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The Science-Policy Nexus: U.S. Policy and International Environmental Governance

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1. Setting the Stage

In June 1991 I was reassigned from the Bureau of Near East Affairs within the U.S. State Department to International Organizations with new responsibilities for shaping U.S. policy vis-à-vis the United Nations specialized agencies. Within a week, I attended the opening of the Geneva conference on International Disaster Response and remained to discuss priorities at the World Health Organization. Two weeks later, I was leading a State Department delegation to the Food and Agriculture Organization's Council meeting in Rome. In the space of one month, I recognized that scientific information and assessment was an essential component behind the complex work of the United Nations—especially that of the economic and social agencies. Coordination mechanisms within the system could call on the scientific expertise within member state governments and any number of academic institutions. Innumerable studies examined communicable and endemic diseases at WHO; the biennial FAO report on the State of Food and Agriculture captured a wealth of national reporting on crops, pests, production, marketing, and farmer practices. The background information resided in studies located in file cabinets throughout these agencies—even in the halls! My initial impression was how can all this information be translated into advice or actionable policy? What spurred this collection of data and information?

I soon came to recognize the U.N. specialized agencies mirrored the rise of 20th century government bureaucracies in the Western world and were heavily influenced by the structure of government in the United States. U.S. agencies that dealt with labor relations, public health, education, agriculture, and commerce were viewed as critical to providing norms and standards that governed private enterprise. Scientific studies informed all these activities. In the post-World War II era, those same studies and practices could help shape international cooperation as a new world took shape.

The international system responded to rising concerns for environmental protection with conferences, assessments, action plans, and even, treaties. This cooperative effort was heavily influenced by precedents set by the United States which had adopted a range of domestic policies and established compliance mechanisms to address environmental challenges. International environmental cooperation accelerated throughout the 1980s and many believed new agreements could be forged to protect biological diversity, forests, and even, the climate.

By the 1990s, every UN agency was preparing for the World Conference on Sustainable Development slated for Rio in June 1992 and public perceptions of social and economic progress were changing as societies took stock of environmental degradation. The preparatory process for the 1992 "Earth Summit" initiated in depth, multidisciplinary collaboration on planetary challenges. Experts recognized that cross-sectoral policies were needed. Negotiations on the Framework Convention on Climate Change and a Convention on Biological Diversity were underway. Science and multidisciplinary approaches would surely shape the next phase of multilateral relations.

Nearly three decades later, in March 2019, I was in Nairobi at the Fourth UN Environmental Assembly (UNEA4), this time in my capacity as a Senior Fellow at the United Nations Foundation. At this event, the UN Environment Program (UNEP) released 3 major scientific assessments:

The 6th Global Environmental Outlook (GEO 6): UNEP's flagship evaluation of the state of the global environment, with sections on air, land, water, pollution, and biodiversity as well as an examination of drivers of environmental change, including demographics, economic growth, urbanization, technology, and climate change. This assessment built on GEO 5 which had been released in 2012 and was more than 6 years in the making [1].

The Global Resources Outlook 2019: UNEP's International Resource Panel (IRP) released the Global Resources Outlook stressing global overconsumption of key material resources and its impact on the environment. This report drew on earlier work by the panel which studies global resource production, consumption, use and environmental impacts. From these historical trends, the IRP underscores the unsustainability of business as usual and offers scenarios to reduce these trends [2].

The Synthesis Report on Global Chemicals Outlook II which was officially launched in April 2019. This report highlighted the international community's failure to meet the 2020 target of reducing the release of toxic chemicals in air, water, and soil, to minimize the impacts on human health and the environment (SDG 12, Target 12.4) [3].

To complement these reports, UNEP as a host/partner in both the Intergovernmental Panel on Climate Change (IPCC) and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) hosted sessions at UNEA 4 to discuss the 2018 IPCC Report on Global Warming of 1.5° [4] and preview the IPBES Global Assessment on Biodiversity and Ecosystem Services [5] that was released in May 2019 which highlighted ongoing deterioration in species conservation and ecosystem preservation since the 2005 Millennium Ecosystem Assessment. Each report or assessment highlighted the risks to the planet of pursuing a business-as-usual approach. The news over the last quarter century had gotten worse not better. Moreover, the drivers of ecological change—population growth, production and consumption, technological shifts, and climate change—are accelerating.

Given this onslaught of sobering reports, I asked myself: Where was the expected progress? Since 1991, I had been directly involved in dozens of international negotiations, including the Kyoto and the Biosafety Protocols as well as the entire suite of 1990 Action Plans that shaped the Millennium Development Goals. After leaving the US State Department to join the United Nations Foundation, I developed partnerships to advance women's reproductive rights, reduce child mortality, and promote renewable energy with many UN agencies. At UNEA 4, I was completing my appointment to the High-Level Review Panel for GEO 6—an extended, multiyear process.

As I cast my mind back to those hallways overflowing with scientific studies I had first encountered in the early 1990s, I was struck by how this continued reliance on science has not delivered on its expected promises—the optimism in the lead-up to the Rio Summit has proven unfounded. In the pages that follow, I build on the perspective my career has afforded me to connect this lack of global progress to an erosion of the trust in science within the U.S. In fact, I have concluded that over the last two decades, U.S. participation in international environmental governance has limited both the strength and effectiveness of agreements due to U.S. noncooperation and/or active obstruction. Perceived costs to the economy and corporations, rather than careful consideration of environmental risk, have increasingly become a rationale for the US not to act domestically nor to cooperate globally on environmental issues [6]. In this contribution to this Special Issue, I discuss how it is the jeopardizing of the science-policy nexus in the U.S. that has prevented international environmental governance from delivering on its promise. First, I briefly recap how science served as the foundation of early environmental regulation in the U.S., and how this precedent was at first emulated at the international scale. Next, I detail the rising polarization, and accompanying breakdown of the science-policy nexus in the U.S. context. Finally, I trace how these domestic U.S. developments have not been appropriately recognized and countered in the international arena and point to strategies for repairing the science-policy nexus to bring about more meaningful international cooperation on the global environment.

2. Early Environmental Regulation in the U.S.: Science Underpinning Action

Relying on scientific research to address environmental problems accelerated in the post-World War II West with the growing understanding that nuclear radiation posed a threat to human health over decades. In moving to reduce exposure to nuclear radiation and ensure the safety of populations, both scientists and civil society realized that pollution by-products of other industrial processes also posed health risks.

With the publication of Rachel Carson's *Silent Spring* in 1962, U.S. public awareness of the links across chemical pollution, species decline, and human health sharply increased. America's longstanding commitment to conservation was augmented by new interests in mitigating the ravages of the industrial age: the Harvard economist, John Kenneth Galbraith termed it, "public squalor and private affluence". This new concern coalesced with the expansion of Federal government power over the emerging consumer society. The public expected government action in the form of regulation [7].

At the time, DDT, an organochlorine compound, was the most widely used pesticide in the U.S. This compound had been used to eliminate malaria in the U.S. and was actively used by the military in World War II. By the 1950s, it was frequently used on crops. This pervasive use resulted in observed symptoms of toxicity that scientists began to examine. As a result, USDA issued cautions to farmers and other users of the chemical. Studies, however, have revealed more problems in both research animals and wildlife [8]. Rachel Carson used the available scientific literature to illustrate DDT's then visible impacts on bird populations in agricultural areas, positing that DDT's impact on shell formation led to declining bird populations. She also highlighted that scientific studies showed that the chemical caused tumors in research animals. Neither the chemical industry nor agribusiness easily accepted these conclusions, fighting back with other scientific studies and cautioning that the elimination of DDT would be costly for industry and labor as well as jeopardizing food production.

Nevertheless, as these debates unfolded, U.S. President Richard Nixon saw the environment as a political opportunity that could be supported across much of the political spectrum—and silence his critics. He responded directly to the public concern with the National Environment Policy Act which was enacted January 1, 1970 and the creation of the Environmental Protection Agency by executive order at the end of that same year. The Agency's first administrator, William Ruckelshaus not only undertook the task of organizing and consolidating the new institution, but also took legal actions under the new Clean Air and Water Acts to put cities, states and corporations on notice that they must take steps to mitigate pollution [7,9].

These actions received broad bipartisan support and prompted the emergence of new environmental organizations that acted as "watchdogs" of the public interest. Two of the most well-known—Natural Resources Defense Council (NRDC) and the Environmental Defense Fund (EDF)—were organized to promote implementation of the new law—and its complementary additions, the Clean Air and Clean Water Acts [10] (p. 80–81). These organizations (among others) initiated lawsuits against governments and corporations to strengthen compliance. This strategy, often termed "litigate to mitigate" proved successful, but stimulated a backlash among corporations and the public as implementation proceeded. The new level of public awareness and environmental engagement in the U.S. emerged along with political action on civil rights and opposition to the Vietnam War. The sense that much of America was in the streets unnerved many more conservative elites and push back was almost inevitable.

U.S. environmental activism arose concurrently with new concerns in Europe, especially among the Nordic countries. In late 1969, the UN General Assembly adopted a resolution calling for a conference on "the Human Environment" to be held in 1972 [11]. Sweden offered to host the meeting in Stockholm and President Nixon responded positively to the Swedish request for support. Although North–South tensions complicated the discussions, the Conference conclusions laid the foundation for international cooperation on environmental issues and stressed the role of science in determining risks. Yet, the path to ensuring robust domestic and international action was not clear.

Early in his tenure, Ruckelshaus believed it imperative to prove the new agency would protect public health from industrial pollution and synthetic chemicals. In 1972, he took steps to phase-out the use of DDT, based on risks to human health, citing scientific studies Carson had drawn on for her work and newer research, underscoring the need for a broad scientific rationale for policy action [12]. This approach established the principles that would govern U.S. environmental regulation until the turn of the century, despite much controversy. The new U.S. policy also signaled to the chemical, hydrocarbon, and other industries that their operations and products would be subject to more federal regulation.

U.S. President Jimmy Carter came into office in 1977 determined to expand the activist course that Ruckelshaus had adopted. Domestically, the Carter Administration sought to advance the environmental regulatory agenda with policies on water, air, and conservation. The new EPA administrator, Douglas Costle, added 600 scientists to the staff and identified priorities for study [12,13] (pp. 10–11). Despite the Administration's domestic priorities, Carter faced other challenges which constrained his ability to act; among them, the ongoing economic downturn (partially driven by the 1973 OPEC oil embargo) and inflationary pressures and fiscal restraint policies [14] (pp. 90–138).

The emerging disaster of Love Canal in New York State became national news and a further test of the Carter administration. Over several decades, Hooker Chemical Company had buried chlorinated alkaline wastes produced in their chemical processes in Love Canal—and later transferred the property to the municipality. Homes and a school built on and near the site were contaminated by these chemicals, resulting in concentrated impacts—dying trees and lawns, chemical burns, respiratory illnesses, cancers, and birth defects within a small population of 200+ families. As the State of New York and the U.S. Government moved to address the problem, EPA realized that Love Canal was just an indication of the threat hundreds of toxic waste sites across the country posed to public health. To mitigate this threat, Congress adopted the Superfund Act in 1980 to support clean up in other regions. This action, ironically, capped the regulatory zeal of the U.S. as the economic costs of environmental regulation rose rapidly [15].

The last two years of the Carter Administration were plagued by the oil embargo, the Iranian hostage crisis, and the Soviet invasion of Afghanistan. Carter's major foreign policy achievement was securing a peace treaty between Israel and Egypt. The combination of a stagnating domestic economy and the Iranian hostage crisis led to the election of Ronald Reagan, whose domestic agenda focused on curtailing the expansion of federal environmental regulation. The Reagan Administration signaled the start of political polarization of U.S. domestic environmental action that would constrain progress through the Obama Administration [13] (pp. 12–15).

Despite this increasing pressure to curtail environmental regulation at the domestic level, on the international stage the global community continued to pursue means of replicating US successes internationally through the enacting of international environmental laws. The explicit need for scientific assessment of environmental problems would also shape cooperation on international environmental governance. US leadership was not absent in these times, and indeed the United States was still able to cap almost two decades of environmental policy action with a new international environmental agreement after the Carter Administration left office: the Montreal Protocol cemented coordinated global action to control ozone-depleting substances.

3. Replicating US Successes Internationally

With the creation of the UN Environmental Program in 1972 at the first UN Conference on the Human Environment, the focus was on "keeping the global environment under review"—a direction that established UNEP's monitoring and reporting function [16] (pp. 107–109). Modern postwar societies were just becoming aware of the environmental risks posed by nuclear fallout, chemical pollution, and land degradation—and the risks these "externalities" of modern life posed to human health and survival. Global population had expanded from 2 billion in 1927 to 3.8 billion in 1972—driving an increase in demand for food, land, water, but also manufactured goods. New trade

policies and expanding middle classes were demanding a range of goods. National environmental management efforts had focused on the risks of radiation, fallout, chemical contamination of land and water. Yet, the emerging industrial sectors were polluting areas of the planet more rapidly than regulation could respond [13].

Assessing and managing these risks demanded scientific evaluation to justify mitigation actions. As national governments considered policies to reduce risk, the scientific community responded with new techniques and assessments to help prioritize action. The idea that "good policy demanded good science" created the new field of risk assessment that was supported by both government and civil society, leading to the emergence of nongovernmental organizations that demanded action. For national governments, these new policies demanded strong rationales as mitigation actions would impose costs on producers; and putting sound policies in place demanded trade-offs and compromises. What level of risk to society was acceptable? What groups in society are most impacted? The still new U.S. Environmental Protection Agency was at the forefront of assessing pollution risk and proposing action: the practices that developed were based on scientific assessments that could be defended in US courts [9].

The UN and its many normative bodies—World Health Organization (WHO), the Food and Agriculture Organization (FAO), World Meteorological Organization (WMO), the UN Education, Scientific and Cultural Organization (UNESCO)—were already relying on close cooperation with the international science community across a range of disciplines, and the International Scientific Unions—organizations that encouraged scientific cooperation among nations and across disciplines offered ready-made resource networks for this new UN program [17]. Emulating this approach, UNEP created a Global Observation platform for sharing environmental information from national government agencies with the UN system.

U.S. agencies like the National Oceanographic and Atmospheric Administration (NOAA), the U.S. Geological Survey (USGS), the US Departments of Agriculture and Interior all had databases that supported other UN efforts and they thus also supported UNEP's platform. European countries and Japan also contributed to the new environmental information systems UNEP was developing. Moreover, collaborative efforts to strengthen earth observation were underway in many developing countries and this new platform accelerated the process.

Science had established the foundation for international environmental cooperation—and governance. For example, early assessments led to the development of the Regional Seas Program in 1975 and action in the Mediterranean that would involve all coastal states. Yet, UNEP only gained real prominence as coordinator of global environmental action in the negotiations designed to protect the ozone layer; and it was here that the science-policy link was enshrined as the catalyst for policy action on international environmental issues. The tale of ozone, however, illustrates many other things: the time it takes for scientific research to identify an environmental threat—and how quickly or slowly the contemporary political environment can shape the response to such threats. Moreover, U.S. support for international environmental governance emerged as a vital element to multilateral cooperation.

3.1. U.S. Leadership on the Montreal Protocol

Certainly, Stockholm participants could not have imagined that within a two-decade span, a team of UK scientists would discover a stratospheric ozone hole above Antarctica. James Lovelock, a UK scientist, had observed a pervasive haze in the atmosphere in the early 1950s that he attributed to industrial pollution. Given its pervasive use since the mid-1930s, Lovelock postulated that chlorofluorocarbons (CFCs) might be part of it—and he proved his theory with an electron capture detector. Using this new tool to measure atmospheric chemicals, Lovelock determined the haze was ground-level ozone (a by-product of combustion) and other gases. Further research demonstrated that air currents carried Western industrial air pollution around the planet—even causing ozone levels to exceed EPA guidelines in Ireland and drift to the Southern Hemisphere. Lovelock asked: were CFCs and other chemicals accumulating in the atmosphere? Were they damaging? While later

studies confirmed accumulation, CFCs were nevertheless viewed as "safe" as they were considered as "inert gases" or nonreactive [18] (pp. 49–55).

In the 1970s, two chemists at Columbia University, however, challenged that assumption and discovered that in the upper stratosphere CFCs degraded, freeing chlorine that destroyed stratospheric ozone, a key layer of the atmosphere in protecting life on earth from ultraviolet radiation. This study was augmented by NASA-funded research at Michigan that indicated rocket fuel also released chlorine compounds that destroyed stratospheric ozone [19] (p. 10). If conclusively proven, such a phenomenon would pose a threat to all life on earth. There was widespread agreement that these processes needed more study and international scientific cooperation. Under public pressure combined with action in more progressive states to limit the use of these chemicals, the U.S. EPA banned CFC use in most aerosols in 1978 [20]. As this action was taken, it was not yet clear how profoundly it would shape an international regime.

The global concern on the potential impact of CFCs on the ozone layer created an opportunity for Mostafa Tolba, the new executive director of UNEP. Tolba asked his governing board to establish a Coordinating Committee on the Ozone Layer in 1977 to track research as it evolved [19]. With the discovery of the "ozone hole" over Antarctica, UNEP was ready to support an international dialogue on protection of the ozone layer, leading to the adoption of the Vienna Convention on the Protection of the Ozone Layer in 1985.

Scientific reviews and further studies prompted more action, resulting in the adoption of the Montreal Protocol in 1987—where parties agreed to reduce and eventually phase-out CFCs and to act, as warranted by science, on controlling other ozone depleting substances in the future. In retrospect, the outcome of the Protocol was more far reaching than observers could have foreseen. Moreover, its success would shape how the international community would consider "wicked" transboundary problems in the future.

The timing, however, was problematic. In 1981, the Reagan Administration arrived in Washington with a platform to "curb excessive environmental regulation" and Reagan had appointed James Watt, an anti-conservationist, and Anne Buford Gorsuch, as the heads of the Department of Interior and the Environmental Protection Agency, respectively. These administration members were "lightning rods" for large environmental organizations and ultimately, were forced to resign. Reagan sought to avoid battles on this front by bringing William Ruckelshaus back as EPA Administrator for the remainder of his first term. Lee Thomas became the Administrator in Reagan's second term and both proved to be active supporters of action on CFCs.

Given this potentially hostile domestic environment, why did the Montreal Protocol negotiation proceed and continue to be shaped by the U.S.? One easy answer: George Shultz, the Secretary of State, had witnessed the public reaction in California to the scientific studies on ozone and the regulatory engagement of states and ultimately, EPA [19] (p. 46). He also understood that half measures had no chance of solving the problem. Protecting the ozone layer required a global response that involved all countries, given the pervasive and decades long use of CFCs as refrigerants, insulators in plastic foam, propellants in pharmaceuticals and cleaning solvents. Moreover, containment and safe destruction of these chemicals required new technology. The U.S. had to convince producers, distributors, consumers, and the public to support long term action. Shultz and the new EPA Administrator Lee Thomas supported continuing the negotiations despite opposition from Interior, Agriculture, and senior White House advisors.

Domestic support for regulatory action to protect the ozone layer had been intense during the Ford and Carter Administrations (1974–1980). U.S. industry, an early critic of the science on CFCs and the ozone layer, had determined that patchwork regulations could not solve the problem. Key companies, notably DuPont, eventually argued for a global approach and lobbied the Administration and Congress. State and EPA coordinated broad government engagement on the science as well as on the need for a coordinated approach, recognizing that a variety of new actors had to be involved, including the EU and Japan, which were the remaining major producers of CFCs for export markets.

The international process continued to move apace with UNEP establishing an Ad Hoc Working Group of Technical and Legal Experts to prepare a "Global Framework Convention for the Protection of the Ozone Layer" in 1982. Canada, Switzerland, and the Nordics formed the "Toronto Group" to examine how to reduce CFC emissions which the U.S. joined in late 1983. By 1984, the U.S. State-EPA negotiating team had become a lead player in the international education effort, hosting workshops to review new studies and bringing EPA's regulatory experience to the table as countries worked to develop a phase-out of CFC production [19] (pp. 27–30). In this effort, additional chemical compounds were identified as potentially ozone-depleting. These compounds include halons which combine fluorine and/or bromine with carbon to create fire suppressants. The new understanding of atmospheric chemistry and future interactions in the stratosphere convinced the framers of the convention that flexibility in adding new chemicals to the regulatory list would be essential to an eventual protocol.

UNEP working with the U.S., the Nordic countries, Canada and Germany had hosted a series of technical meetings to familiarize international players with the risk of continued CFC production and the prospect that other ozone-depleting substances would need to be addressed in the regime's design. In 1984, UNEP and the World Meteorological Organization (WMO) joined in an integrative research project coordinated by NASA with the participation of NOAA, the U.S. Federal Aviation Administration, the German Ministry for Research and Technology, and the EC Commission that would review all the peer-reviewed research available on the ozone layer. This comprehensive study, involving 150 scientists, would become the model for the subsequent international assessments (e.g., on climate, biodiversity, persistent organic pollutants, etc.) and that UNEP uses currently to highlight emerging environmental issues [19] (p. 14).

3.2. Engaging the Developing World

Although the study arising from this initiative was only released in 1986, many elements of the research shaped the international discussions which culminated in the 1985 Vienna Convention that codified the urgency of further collaborative research and secured agreement that UNEP would convene a new process in 1987 to work on a regulatory protocol. Tolba's leadership was key to coordinating the scientific assessments that were vital to shape this groundbreaking environmental treaty. Recognizing the risks and uncertainties involved in establishing a global regulatory system, Tolba not only provided a platform for international engagement, he was instrumental in ensuring the participation of developing countries in the process.

The complexity, risk and uncertainty underlying the effort to develop an international regulatory regime were enormous given the vast differences among the more developed Western democracies, the Eastern bloc, and the developing world. Tolba, with support of key developed countries (Canada, the Nordics, Germany, U.S. and Japan), used the Montreal Protocol process to educate both developing country scientists and policymakers to emerging issues that would demand their attention if they were to pursue development goals successfully [19] (pp. 99–101). The U.S., the EU and Japan believed that any protective regime would need to be global and all countries would need to take specific action. Moreover, replacing existing technology would entail costs and developing countries could be disadvantaged as new technology came on stream.

Mostafa Tolba brought developing countries with emerging industrial sectors into these dialogues early in the process. Egypt, Mexico, Venezuela, as well as China and India had some CFC production. Ending this profitable activity posed concerns for the industrial sectors in these economies. Other participants, including Panama, Senegal, Ghana, and Togo, were interested in engaging at an international level and building the capacity of their scientists and diplomats. As negotiations progressed, delegates from the Global South began to realize the potential implications of a global regulatory regime and how it might limit their efforts to build chemical industries. A joint UNEP/EPA workshop on the potential impacts to human health of a thinning ozone layer was among the conferences that helped allay concern among developing countries and persuade them that cooperative action was essential.

Negotiators initially accommodated developing country concerns by establishing a production phase-out schedule that provided these countries more time to eliminate production. This principle, known as "common, but differentiated responsibilities" was critical to bringing larger developing countries into the negotiation and ultimately ensuring participation in the final agreement. As implementation continued between 1987 and 1995, more chemicals and uses were included in schedules for elimination. Paralleling the international effort, new scientific studies reinforced the links posited in the original negotiation between CFCs, halons and related compounds; the pace of implementation and scientific review accelerated [19]. China and India, major developing country chemical producers demanded financial support in order to join the Protocol. The creation of the Multilateral Fund in 1990 was the crucial compromise in moderating many concerns that the Global South would be disadvantaged by new technology. Moreover, its effective operation encouraged more countries to join the effort.

In his analysis of the global ozone regime, David Downie cites, "scientific knowledge" as only one factor in the creation and expansion of policy [21]. This feature of the regime was complemented by the inclusion of regular risk assessments of other compounds, analyses of costs and benefits of actions, and status reports on progress in "healing" the ozone layer. The flexibility of the agreement in adding new chemical compounds through "adjustments" that became immediately binding, clear guidelines on exemptions, and annual consultations, offered diverse states clarity on what was required. The anticipatory nature of the agreement (e.g., that additional mitigation actions and costs would be required in the future) introduced a new element into the international calculus. Ultimately, U.S. legislators determined that depletion of the ozone layer was a threat to the U.S. public and merited action despite the uncertainties. Regular reporting by parties to the Protocol offered a new level of transparency to both participating states and the public. While imperfect, trade restrictions on ozone-depleting substances had the effect of reshaping markets and strengthening compliance.

The role of science in shaping a relatively rapid response to the CFC problem, the effective design of a flexible international regime, and its sustained progress immediately prompts the question: why have we failed to create similar regimes for other toxic chemicals, biodiversity, resource use, and climate change? The UNEA 4 illustrated that UNEP continues to produce a wealth of scientific information that offers both a rationale and solution sets for the international community to act on any number of global environmental challenges. Why is action so limited?

4. The Science Policy-Nexus

For much of the 20th century, science held a unique place in molding American public opinion. The Cold War was often framed as "whose scientists are better? Those in the Soviet Union or the U.S.?" The U.S. public saw science and the development of nuclear power as key to our World War II success. Postwar America could now benefit from using the knowledge gained to win the war for peaceful means. The U.S. increased its use of hydrocarbons as war factories turned to producing automobiles and commercial airplanes. Factories expanded, and new ones were built. Farm productivity soared with labor-saving equipment, improved seeds, and fertilizers. Television promoted modern technology through a variety of programming and became the medium that glamorized new levels of consumption. By one assessment, U.S. government supported science contributed to 50% of the U.S. economic growth in the period 1946–1996 [21].

The byproduct of this prosperity was environmental pollution and land degradation, but it took the public decades to raise concerns. Scientists who worked for corporations and universities often focused on product development—everything from new cleaning solutions to cereal to TV dinners drove profits and corporate expansion. Frozen food reshaped the U.S. markets and public tastes. Many of these innovations relied on the use of those very CFCs that were already compromising stratospheric ozone as explained above. Consumption of fossil fuels soared as the American public expanded its footprint in new suburbs, traveled new highways, and bought electric appliances to

reduce household drudgery, all while accelerating atmospheric warming. Science connected to the economy had transformed our natural world.

Advancing innovation, developing new cures for disease, and enhancing corporate profits offered an acceptable role for science. As the public recognized the externalities of the modern economy, however, the public became less certain that science held the answers. As scientists were increasingly expected to determine how to balance risks to the public with costs to continued progress, divergent perceptions of science and its role in the expansion of U.S. environmental regulation emerged. Indeed, as headway was made on the international front, the domestic environmental agenda stalled and progress slowed under Reagan. Conservative voices not only opposed regulation on the basis of costs, but also began to challenge the science [22].

In May 1996, a lead editorial in *Science* highlighted the growing disconnect between the public and scientific research, citing the alarming anti-intellectualism in public discourse. The American Academy for the Advancement of Science (AAAS) called for a coalition of public institutions, private corporations, and academics to band together in support of ongoing, peer-reviewed scientific studies and assessments [23]. The article signaled the growing concern among U.S. scientists that the postwar constituency in support of science was eroding. In the U.S. in particular, the bipartisan coalition that had sustained environmental activism for nearly a quarter of a century would fall victim to public skepticism of scientific analyses and political polarization, with still unacknowledged consequences for an emerging global environmental agenda that the United States had shaped. Close to 25 years later, we see that the debates about science, costs, and benefits have hardened into what Paul Krugman termed, in 2014, "a toxic mix of ideology and anti-intellectualism" that has limited the ability of the U.S. to mobilize bipartisan coalitions for action on climate change and other environmental problems [24].

The success of managing the ozone problem, obscured some potential fault lines that would emerge as the international community started to reshape the development paradigm around the concept of sustainability, echoing polarization that had emerged earlier in the US context. Environmental advocates were encouraged and believed new links between science and policy action could be forged. Opponents of government regulation and the private sector were more concerned. Even as the U.S. Congress ratified the Montreal Protocol, new coalitions emerged to counter or limit environmental action. These tensions around the science-policy nexus were neatly captured in Principles 15 and 16 of Agenda 21 [25] as agreed at the 1992 UN Conference on Environment and Development in Rio:

> *In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.* (Principle 15)

> *National authorities should endeavor to promote the internalization of environmental costs and the use of economic instruments, taking into account the approach that the polluter should, in principle, bear the cost of pollution, with due regard to the public interest and without distorting international trade and investment.* (Principle 16)

The carefully negotiated text in these two principles opened the door to ever more intense debates on the underlying questions: What is scientific certainty? What actions are cost-effective? If internalization of costs compromises large corporations will that hurt employees, the public and the economy in other ways?

In the U.S., such concerns heightened internal tensions within the George H.W. Bush Administration (1989–1993). EPA Administrator William Reilly espoused approaches that continued the regulatory initiatives of the previous administrations. In contrast, at the White House, the domestic policy chief, John Sununu and Vice President Dan Quayle, who headed a new Council on Competitiveness, argued against tighter regulations and action on new environmental threats, including chemical pollution and climate change given "scientific uncertainty and the need for 'cost-effectiveness' of new regulations" [13] (pp. 68–70). Congressional leaders, such as Senator Timothy Wirth and Senator

John Heinz, devised bipartisan approaches to resolve some of these tensions. Among the most innovative ideas was the emissions trading regime aimed at reducing sulfur dioxide pollution from coal plants which was causing "acid rain" and devastating the Northeastern forests. This initiative emerged under the amendments to the Clean Air Act in 1990 and in practice proved to be cost-effective for plant operators as well as rapidly improving air quality [13] (pp. 209–210). The White House Counsel, C. Boyden Gray, was a strong proponent of the approach, overriding internal concerns. Yet, fewer bipartisan approaches would be advanced in the years ahead. And the template for this approach known as "cap-and-trade" has yet to be advanced effectively at the U.S. federal level to address other environmental problems. I note, however, although this mechanism has not been used recently at the Federal level, U.S. states have created regional markets and the EU promulgated a Union-wide scheme. China has also used this approach. While neither maximum economies of scale nor cost-savings have yet been achieved, these arrangements have reinforced the potential of the market-shaping system. The discussion in Box 1 draws on the IUCN 1980 World Conservation Strategy. These ideas shaped Our Common Future and Agenda 21.

Box 1. From Environmental Action to Sustainable Development, And Rising Concerns Over U.S. Sovereignty.

In the U.S., environmental activists concerned with pollution and environmental health concerns joined forces with older conservation movements that valued wilderness and species diversity. The common interest in protecting land, water, and air, translated into a quest for "sustainable development."

On the global stage, the 1972 Stockholm Conference on the Human Environment, spurred the preparation of a 1980 UNEP commissioned report, *World Conservation Strategy: Living Resources Conservation for Sustainable Development*, from the International Union for the Conservation of Nature (IUCN). This report introduced the concept of sustainable development highlighting the need to "maintain essential ecological process and life support systems"; "preserve genetic diversity" for both flora and fauna; and "ensure sustainable utilization of species and ecosystems" [26]. This report also highlighted the concept of "planetary capacity to support people" and underscored the need to reduce poverty in order to stem environmental degradation. In this analysis, the obstacles to achieving conservation included: (1) lack of recognition of the constraints on resource conservation; (2) the failure to integrate conservation with development; (3) the inflexibility and destructiveness of a global development process; and (4) a lack of support for conservation-based development. The strategy advocated prioritizing conservation; investing in rural communities to conserve ecosystems and living resources; more comprehensive international conservation law; and a new focus on preserving the global commons—the atmosphere, oceans, tropical and temperate forests, and all genetic resources [26]. These concepts continue to shape international efforts at environmental governance to this day.

In 1983, the UN created the World Commission on Environment and Development, under the leadership of Norwegian Prime Minister Gro Harlem Brundtland, producing *Our Common Future*, which defined sustainable development as "meeting the needs of the present without compromising the ability of future generations to meet their own needs". These reports and a series of international dialogues shaped UN Agenda 21—an action plan for national strategies that would promote more equitable human development that was adopted at what was broadly referred to as the "Earth Summit."

Virtually all UN member states welcomed this new approach and established national implementation mechanisms in line with Agenda 21 to strive for sustainable development. This new, intergenerational concept of integrated management of national resources, however, presented U.S. opponents of environmental protection with a novel argument. This sustainable development approach, and the envisioned locally-driven implementation of Agenda 21, was viewed by U.S. conservatives as "an attack on private property" and U.S. sovereignty, further fueling domestic opposition to multilateral environmental agreements more broadly.

(Note: Further details can be found in Urban Studies Journal 2015, Volume 52 (2) 209–232 usj.sagepub.com [DOI:10.1177/004209801m4528397] *"The politics of sustainable development opposition: State Legislative Efforts to stop the United Nations' Agenda 21 in the United States*." By Karen Trapenberg Frick, David Weinzimmer, and Paul Waddell, University of California, Berkeley.]

When George H.W. Bush arrived in Rio de Janeiro in June 1992 for the Rio Earth Summit, amidst protests against U.S. policy, he famously underscored, "the American way of life is not up for negotiation." [27]. This statement signaled to the international community that efforts to reduce consumption and production or transform capitalism would meet with U.S. opposition. Today, we can almost mark that date as when the science-policy nexus began to weaken significantly—at least in the U.S.

5. Polarization

The erosion of U.S. support for international environmental governance, in parallel with the weakening of the U.S. science-policy nexus, was not well-understood among the international community. The quick ratification of the UN Framework Convention on Climate Change (UNFCCC) in the U.S. Senate in late 1992 without opposition and the arrival of the Clinton Administration in 1993, encouraged both domestic and global environmental activists to assume that internal U.S. tensions would disappear and support for new policies underpinned by science would accelerate.

Vice President Al Gore had just published his best-selling book, *Earth in the Balance*, which captured emerging environmental concerns—notably climate change—and the science underlying them. The book also called for remaking institutions and ultimately, civilization through collective political action and investing through a "Global Marshall Plan" to protect the environment [28]. Under this vision, a framework of global treaties would outline global approaches to specific problems and the developed world would support developing countries in taking actions. Such agreements would commit developed countries to improving their own policies and provide technology to developing countries to improve national level management of environmental problems. These proposals, while popular with environmental activists, raised many concerns and solidified the opposition in Washington, D.C. to new international treaties and limited the U.S. ability to take the lead in shaping new international agreements.

At the domestic level, "environmental targets were made more stringent, and environmental quality improved" in the Clinton years [29] (p. 2). Among the successes were the administration's ability to strengthen the National Ambient Air Quality Standards (NAAQS) and its initiative to reduce subsidies for resource extraction on public lands [29] (p. 2). Congress, however, actively promoted the use of benefit–cost analysis for assessing environmental regulation which became a major point of controversy between the executive and legislative branches of government. As a result, the Administration often issued executive orders to advance key environmental initiatives. Legislative reform initiatives that focused on economic efficiency and lowering regulatory costs became a dominant feature of U.S. environmental legislation. The focus on cost-effectiveness heightened the interest in market-based instruments, particularly in tradable permit systems [29] (p. 3). The Congressional emphasis on economic efficiency was met with skepticism at the EPA which saw its mandate to protect to human health as more important than the costs of new regulatory policies. EPA downgraded the role of its economic policy staff within the Office of Policy, Planning and Evaluation (OPPE) and ultimately eliminated that office in a 1999 reorganization [29] (pp. 8–9).

The domestic tensions and debate on environmental questions heavily impacted perceptions of international environmental agreements within the US. Although both the Montreal Protocol and the UNFCCC had received virtually unanimous support in the U.S. Senate, efforts to apply the Montreal formula of a flexible protocol to negotiations on climate change were resisted. In a comprehensive assessment of U.S. unilateralism on international environmental governance, Elizabeth R. DeSombre highlights key factors in whether or not the U.S. engaged. These factors include: (1) whether or not domestic policy had been established; (2) whether or not "binding obligations" are applied to both developed and developing countries in the same time period; (3) whether or not assistance from the U.S. was required for developing country implementation; and (4) whether or not the U.S. was vulnerable to the environmental threat [6]. These elements came to the forefront in Senate consideration of not only the Kyoto Protocol, but also agreements as diverse as relating to toxic chemicals (Basel Convention on trade in hazardous waste) and marine mining (UN Convention on Law of the Sea). Al Gore's assumption that U.S. ratification of international agreements would lead to domestic policy actions ran counter to the reality of how and why the U.S. acts.

Applying the Montreal Model to Climate?

The impact of growing emissions of CO_2 in intensifying the planetary "greenhouse effect" had long been a concern among scientists [30]. The cautionary experience of CFCs was sobering and prompted

the UK and the U.S. to ask UNEP and the World Meteorological Organization (WMO) to establish the Intergovernmental Panel on Climate Change (IPCC) to provide governments regular assessments on climate change, its implications and potential future risks as well as options for mitigation and adaptation [31]. This mechanism of inviting governments to nominate scientists to an international panel had worked well in supporting government officials in determining a course of action on a complex environmental question that posed planetary risks and demanded international cooperation. However, the magnitude of the challenge was significantly larger than ozone as it addressed the accumulation of hydrocarbon gases that were a burgeoning byproduct of modern life.

The IPCC, an ambitious undertaking for the UN formally established in 1988, was designed to organize regular, scientific reviews of the literature on the impact of accumulation of greenhouse gases—initially, CO_2; (carbon dioxide) and CH_4 (methane) in the atmosphere. Scientific research identified more gases of interest-N_2O (nitrous oxide), HFCs (hydrofluorocarbons—also an ozone depleting gas), PFCs (perfluorocarbons), and SF_6 (sulfur hexafluoride). This basket of gases—but, in particular, CO_2; and CH_4—were the major contributors to the intensification of the "greenhouse effect" the protective layer in the upper atmosphere that makes life on earth possible. Specifically, in its early years the IPCC sought to examine peer-reviewed science on (1) the concentration of GHGs in the upper atmosphere and (2) whether the increased concentrations since the beginning of the Industrial Revolution were the result of anthropogenic activities.

The IPCC's reports have gained increasing publicity from the early assessments in 1990 and 1992 [32] that highlighted the risk that ongoing human activities that increased the emissions of GHGs would intensify the "greenhouse effect" and that this fact required the international community to develop a framework for further research, study and ultimately, action. These reports, in turn, led to the adoption of a resolution in the UNGA, that would establish an International Negotiating Committee to develop a Framework Convention on Climate Change. Once again, a comprehensive scientific review stimulated international action—and many assumed that a new, and effective, international environmental regime would result [30]. Yet, despite increasingly urgent warnings from the scientific community, genuine policy actions have been slow to emerge. The intensifying polarization of US politics described above, and the ensuing weakening of the science-policy nexus, are an underexplored explanation for why governments—and in particular, the U.S.—have been so slow in responding to this planetary challenge.

Despite the growing consensus on the threat over nearly three decades, agreement has been difficult, and opposition to the science has become a real force. In the 1980s, the Reagan administration formally criticized "environmental science" and a corporate alliance led by the oil companies, the Global Climate Coalition (GCC), emerged to counter the recommendations of the IPCC. The GCC was a powerful coalition of major industries and manufacturers, that organized a public relations campaign to question the underlying principles of climate science and highlight the uncertainties in the assessments. Recently, investigative journalism has uncovered that industry experts fully understood the role of greenhouse gases in global warming and that anthropogenic activities were contributing to CO_2; emissions [33]. George Monbiot, a UK environmentalist and writer, stressed that the GCC "didn't have to win the argument to succeed" rather the GCC only had "to cause as much confusion as possible." [33].

Fossil fuels, particularly oil, have created the modern world. Box 2 highlights how reducing fossil energy use posed a new challenge for policy makers.

Box 2. The Fossil Energy Challenge: More Complex Than Ozone-Depleting Substances?

Modern economies have expanded through accelerating consumption of energy—primarily, fossil energy—that has been relatively abundant and cheap. Unlike controlling manmade ozone depleting chemicals, reducing energy consumption at the scale required to stabilize carbon dioxide concentrations at current levels (or lower) targets the circulatory system of the global economy. Even as energy use became more efficient, growth continued to increase demand. Modern agriculture which expanded land use by one third in the 20th century, used 80 times more energy to produce food. Much of this transformation stems from the use of synthetic nitrogen fertilizer which is extracted from natural gas—an energy intensive process. Other innovations have allowed food supply chains to expand globally, moving food from fields to consumers everywhere in the world. Virtually every manufactured product embeds fossil energy in its production, delivery, and consumption. And the waste product of this exponential production is GHG emissions (primarily CO_2;, methane, and nitrous oxide)—which continue to grow even in the face of recent international efforts to slow them.

Behind this unprecedented growth in the developed and emerging economies is a vast network of producers, suppliers, consumers, corporations, and governmental systems that have benefited directly from the transformation wrought by the use of fossil energy. Unpacking these networks and redesigning them at planetary scale is not easily accomplished. Moreover, the underlying implications are complex and politically difficult. Transforming the global energy system ultimately depends upon changing our consumer lifestyle, foregoing amenities, paying higher taxes, and supporting developing countries to speed their own transition. This complex prescription has been met with resistance, especially in the wealthiest countries—the very ones that have contributed the most to our current dilemma. (A deeper discussion is available in Margaret Robertson's *Sustainability Policy and Practice* [34].)

In 2004, a new, more realpolitik, view was emerging within the environmental community. The Breakthrough Institute founders, Ted Nordhaus and Michael Shellenberger, had released an essay, "The Death of Environmentalism", arguing that past mitigation approaches would not succeed in the climate debate. In a review of that perspective in 2011, the authors asserted that faith "in the science" and predictions of catastrophic change were ineffective at mobilizing a public response [35]. They stressed that the price competitiveness of wind and solar, rather than hostility to fossil fuels has driven investment in these alternatives. No longer is the American lifestyle the major factor in global warming and environmental degradation they argued, rather they blamed population and global economic growth for driving consumption and energy use in the developing world. Regulation for mitigation strategies is insufficient they concluded; and while better taxation policies could reshape consumer choices, they predicted these are likely to be resisted in the U.S.

Early arguments countering action on climate change also focused on the "common, but differentiated, responsibilities" formula that had been central to the Montreal Protocol's success. Many U.S. companies contended that controlling U.S. action without applying the same rules to China, India and Mexico was "unfair" and would restrict their ability to compete in global markets. Some scientists, aligned with fossil fuel interests, criticized the assumptions that the warming of the earth would change entire ecosystems, drying out some regions and increasing rainfall in others. They also dismissed the projections that glacial melt would cause sea level rise [33].

The polarization of U.S. politics continued to hamper global environmental governance in the first decade of the new millennium. George W. Bush rejected the Kyoto Protocol and was unable to secure ratification of the Stockholm Convention on Persistent Organic Pollutants, although he later embraced some elements of an energy security agenda that promoted cleaner fuels. In 2006, Al Gore had published another bestseller, *An Inconvenient Truth*, which also became a documentary and won both the Nobel Peace Prize (with the IPCC) and an Oscar. The book and film highlighted the science of climate change and its impacts and encouraged rapid adoption of clean energy and other technologies. With the election of Barack Obama in 2008, there was renewed interest in strengthening the science-policy nexus.

The incoming Obama administration (2009–2017), while committed to engaging in international environmental governance, delayed many actions until the second term as the 2008 global financial crisis severely impacted the domestic economy. Fiscal policy and safety net programs were an immediate priority. The White House also determined that affordable health care legislation was critical, limiting the administration's ability to move other policies forward. Thus, although Congressman Henry Waxman and Senator Ed Markey introduced "cap-and-trade" legislation in 2009 and hearings focused on the science and the potential of clean energy to expand employment opportunities, public skepticism grew.

Although the Obama administration firmly endorsed the scientific consensus, achieving necessary changes in domestic legislation proved to be impossible. Yet, at the UNFCCC Conference of Parties in Copenhagen in 2009, President Obama and his team of negotiators successfully advanced a new international consensus in the climate negotiations that would enable U.S. participation. The Copenhagen Accord ensured that all countries would pursue national strategies to limit carbon emissions and set the stage for negotiations to move beyond the Kyoto Protocol.

Congressional opposition to both the science and policy actions, however, hardened over the course of the next five years, forcing the Administration to center its domestic approach on the EPA's regulatory authority to protect human health which had been reinforced by a 2007 Supreme Court decision that recognized the potential health impacts of GHGs and reaffirmed EPA's authority to regulate these "pollutants" under the Clean Air Act.

Faced with the need to mobilize developing country action on climate change, key administration players designed a suite of domestic actions that would underscore a new level of U.S. commitment to reducing emissions. The process began with an "endangerment finding" by EPA in 2009 and a series of steps to reduce emissions from vehicles. Implacable congressional hostility to new climate legislation, however, posed challenges for the Administration's ability to reduce emissions from power generation. As international negotiations proceeded, EPA devised a state-based program, that would accelerate investment and deployment of clean energy as an alternative to coal, oil, and even, natural gas. The plan drew on various state policies in the Northeast and the West that had shown promise and offered states broad flexibility in their approach. The Administration unveiled the Clean Power Plan in August 2015 and made it the centerpiece of the U.S. climate action, stressing its significant contribution to reducing emissions.

These new policies reinforced the diplomatic efforts of Secretary of State John Kerry and U.S. Climate Envoy Todd Stern to bring all major emitters to Paris with new commitments on emission reductions, including China and India. President Obama directly engaged President Xi and Prime Minister Modi to ensure their cooperation. The U.S. joined 194 countries in adopting the Paris Agreement in 2015 and formally accepted it by executive order in September 2016—a highwater mark for international climate cooperation.

Domestically in the U.S., however, Paris did not end climate controversies. As diplomacy accelerated, court rulings that limited the scope of EPA's regulatory authority and state legal action against the Clean Power Plan were already threatening U.S. ability to act on climate change. In 2017, President Trump announced his intent to withdraw from the Agreement and the Administration has proceeded with formal notification. Many states, cities, and corporations have countered the federal policy by adopting or expanding their own efforts. Yet, the science-policy nexus has yet to be restored. Moreover, the COVID-19 pandemic has only served to further highlight U.S. political polarization over scientific thought. These attitudes provide little comfort for the future.

6. Conclusions

6.1. Waning U.S. Influence or Waning Influence of Science

The post-World War II U.S. enjoyed a unique role in shaping international cooperation in the last half of the 20th century. The newly formed UN captured the aspirations of U.S. leadership in its Charter: to cooperate to ensure peace and security; to advance fundamental freedoms and human rights; and to improve economic and social conditions for all [36]. These ideals were translated into practice through not only the UN itself, but also, its agencies which set normative standards in a range of areas. As the leader of the free world, the U.S. shaped new international regimes in line with its domestic and regional policies. U.S. norms on nuclear nonproliferation, health, food safety, and, in some cases, workers' and women's rights, shaped subsequent UN agreements, conventions and action plans.

While the U.S. influence on the Montreal Protocol can be clearly traced, as can its reliance on science assessments, this success in addressing the ozone problem obscured some emerging fault lines that would only sharpen as the international community reshaped the development paradigm around the concept of sustainability. With the advent of Agenda 21, environmental advocates were encouraged and believed new links between science and policy action could be forged. Conversely, opponents of government regulation and the private sector mounted their response. Even as the Congress ratified the Montreal Protocol, new coalitions had emerged, in the U.S. and on the global stage, to counter or limit environmental action.

The Montreal Protocol process that was shaped by scientific assessment and received broad bipartisan support could not be replicated to address the climate challenge. Nor has it been effectively applied to other multilateral environmental agreements, including the UN Convention on Biological Diversity or myriad chemical agreements that have global scope [37]. In fact, the U.S. failure to ratify these treaties has meant European regulations now set the standard for chemicals management, but the economic dominance of the U.S. poses limitations on new multilateral efforts. And yet international processes, like the IPCC, IPBES and UNEP, continue to churn out assessments and countless hours of summits and talks focus on bringing about coordinated policy responses.

The fits and starts in U.S. policy have slowed international progress on implementing a variety of agreements and has limited the ability to build coalitions to advance the global environmental agenda that the U.S. had shaped. George Shultz famously said, "nothing ever gets settled in Washington ... it's a debating society." This statement aptly captures U.S. efforts to respond to the threat of climate change. The Clinton administration laid a foundation for more investment in renewable energy and strengthened the Clean Air Act, and yet could not secure Kyoto ratification. Much like Trump administration actions have set out to roll back Obama-administration gains, the George W. Bush administration abandoned the Kyoto Protocol and sought to reverse environmental regulation. The surprise election of Donald Trump indeed shifted the dynamics once again—and in June 2017, the Trump administration announced its intent to withdraw from the Paris Agreement [38]. A measure of foresight in the agreement prevented a simple withdrawal which could only be notified officially in November 2019 and required a year to take effect (one day after the 2020 Presidential election) [39].

6.2. Will the Pandemic Strengthen the Science-Policy Nexus for Environmental Cooperation?

The world has changed dramatically since 2016 when new optimism about environmental prospects seemed to flower. Under the Trump administration, science has been devalued even further than many had feared. To add to the challenge, the unpredictability encountered in the first half of 2020 is perhaps best captured by the Yiddish saying, "man plans, and God laughs". With the advent of the COVID-19 pandemic, Americans are again caught in many competing narratives: "the cure can't be worse than the disease"; "limiting social interaction will protect us"; "no one could have predicted this"; "the previous administration did nothing"; and, of course, "it will disappear". With a virus in our midst, the coming years are likely to usher in a new dynamic of the science-policy nexus. Perhaps, if the public accepts the relevance of health science, we may witness increased scientific influence on policy? But even so, can we expect such a strengthening of the science-policy nexus as we continue to face unprecedented global environmental challenges? Some environmental activists are optimistic that the pandemic and economic crises can serve as a policy window for spurring a renewed effort to address climate change and other grand challenges facing society; they call for a "Green New Deal" [40] as an opportunity for renewal. Meanwhile, epidemiologists say "we're in the second inning of a nine-inning game" [41]; while President Trump disputes the veracity of the models and pins his hopes on a recovery by early November.

Amidst these new uncertainties, it is useful to consider how existing and upcoming scientific assessments will shape the international process. UNEA 5 is slated to convene in February 2021—a date that could yet be impacted by the current pandemic. The IPCC 6th Assessment Report is due out later that year, but the UNFCCC annual meeting has been delayed to November 2021 in addition to the

normal preparatory meetings. The focus for both UNEA and the UNFCCC meeting is implementation of Agenda 2030 and the Paris Agreement (which is embedded in Agenda 2030). To some extent, progress on Agenda 2030 depends on the evolution of the pandemic—and it is too early to predict how it might reshape the international order. The United States polarization and poor internal coordination has limited its ability to manage the pandemic effectively [42].

Even the best science cannot mobilize policymakers if they are disinclined to act. The Montreal Protocol came about when science and modeling directly shaped U.S. policy and attitudes, but these circumstances no longer prevail—and that model of science-based solutions is not producing global action. Planetary challenges, however, remain and the international community must find new ways of cooperation in the absence of U.S. leadership. We can look, for example, at the 2019 Global Resources Outlook. Key messages included: (1) current patterns of resource use are negatively impacting both the environment and human health; (2) decoupling natural resource use and its impacts is essential for sustainability; (3) implementing policies to recycle, reuse and repurpose are essential; and (4) international cooperation can achieve systemic change [43]. These practices might be applied regionally to advance sustainable consumption and production (SDG 12).

Frustration with the U.S. has been growing within the international community. In some cases, the EU has filled the vacuum, but internal pressures within the Union have limited its leadership. At UNEA 4, a major push was made to have a global ban on single use plastic bags—one of the most pervasive sources of plastic pollution. Use of these bags in the U.S. alone requires 12 million barrels of oil annually [44]. Domestically, many states put taxes on bags and others have taken steps to ban their use. Internationally, more than 60 countries have taken steps to regulate use [45]. Despite this, U.S. opposition to negotiating a global ban at UNEA 4 prevented coordinated action. Six weeks later, however, Parties to the Basel Convention adopted a series of amendments expanding the mandate of the convention to plastic waste [46]. This step was possible, if imperfect, because the U.S. is not a party to the Basel Convention. This example is but one variant of steps the international community might take to further environmental governance and its goals.

As we prepare for a post-COVID world, many observers view international cooperation and the multilateral institutions that advance it as under threat. Given the current disruption in economic activity; unemployment; food and health insecurities, can we realistically achieve Agenda 2030 and its 17 Sustainable Development Goals? Although this ambitious agenda seems currently out of reach, I believe a new effort could be made to restart cooperation without the U.S. Such an effort would involve: (1) recasting scientific assessments to focus on regional and/or subregional issues—e.g., environmental degradation, food waste, maternal and child health, social justice; (2) building coalitions of states that are working on the problem; (3) identifying reinforcing policies that can help to address regional issues; and (4) expanding capacity among regional groups to develop local/regional solutions for transboundary problems. We can anticipate that some early efforts may fail, but we need more experimentation and cooperation at local and regional levels to address specific questions. The UN, with its regional economic and social commissions, and UNEP offer existing platforms that can draw on global assessments and tailor them for "coalitions of the willing."

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