the planet. It is ironic that a culture that accuses another of having no concept of time and the future, has itself no concept of this responsibility other than accumulation of wealth.

Figure 40. Preferences over Capital $K$ and Internalization of Environmental Degradation $\theta$

as Function of Relative Wealth $\omega$, in a World with Bounded Hicksian Income

Preferences over Internalization of Environmental Degradation $\theta$

as Function of Relative Wealth $\omega$:

Prefer to increase $\theta$  1  Prefer to decrease $\theta$

Preferences over Capital $K$, as Function of Relative Wealth $\omega$ and System Parameter $\left(\frac{k}{r}\right)$

Prefer to decrease $K$  $\frac{k}{r}$  Prefer to increase $K$

Ideal Points $(K, \theta)$ of Capital $K$ and Internalization $\theta$

as Function of Relative Wealth $\omega$ and System Parameters $\left(\frac{b_x, b_d}{r, r}\right)$

$(K_{x,1})$  $(K_{m,1})$  $(K_{m,0})$  $(K_{0,0})$

$0$  $\frac{b_x}{r}$  $1$  $\frac{b_d}{r}$  $\omega$

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Suppose there is explicit uncertainty about the amount of environmental degradation, so that it is a random variable capitalized at $\bar{K}_{end}$ (given current economic capital and levels of internalization), with expectation $\bar{K}_{end}$ and standard deviation $\sigma_{\bar{K}_{end}}$. Suppose further that we base our degree of prospective internalization on $\bar{K}_{end}$, so that:

$$\bar{\kappa}_{T}^{\theta} = \omega \left( \frac{K - \theta \bar{K}_{end}}{N} \right) + \theta \bar{K}_{end} - \frac{\bar{K}_{end}}{N}$$

Suppose that utility, based on the "precautionary principle", is defined to be the capital which can be expected to be exceeded with some specified probability greater than 50%, based on the further assumption that the random variable $\bar{\kappa}_{end}$ is normally distributed. Then utility can be written as:

$$U = \bar{\kappa}_{T}^{\theta} - \beta \sigma_{\bar{\kappa}_{T}}^{\theta},$$

where the parameter $\beta > 0$ is determined by the probability specified above.

It is instructive to demonstrate how this "distributional utility function" can be (non-uniquely) related to a classic von-Neumann Morgenstern utility function, and in the process shed some new light on the interpretation of the divergence between the "willingness-to-accept" (WTA) and the "willingness-to-pay" (WTP).\textsuperscript{22}

\textsuperscript{22}For an analysis of this type of distributional utility function for a lognormal distribution, see
Assume a von-Neumann Morgenstern utility function which is a piecewise linear function of total capital and which reflects an "endowment effect", i.e., there is a kink in the utility at the expected value of total capital. Assume further that this piecewise linear function has the simple form:

$$U(\kappa_T^\theta) = \kappa_T^\theta - \gamma |\kappa_T^\theta - \hat{\kappa}_T^\theta|.$$ 

An example is depicted below, scaled for $\gamma = .5$.

![Utility Graph](image)

---


23 The endowment effect occurs at the expected value because that is the focal value to which individuals attach significance. I.e., individuals' psychological endowment can be considered to be what they have, or, in the case of uncertainty as here, what they expect to have.

24 If this utility function has possibly different weights $\gamma_l, \gamma_h$ on $|\kappa_T^\theta - \hat{\kappa}_T^\theta|$ according to whether $\kappa_T^\theta$ is less than or greater than $\hat{\kappa}_T^\theta$ respectively, all combinations with the same mean weight $\gamma = \frac{\gamma_l + \gamma_h}{2}$ would be associated with the same distributional utility function. However, our assumption that $\gamma_l = \gamma_h = \gamma$ will allow us to derive an intuitive relationship between $\gamma$ and (WTA, WTP).
By inspection, the marginal utility for realizations of $\tilde{\kappa}_T^\theta$ above $\tilde{\kappa}_T^\theta$ is $1 - \gamma$, and the marginal utility for realization of $\tilde{\kappa}_T$ below $\tilde{\kappa}_T^\theta$ is $1 + \gamma$. Assume that realizations of $\tilde{\kappa}_T^\theta$ above its expected value can be associated with an individual’s willingness-to-pay. Likewise assume that realizations of $\tilde{\kappa}_T^\theta$ below its expected value can be associated with an individual’s willingness-to-accept. Then the condition for consistent individual preferences, in the sense of equal ratios of marginal utilities to prices for increases and decreases relative to the expectation, yields:

$$\frac{1 - \gamma}{WTP} = \frac{1 + \gamma}{WTA},$$

from which we can derive $\gamma$:

$$\gamma = \frac{WTA - WTP}{WTA + WTP}.$$

(Note than the figure above, where $\gamma = .5$, would be scaled consistently with a benchmark of WTA being triple WTP.)

Therefore, an endowment effect in an individual’s utility function, in the form of a kink at the expected value, can result in a spread between the willingness-to-accept and the willingness-to-pay. Let us define the average of the willingness-to-accept and the willingness-to-pay as:

$$P_{ave} = \frac{WTA + WTP}{2}.$$

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25Note that this implies that the standard Arrow-Pratt measures of absolute and relative risk aversion are zero everywhere except at $\tilde{\kappa}_T^\theta$, where they are unbounded.
Further define $\Delta = WTA - WTP$. Then:

$$\gamma = \frac{\Delta}{2P_{ave}}.$$ 

Making use of the normal distribution of $\hat{k}_T^g$, it can be shown that expected utility is:

$$E(U) = \kappa_T^g - \gamma \sqrt{\frac{2}{\pi}} \sigma_{\hat{k}_T^g}$$

$$= \kappa_T^g - \left( \frac{1}{\sqrt{2\pi} P_{ave}} \right) \sigma_{\hat{k}_T^g}.$$ 

Therefore, the expected utility of the von-Neumann Morgenstern utility function

$$U(\kappa_T^g) = \kappa_T^g - \gamma \left| \kappa_T^g - \hat{k}_T^g \right|$$

will be equivalent to the "distributional utility function"

$$U = \kappa_T^g - \beta \sigma_{\hat{k}_T^g}$$

associated with the "precautionary principle", if we set:

$$\beta = \gamma \sqrt{\frac{2}{\pi}} = \frac{1}{\sqrt{2\pi} P_{ave}} \Delta,$$

where $\Delta$ is the spread between WTA and WTP, and $P_{ave}$ is their average.\textsuperscript{26}

\textsuperscript{26}In the current context: each individual has the same distributional utility function over their total capital; a higher spread WTA-WTP implies a higher distributional risk aversion parameter $\beta$ resulting in a more conservative probability threshold for the amount of capital which the probability distribution is worth; and for a market in equilibrium the price of economic capital will fall between WTP and WTA.

This framework can also be applied to more conventional markets. In that case, heterogenous market participants can be classified by the size of their typical spread WTA-WTP, how they determine their average $P_{ave}$, and whether they make two-sided markets. As stylized facts: 1) "scalpers" are speculators with small spreads (and therefore small distributional risk aversion parameters) who make both sides of the market and continuously adjust their $P_{ave}$ to approximate current market prices; 2) "traders" are speculators who make both sides of the market and whose $P_{ave}$ can diverge significantly from the current market price, since it incorporates their projection of future market prices over a time horizon longer than scalpers; 3) "consumers" and "suppliers" have wide spreads (and
With this in mind, we can expand the equation for utility by taking the expectation of the random variable $\bar{\kappa}_2^\theta$ and noting that $\sigma_{\bar{\kappa}_2}^\theta = \sigma_{\bar{\kappa}_{end}}$ as follows:

$$U = (\omega (\kappa - \theta \bar{\kappa}_{end}) - (1 - \theta) \bar{\kappa}_{end}) - \beta \sigma_{\bar{\kappa}_{end}}$$

$$U = \omega \kappa - (\omega \theta + (1 - \theta)) \bar{\kappa}_{end} - \beta \sigma_{\bar{\kappa}_{end}}.$$

Consider a process of further internalization of environmental degradation which is implemented by the following sequence:

1) the degree of further internalization $\theta$ is chosen;

2) depending on $\theta$, additional resources are invested over a fixed, relatively small interval, from which we will learn more about the extent of environmental degradation;

3) the additional knowledge leads to a reduction in $\sigma_{\bar{\kappa}_{end}}$.\(^{27}\)

The “learning curve” is represented by a dependence of $\sigma_{\bar{\kappa}_{end}}$ on the additional net resources invested in research “$R$",\(^{28}\) where: $\frac{d\sigma_{\bar{\kappa}_{end}}(R)}{dR} < 0$ (uncertainty decreases with additional research), and $\frac{d^2\sigma_{\bar{\kappa}_{end}}(R)}{dR^2} > 0$ (but there are diminishing returns).

---

\(^{27}\)Note that $\frac{\partial \bar{\kappa}_{end}}{\partial \theta}$ is assumed to be zero, e.g. because the original expectation is an unbiased estimate of the updated expectation. The distributional utility function is also able to model directly effects such as euphoria (unrealistic increase in $\bar{\kappa}_F^\theta$) or avoidance (keeping $\sigma_{\bar{\kappa}_F}$ large to prevent the possibility of learning that $\bar{\kappa}_F^\theta$ is low).

\(^{28}\)The phrase “additional net resources” is used to indicate the cost, beyond any value placed on it extrinsic to the reduction in $\sigma_{\bar{\kappa}_{end}}$, of additional research.
With no further internalization ($\theta = 0$), the investment in research can be optimized by noting that net research costs directly reduce expected capital and utility:

$$U = \omega \kappa - [\omega \theta + (1 - \theta)] \hat{\kappa}_{\text{end}} - R - \beta \sigma_{\text{end}}(R).$$

The first order condition for optimizing research investment $R$ is then:

$$\frac{\partial U}{\partial R} = -1 - \beta \frac{d\sigma_{\text{end}}(R)}{dR} = 0.$$

In other words, the optimal research investment $R^*$ is implicitly determined by:

$$\frac{d\sigma_{\text{end}}(R)}{dR} \bigg|_{R^*} = \frac{1}{3}.$$

According to this expression, a higher weight on uncertainty, $\beta$, in the distributional utility function would justify greater investment in research. For the purpose of this discussion, we will assume that the optimal investment in additional research $R^*$ is positive.\(^{29}\)

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\(^{29}\)This research has the nature of a public good, and this assumption means that it is currently underprovided. This assumption abstracts away the political argument over whether government or the private sector is the best locus for additional research.
Now suppose that the amount of research $R$ into the distribution function of $\tilde{\kappa}_{end}^{30}$ will be a monotonically increasing function of the degree of further internalization $\theta$:

$$R(\theta) : [0, 1] \rightarrow [0, R^*];$$

$R(0) = 0; \frac{dR}{d\theta} > 0; R(1) < R^*$ (i.e., even full internalization would not lead to optimal provision of research). This pattern of funding additional research could be a plausible reaction to a decision to increase the internalization of environmental degradation.

Explicitly showing the dependence of $R$, and therefore $\sigma_{\tilde{\kappa}_{end}}$, on $\theta$ results in the following formula for utility:

$$U = \omega \kappa - [\omega \theta + (1 - \theta)] \tilde{\kappa}_{end} - R(\theta) - \beta \sigma_{\tilde{\kappa}_{end}}(R(\theta)).$$

To find the constituency for further internalization in the context of uncertainty, differentiate the distributional utility function with respect to $\theta$:

$$\frac{\partial U}{\partial \theta} = (1 - \omega) \tilde{\kappa}_{end} - \frac{dR(\theta)}{d\theta} - \beta \sigma_{\tilde{\kappa}_{end}} \frac{dR(\theta)}{d\theta}.$$

The condition for positive differential of the distributional utility function with respect to $\theta$ is

30Note the assumption throughout this analysis that a framework of probabilistic uncertainty can help shed light on an issue with important elements of non-probabilistic uncertainty.
then:
\[
\frac{\partial U}{\partial \theta} > 0 \iff (1 - \omega)\tilde{\kappa}_{\text{end}} > \frac{dR(\theta)}{d\theta} + \beta \frac{d\sigma_{\text{end}}}{dR} \frac{dR(\theta)}{d\theta}
\]
\[
\iff \omega < 1 - \frac{1}{\tilde{\kappa}_{\text{end}}} \left[ \frac{dR(\theta)}{d\theta} + \beta \frac{d\sigma_{\text{end}}}{dR} \frac{dR(\theta)}{d\theta} \right] \equiv \omega^u_{\theta}.
\]

Can we sign the expression in brackets? Recall our assumptions that:

1) \(R(\theta) < R^*\),

2) \(\frac{d\sigma_{\text{end}}}{dR} \bigg|_{R^*} = -\frac{1}{3}\), and

3) \(\frac{d^2\sigma_{\text{end}}}{dR^2} > 0\).

Together, these imply that:
\[
\frac{d\sigma_{\text{end}}}{dR} < -\frac{1}{\beta}.
\]

Therefore, recalling that \(\beta\) and \(\frac{dR(\theta)}{d\theta}\) are both positive, we can conclude that the expression in brackets is less than:
\[
\frac{dR(\theta)}{d\theta} + \beta \left(-\frac{1}{\beta}\right) \frac{dR(\theta)}{d\theta} = 0.
\]

This implies that \(\omega^u_{\theta} > 1\). Therefore, the threshold wealth \(\omega_{\theta}\), which partitions the electorate into constituencies for \((\omega < \omega_{\theta})\) and against \((\omega > \omega_{\theta})\) further internalization in the context of uncertainty, is greater than the threshold without uncertainty \((\omega = 1)\). In other words, with a positively skewed wealth distribution, the majority in favor of further internalization will increase in size in the context of uncertainty. In addition, by inspection, the majority in favor of
further internalization will increase in size as the distributional risk aversion parameter increases.

To find the composition of the constituencies with respect to the other control variable, the trajectory of capital. suppose first that internalization is based on the expected value of the external natural degradation determined as follows:

\[
\dot{K}_{\text{end}} = \frac{a + bK}{r}.
\]

\[
\dot{\kappa}_{\text{end}} = \frac{a}{N_T} + \frac{b\kappa}{r}.
\]

Substituting this into the formula for utility yields:\(^{31}\)

\[
U = \omega \left[ \kappa - \theta \left( \frac{a}{N_T} + \frac{b\kappa}{r} \right) \right] - (1 - \theta) \left( \frac{a}{N_T} + \frac{b\kappa}{r} \right) - R(\theta) - 3\sigma_{\dot{K}_{\text{end}}}(R(\theta), \kappa)
\]

\[
= - \left[ \frac{a}{N_T} (\theta \omega + (1 - \theta)) + R(\theta) \right] + \left[ \omega - \frac{b}{r} (\theta \omega - (1 - \theta)) \right] \kappa - 3\sigma_{\dot{K}_{\text{end}}}(R(\theta), \kappa).
\]

The differential of the distributional utility function with respect to \(\kappa\) is then:

\[
\frac{\partial U}{\partial \kappa} = \omega - \frac{b}{r} (\theta \omega + (1 - \theta)) - 3\frac{\partial \sigma_{\dot{K}_{\text{end}}}(R(\theta), \kappa)}{\partial \kappa}.
\]

\(^{31}\)Note that the potential dependence of \(\sigma_{\dot{K}_{\text{end}}}\) on economic capital is now explicitly included, and that for convenience average per capita economic capital \(\kappa\) will be used.
The condition for a positive differential with respect to $\kappa$ is:

$$\left[ \frac{\partial U}{\partial \kappa} > 0 \right] \iff \omega - \frac{b}{r} \theta \omega > \frac{b}{r} (1 - \theta) + \beta \frac{\partial \sigma_{\text{rend}}(R(\theta), \kappa)}{\partial \kappa}$$

$$\iff \omega - \frac{(1 - \theta) \frac{b}{r} + \beta \frac{\partial \sigma_{\text{rend}}(R(\theta), \kappa)}{\partial \kappa}}{1 - \theta \frac{b}{r}} = \omega^u. \quad \kappa \ast$$

Note that this is identical to the threshold between constituencies for and against increases in capital without uncertainty, except for the new term in the numerator:

$$3 \frac{\partial \sigma_{\text{rend}}(R(\theta), \kappa)}{\partial \kappa}.$$ 

To sign the new term, recall that increasing economic capital is assumed to increase externalized natural degradation. It is reasonable to assume that increasing the amount of externalized natural degradation will also increase the amount of uncertainty in its estimate, so that:

$$\frac{\partial \sigma_{\text{rend}}(R(\theta), \kappa)}{\partial \kappa} > 0.$$ 

Since $3$ is positive, the new term is positive, and $\omega^u \kappa > \omega \kappa$. This means that, in the context of uncertainty, the pro-growth constituency ($\omega > \omega^u \kappa$) will be smaller than the pro-growth constituency without uncertainty ($\omega > \omega \kappa$).  

\[ \text{32 In the deterioration region, if} \quad \frac{b}{r} > \frac{1}{b}, \quad \text{the constituency would continue to be unanimously in favor of a trajectory of capital toward} \quad \kappa_{\text{meg}}. \]
Suppose we determine the degree of further internalization \( \theta \), and that we desire to optimize the level of capital (at a level designated as \( \kappa^* \)), in the situation where uncertainty is a significant issue, and

\[
\frac{\partial \sigma_{\kappa_{\text{end}}}(R(\theta), \kappa)}{\partial \kappa}
\]

is non-constant. Then, the first order condition becomes:

\[
\left[ \frac{\partial L}{\partial \kappa} = 0 \right] \Rightarrow \left| \frac{\partial \sigma_{\kappa_{\text{end}}}(R(\theta), \kappa)}{\partial \kappa} \right|_{\kappa^*} = \frac{1 \omega - b}{r} \left( \theta \omega + (1 - \theta) \right).
\]

Consider the extreme case of full internalization (\( \theta = 1 \)).\(^{33}\) Recall that without uncertainty, the unanimous ideal point for capital was \( \kappa_{\text{msy}} \). With uncertainty, the ideal point for capital for an individual is implicitly determined by:

\[
\left| \frac{\partial \sigma_{\kappa_{\text{end}}}(R(\theta), \kappa)}{\partial \kappa} \right|_{\kappa^*} = \frac{\omega}{\beta} \left( 1 - \frac{b}{r} \right).
\]

Because the left hand side of this equation is positive, and because in the deterioration region \( \frac{b \kappa}{r} > 1 \), we know that each individual's ideal point will be in the growth region where \( \frac{b \kappa}{r} < 1 \), or at \( \kappa_{\text{msy}} \) itself.

\(^{33}\)This case is chosen for illustrative clarity, but the same analysis applies to any internalization \( \theta \), if we additionally assume a positively skewed distribution of wealth.
In the case where each successive increment of economic capital adds an increasing increment of uncertainty to the externalized natural degradation (which is plausible for a system undergoing increasing stress), we have:

\[ \frac{\partial^2 \sigma_{x_{\text{end}}}(R(\theta), \kappa)}{\partial \kappa^2} > 0. \]

Then, under the following condition:

\[ \left. \frac{\partial \sigma_{x_{\text{end}}}(R(\theta), \kappa)}{\partial \kappa} \right|_{\kappa_{\text{msy}}} > \frac{\omega_m}{\beta} \left( 1 - \frac{b_g}{r} \right). \]

the "uncertainty cost" of adding economic capital near \( \kappa_{\text{msy}} \) is too high, and the optimum capital \( \kappa^* \) for the median voter with wealth \( \omega_m \) will fall below \( \kappa_{\text{msy}} \).

This can be thought of as a pronounced example of the potential value of the "precautionary principle" in the context of uncertainty.
The Special Significance of Sustainable Development for the Political Process

If the perception grows that the world system does behave in some respects as if there is a bound to Hicksian income, then the political significance of sustainable development can be expected to rise still further. In other words, while we have already discussed how the political process is essential to the pursuit of sustainable development, it is also true that sustainable development can increasingly impact the political process itself. We will now discuss features of the political process which may leverage even further the significance of sustainable development.

Throughout this appendix, we have assumed a single-issue vote in one-dimensional policy space, with the outcome determined by the median voter in accord with Black’s Theorem. Of course, in the real world, politics is multi-dimensional and issue framing is critical. There are numerous ways to parse political issue space into dimensions, and different researchers have found varying significance to dimensions above one.

If we view political issue space as two dimensional, perhaps the dominant interpretations of the orthogonal dimensions (with increasing concreteness) would be economic and social,

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35 E.g., Poole and Rosenthal studied U.S. congressional elections and found “1.5” dimensions, i.e., one dominant and one minor but real dimension. Keith T. Poole, Howard Rosenthal, “Patterns of Congressional Voting”, 35 American Journal of Political Science 228, 232 (1991).
On the other hand, Kitschelt found the second dimension in European politics over the past thirty years to be of growing importance. H. Kitschelt, “The Transformation of European Social Democracy” (1994), as characterized by John Roemer, “Why the Poor do not Expropriate the Rich in Democracies: A New Argument” (draft, Jan. 1996).
redistributive and communitarian, dollars and values. Sustainable development is an
extraordinary issue, not only for its growing substantive significance, but because it is
important in both dimensions, and in each dimension it can be framed with either polarity.

Policies relating to sustainable development clearly have a major redistributive aspect, as
emphasized in this appendix. Further, the redistributive aspect can be framed, as just one
example, either as a transfer from corporations (and wealthy shareholders) to the general
population due to pollution taxes, or as an ongoing transfer from the general citizenry to
economic wealth-holders, to the extent that environmental degradation is externalized.

Sustainable development also has a major communitarian or value-laden aspect. In this regard,
it is sometimes framed as a duty to preserve the environment for the benefit of future
generations, or alternatively as a mandate for more economic growth to alleviate the hardship
of those who are poor today (recall the discussion on the right to development).

Sustainable development has the potential to powerfully impact the political process, on
multiple dimensions in either direction. It is this universal relevance, and susceptibility to
framing and agenda manipulation, which may prove to powerfully leverage the already
powerful substantive significance of sustainable development.
SOURCES


366


111. —. *Natural Resource and Environmental Policies*, The Center for International Affairs - Harvard University, August 1994.


166. —. *A Study of Future Worlds.* 1975.


376


267. Kahn, Herman. Thinking About the Unthinkable. 1962.


380


316. —. *Self-determination: A Discussion of the Phrase*. May 1921.


556. Tsu, Lao. *Tao Te Ching*, Gia Fu Feng, translator.


589. The Works of Edmund Burke, 1839.


