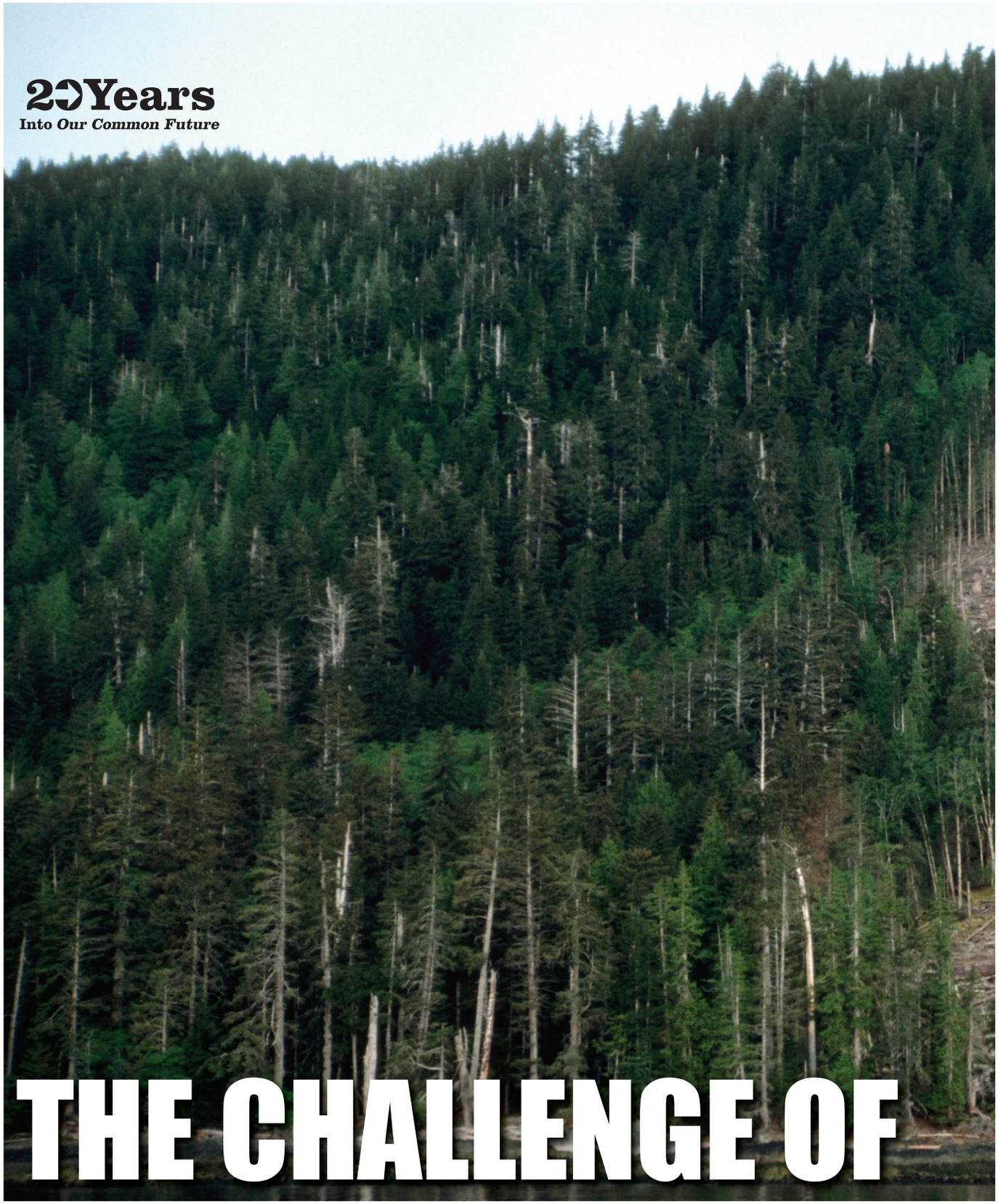
20 Years
Into *Our Common Future*



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THE CHALLENGE OF Common-Pool

Resources

by Elinor Ostrom

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In 1987, the World Commission on Environment and Development (WCED) released its seminal report, *Our Common Future*, which created a serious discussion about how we should engage in sustainable development of the world's future, including how to address global resource systems, or "commons."[1] In the two decades that followed, humans have failed to halt the tragedy of massive overfishing of the oceans, major deforestation, and excessive dumping of carbon dioxide in the atmosphere. However, in some specific niches, such as the Maine lobster fishery, the commons are in better condition today than they were a decade or two ago.

Part of the reason for the mixed results is that most common-pool resources differ vastly from one another. Many government officials and policy analysts' advocacy of a single idealized solution for all of these resources has been a key part of the problem instead of the solution.[2] Further, many of the most pressing problems future generations will face are on a global scale. Establishing effective governance arrangements on this scale has proved to be more difficult than on a local scale.

As the WCED noted in its report, "the traditional forms of national sovereignty are increasingly challenged by the realities of ecological and economic dependence. Nowhere is this more true than in shared ecosystems in 'the global commons.'"[3] Yet the WCED, headed by then–Norwegian Prime Minister Gro Harlem Brundtland, challenged scholars, public officials, and citizens to recognize that we all share a common future. That future is severely threatened, however, if we do not focus on how to protect our common heritage while endeavoring to achieve greater economic returns for the peoples of the world. The WCED conceived "environment" as where people live, and "development" as how people try to improve their lives. In *Our Common Future*, the commission wrote, "Humanity has the ability to make development sustainable—to ensure it meets the needs of the present without compromising the ability of future generations to meet their own needs."[4]

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Without clear property rights, fisheries can harvest as much as they want, leading to massive overfishing of the world's oceans.

William Clark of the Harvard Kennedy School of Government evaluated the impact of the Brundtland Commission's work for *Environment* a decade after its release.[5] Clark reflected that many disappointments, resignations, and increased cynicism were expressed at the international meetings held to evaluate progress toward sustainable development. In addition to the major disappointments of the decade, Clark found some more optimistic developments. To see these, he argued,

> *requires a shift in perspective from the current short-term, global view of international environmental diplomacy to longer term and more local views of sustainable development. These views cannot be found in any one spot. . . . The pictures they provide are, of course, mixed, with their own share of environmental horrors, economic greed, and program failures. But compared with 20, 10, or even 5 years ago, the extent to which notions of sustainability have entered mainstream development thinking is astounding.*[6]

A few years later, from 2001–2005, the Millennium Ecosystem Assessment (MEA) conducted a massive review of the state of the world's ecosystems and their services.[7] Their first major finding was that the change to ecosystems during the past half-century has been more rapid than any comparable period in human history. Their second major finding was that while these changes have led to substantial net gains in economic development and human well-being, the gains

> *have been achieved at growing costs in the form of the degradation of many ecosystem services, increased risks of nonlinear changes, and the exacerbation of poverty for some groups of people. These problems, unless addressed, will substantially diminish the benefits that future generations obtain from ecosystems.*[8]

Thus, the most recent worldwide review of our common future warned that major changes threatened our future. The MEA also advised that policymakers search for solutions for specific niches rather than generalized problems and avoid standardized solutions.

Looking ahead toward long-term effective management of resource systems on a global scale, several important questions require examination: What are "the commons?" How successful have efforts been to sustain the world's oceans and forests since the publication of the Brundtland report? What role do international regimes play in a sustainable future? What lessons have scholars learned about adaptive governance of common-pool resources over the past 20 years that can be applied to the next 20 years and beyond?

The Commons and Common-Pool Resources

Scholars are still in the process of developing a shared language for the broad set of things called "the commons." Commons refer to systems, such as knowledge and the digital world, in which it is dif-

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ficult to limit access, but one person's use does not subtract a finite quantity from another's use.[9] In contrast, common-pool resources are sufficiently large that it is difficult, but not impossible, to define recognized users and exclude other users altogether. Further, each person's use of such resources subtracts benefits that others might enjoy.[10] Fisheries and forests are two common-pool resources that are of great concern in this era of major ecological challenges. Others include irrigation systems, groundwater basins, pastures and grazing systems, lakes, oceans, and the Earth's atmosphere.[11] Chapter 10 of the Brundtland report primarily discusses the problematic condition of common-pool resources in the late 1980s; thus this update will focus on common-pool resources.

Common-pool resources may be governed and managed by a wide variety of institutional arrangements that can be roughly grouped as governmental, private, or community ownership. Since the WCED report, a considerable number of common-pool resources are comanaged by communities working with governments.[12] Depending on the setting, government ownership, private property, community property, and comanagement may succeed or fail in sustaining resources and providing good economic returns.[13] Open-access resources—common-pool resources that anyone can enter and/or harvest—are likely to be overharvested and potentially destroyed. In his classic article, "The Tragedy of the Commons," leading ecologist Garrett Hardin confused open-access commons with commons that are the joint property of a community.[14] While Hardin correctly pointed out that valuable open-access common-pool resources would be overharvested, his conclusion of an inevitable tragedy was too sweeping.

Continued Overharvesting of Ocean Fisheries

Chapter 10 of the Brundtland report presents a grim picture of ocean fisheries' management. In 1979, according to data cited in this chapter, the total volume of fish captured (from wild fisheries and aquaculture—cultivating fish, especially for food) was more than 70 million tons, and overexploitation threatened many fishery stocks. "With conventional management practices, the growth era of fisheries is over," the report predicted.[15]

The situation has not improved in the 20 years since the report was issued, although at first glance, the data might seem to indicate the WCED's prediction was *in*correct. Table 1 below presents world fish catch data in major regional fisheries from 1979 through 2005.[16] The total volume of fish caught in major fisheries around the world has doubled in

Table 1. World fish catch in major fisheries, 1979–2005

Region	Catch (thousand tons) 1979[a]	Five-year trends in total world catch[b]					Catch (thousand tons) 2005[c]
		1980–1984	1985–1989	1990–1994	1995–1999	2000–2004	
North Atlantic	14,667	–3.33	–6.5	5.17	–0.15	–3.69	13,278
North Pacific	20,303	27.41	12.6	3.88	12.04	3.37	38,559
Central Atlantic	6,064	5.8	6.36	–5.22	3.34	–4.54	6,883
Central Pacific	7,536	7.28	19.06	14.07	3.54	14.73	13,800
Indian Ocean	3,541	22.42	6.12	44.4	10.77	13.43	9,231
South Atlantic	4,420	0.53	13.55	2.87	5.71	–8.61	3,682
South Pacific	7,242	33.22	43.43	44.23	–15.3	–0.56	16,188
Inland	7,240	30.96	31.24	29.44	35.82	24.01	37,921
Total world catch	71,013	14.96	16.61	19.23	8.86	7.02	141,403

SOURCES:
[a] As reported in World Commission on Environment and Development (WCED), *Our Common Future* (New York: Oxford University Press, 1987), 267.
[b] Based on data from Food and Agriculture Organization (FAO) of the United Nations, Fisheries and Aquaculture Information and Statistics Service, *Global Aquaculture Production, 1950–2005* and *Global Capture Production, 1950–2005* (Rome: FAO, 2007), http://www.fao.org/fishery/topic/16073 (accessed 8 April 2008).
[c] Column 2005 does not add due to rounding. Total data for 1980 to 2004 is from the WCED, *Our Common Future* (New York: Oxford University Press, 1987), 267; and FAO, Fisheries and Aquaculture Information and Statistics Service, *Global Aquaculture Production, 1950–2005* and *Global Capture Production, 1950–2005* (Rome: FAO, 2007), http://www.fao.org/fishery/topic/16073 (accessed 8 April 2008).

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size from 70 million tons in 1979 to 141 million tons in 2005. A closer look reveals that this prediction is true for developed countries, where the volume of catch has steadily declined since 1979. As of 2005, just 20 percent of the total catch is now harvested in developed-country fisheries. On the other hand, harvesting from fisheries of developing countries, but not necessarily by local fishers, has continued to grow and is now 80 percent of the vastly increased overall total. The proportion of the world's total catch that is derived from aquaculture—again largely in the developing world—has also steadily risen.[17]

While the harvesting volume has doubled, the population of many species harvested for food has declined or disappeared.[18] A basic problem leading to massive overfishing in the oceans is the lack of *any* property rights for the many commercially valuable species in the open ocean. Most of the ocean fisheries are truly open access. Fishery after fishery has been subject to massive overfishing, including the tuna and whale fisheries in the Pacific, the cod fishery in the Atlantic, and the lobster and conch fisheries in the Caribbean.[19]

In 1982, the United Nations Conference on the Law of the Sea did remove around one-third of the oceans from the international realm by establishing Exclusive Economic Zones (EEZs) that extend 200 nautical miles along the oceanic borders of coastal states. EEZs assign sovereign powers to coastal states to manage these resources and assure they are not endangered by overexploitation.[20] That agreement was heralded by the WCED, which stated "not only do governments now have the legal power and the self-interest to apply sound principles of resource management within this area, but they have an obligation to do so."[21] Instead, many governments subsidized an expansion of their own national fleets, leading to increased rather than decreased fishing in coastal regions. National governments also tended to use relatively crude models of fishery dynamics in the early years of their responsibilities and had insufficient data to assess stocks.[22]

In Canada, for example, the Department of Fisheries and Oceans (DFO) used a model of stock regeneration for northern cod that scientists later determined was flawed.[23] Further, highly aggregated and incomplete data was used in deciding on quotas. Even though local fishers in Newfoundland feared a collapse was near, the Canadian DFO assured everyone that the cod fishery was recuperating from earlier excessive harvests. In 1992, however, they reversed earlier policies and declared a moratorium on all fishing for northern cod in Canadian waters.[24] The real tragedy here is that the local fishers, who had established local rules for managing the fishery before the government's intervention and were the backbone of local economies, paid the cost of the collapse rather than the officials who had not listened to them. The cod fishery has not yet recovered: the cod fishers have had to leave local villages, find jobs elsewhere, or go on welfare.

Setting scientifically recommended fishing quotas for large coastal fisheries—even when official authority exists—frequently has been difficult and conflict-laden for public officials. The 2007 Fishing Quota established by the European Union for eastern Baltic cod, for example, ignored the warning of the International Council for the Exploitation of the Sea (ICES), the scientific body advising the European Union on catch sizes, which strongly advised skipping at least one year in authorizing any catch.[25] Even the reduced catch levels set for western Baltic cod remained 30 percent over the level recommended by ICES. Thus, the authority to act and the willingness to make decisions that involve short-term costs for the fishing industry (even when it is in their long-term interest) are not equivalent.

A team led by Fikret Berkes of the University of Manitoba's Natural Resources Institute documents another harvesting process practiced by "roving bandits" that is sequentially devastating coastal fisheries even within EEZs: "Roving banditry is different from most commons dilemmas in that a new dynamic has arisen in the globalized world: New markets can develop so rapidly that the speed of resource exploitation often overwhelms the ability of local institutions to respond."[26] Due to developments in the technology of fishing, large, high-powered boats can zoom into a local fishery, massively harvest it for a valuable species in the international market, and then move to another location before local authorities respond. These roving bandits have depleted the sea urchin fisheries in Japan, Korea, Mexico, Chile, Russia, Alaska, the eastern coast of Canada, and the northwestern and northeastern coasts of the United States.

While the news related to ocean fisheries and many coastal fisheries is bleak, it is not entirely grim for fishery stocks on all coasts. In the state of Maine, for example, local fishers and state officials have successfully evolved ways to manage lobster stocks. The fishery underwent a major shock around 1930 when the stocks fell sharply for unknown reasons. Since that time, stocks have risen substantially and are now higher than they were in the nineteenth century. This resurgence is due to favorable environmental conditions combined with the evolution of effective rules of diverse origins. State legislature passed formal conservation laws as a first set of rules in response to substantial lobbying from fishers and their associations. These rules give effective protection to juvenile lobsters and proven breeding stock as well as limit the number of lobster traps. A second set of territorial rules developed by fishers allocate fishing locations to fishers living near and fishing from a particular harbor. These rules enable lobster fishers to monitor each other's harvesting with substantial effectiveness.[27]

The evolved Maine lobster system strikes a relatively delicate balance. James Wilson of the University of Maine and colleagues have developed a detailed set of simulations showing that if fishers had not taken substantial responsibility for monitoring each other's harvesting behavior, the successful fishery would have been overharvested—and potentially may have collapsed like many others around the world.[28] In contrast, while international groups, state-level public officials, and the fishers tried to regulate the lobster fisheries in the Caribbean, none of these

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Collaboration between state officials and local fishermen to monitor and protect the Maine lobster fishery averted overharvesting in the region.

groups' efforts have been able to stem the overharvesting of lobster in this region.[29]

In the November 2007 issue of *Environment*, Raul P. Lejano and Helen Ingram of the University of California, Irvine, document a very successful local system that evolved over a decade in the Turtle Islands of the Philippines.[30] While outsiders were deeply involved in the effort to find mechanisms that would control overfishing of turtle eggs, they worked very closely with local fishers and officials to develop a system, the Pawikan Conservation Project, which was well-matched to the local economy. As can be seen in Figure 2 of their article,[31] the percentage of eggs conserved steadily rose from the commencement of the Pawikan program in the mid-1980s through the 1990s without any major conflict among participants.

Tragically, national officials did not recognize local rules when they passed the Wildlife Resources Conservation and Protection Act in 2001, which prohibted hunting of threatened wildlife and banned the collection of marine turtle eggs. The law was largely based on international conventions that stress the importance of protecting endangered species. Very soon after the law was passed, "turtle egg conservation in the Turtle Island system ceased altogether, and depletion of turtle eggs proceeded at an alarming rate. One preliminary assessment estimates that egg conservation rates dropped from about 80 percent to 40 percent in about one year."[32] The imposition of an external, but unenforceable, rule destroyed the pre-existing local rules. Lejano and Ingram's article provides a counterargument to the notion that only government ownership or management solves the problem of the commons, detailing how top-down rulemaking without an awareness of local norms, rules, and evolved institutions can lead to disaster.

With the establishment of EEZs, some coastal fisheries in Canada, New Zealand, and Iceland have been able to develop individual transferable quota (ITQ) systems that have reduced the level of harvesting in key coastal fisheries. Governments assign ITQs, official harvesting quotas, to a fisher

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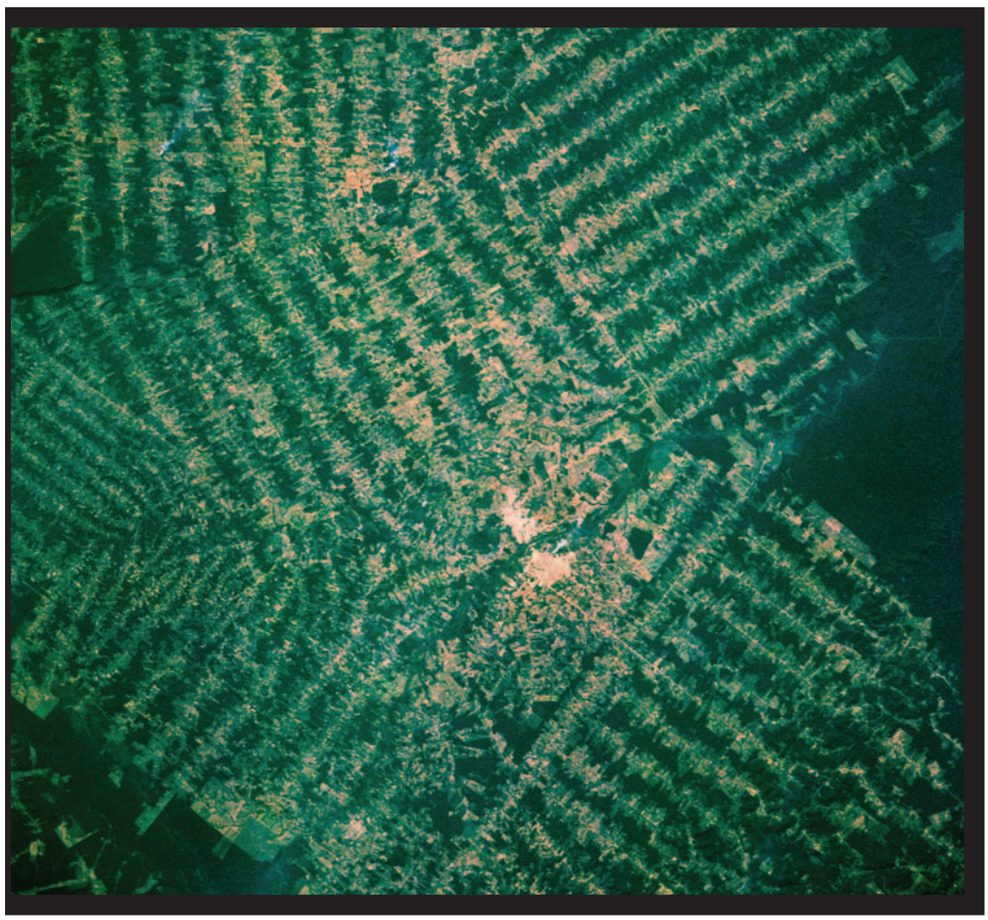
that then may use them to harvest his or her assigned quantity or sell them to another fisher (hence the term "transferable"). In British Columbia, early governmental policies trying to control overfishing of the trawl fishery for groundfish included restricting the number of fishing vehicles and the equipment that could be used, as well as assigning total allowable catch (TAC) and fishing trip quotas. In 1995, the fishery was closed, however, due to a major collapse. The DFO reopened the fishery several years later with new regulations, including an annual ITQ system.[33] Further, they established a rigorous monitoring program in which onboard observers record all catches. The ITQ system has collected more valid data, decreased fleet overcapacity, recorded catch levels close to allocated quotas, and reduced discard of unwanted species. By comparison, ITQ systems that lack an effective monitoring system have suffered from considerable underreporting of catch levels.

New Zealand declared its 200-mile EEZ in 1983. In 1986, New Zealand became one of the first countries to adopt a market-based fishery regulation when it adopted a quota management system and allocated ITQs to a subset of domestic fisheries.[34] New Zealand authorities found that the biological models underlying the initial allocation of permanent allocation of fixed quotas needed to be adjusted over time in light of further evidence. As a result, in 1990, the commercial fishers received a revised ITQ based on a proportion of the total catch assigned annually.[35] Over time, the original ITQ system has evolved into a comanagement system in which the fishers participate in gathering data and making policies. The system is still evolving and faces problems related to mismatches among the temporary and spatial dimensions of the property rights assigned to diverse groups.[36]

In 1990, Iceland also introduced an ITQ system after multiple crises in Icelandic fishery stocks.[37] Similar to the evolved New Zealand ITQ system, quotas do not assign fixed quantities but rather a share of the annual authorized catch level set by the government. The Iceland ITQ system appears to have averted the collapse of many valuable species for the Iceland fishery but has been less successful in restoring the Icelandic cod stocks. In his analysis of the long and conflict-ridden road to the Icelandic ITQ system, New York University professor of politics Thráinn Eggertsson[38] reflects that introducing major institutional changes is a "subtle art" compared to using a simpler "one-size-fits-all" formula. Designing a system in a top-down fashion and imposing it on the harvesters is not as successful as working with the users of a common-pool resource over time to develop a system that is well-matched to the ecological system as well as to the practices, norms, and long-term economic welfare of the participants, as was accomplished in New Zealand.



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Farmers who clear private land for agriculture contribute to deforestation of the Brazilian rainforest, as shown by the thousands of fields cut into this Rondônian forest.

Continued Overharvesting of Forest Resources

Forest resources were not a focus of chapter 10 of the WCED's report, but they have become major news of recent times, especially given the impact of deforestation on global climate change. The MEA noted that the global area containing forested land has been cut in half over the past three centuries:

Forests have effectively disappeared in 25 countries, and another 29 have lost more than 90% of their forest cover. Forest systems are associated with the regulation of 57% of total water runoff. About 4.6 billion people depend for all or some of their water on supplies from forest systems. From 1990 to 2000, the global area of temperate forest increased by almost

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3 million hectares per year, while deforestation in the tropics occurred at an average rate exceeding 2 million hectares per year over the past two decades.[39]

As Table 2 on this page shows, total hectares of forested land have steadily declined between 1990 and 2005. The only major increases in forested areas have occurred in East Asia, where China has, taken aggressive steps to reduce deforestation, and in the Caribbean, where substantial urban migration has led to reforestation of the highland areas of Puerto Rico and the Dominican Republic.[40]

Whereas open access to oceans, compounded by roving bandits and ineffective governance in EEZs, is a major cause of overfishing, one cannot blame the problem of overharvested timber and deforestation on lack of ownership. Governmental units own most forested land, while private owners and, to a lesser extent, communities own the remaining forested land.[41] Some policy analysts call for massive increases in the extent of government-owned protected areas as the only way to protect biodiversity and reduce deforestation.[42] Others have called into question whether officially designated protected areas are the best strategy for conserving the world's forests, arguing that many such "paper parks" are counterproductive.[43] The International Union for Conservation of Nature (IUCN) estimates that about 10–12 percent of the world's forested lands are already in protected areas, and the Food and Agriculture Organization (FAO) of the United Nations' Global Forest Assessment estimates that 479 million hectares are inside protected areas.[44] No question exists that some protected areas are very successful in protecting local forests, such as the Tikal National Park in Guatemala or the Machadinho d'Oeste reserves in Rondônia, Brazil.[45] On the other hand, deforestation threatens many areas around the world that are designated as protected but are not sufficiently budgeted or staffed to actually protect the forest.[46]

For the past decade, colleagues from a dozen countries have been conducting studies of forests as part of the International Forestry Resources and Institutions research program.[47] At each site, an interdisciplinary team measures trees, shrubs, and groundcover for a random sample of forest plots. Scholars knowledgeable about the local culture and history conduct participatory, in-depth studies of the activities, norms, and rules of local users. In an analysis of data from 76 government-owned forests that were legally designated as protected forests and 87 public, private, and community-owned forested lands that were not protected and were used for diverse purposes, no statistical difference existed between vegetation densities of officially designated, government-owned protected areas and all other property regimes.[48]

Monitoring by officials or users of a forest makes a consistent difference in the forest conditions found in government and community forests.[49] In fact, findings from multiple studies of government- or community-managed forests illustrate the crucial role monitoring played in impacting the cohesiveness of institutions, as well as the success of diverse forest management initiatives.[50] When harvesting rules are effectively monitored and enforced, they prevent the spread of freeriding behavior, thereby instilling a sense of trust in the community.

While many policy analysts think that extending private ownership of a common-pool resource is an assured method for long-term sustainability, private ownership

Table 2. Change in extent of forest land, 1990–2005

Region	Millions of hectares			Percent change		
	1990	2000	2005	1990–2000	2000–2005	1990–2005
Eastern and Southern Africa	252.4	235	226.5	–6.86	–3.62	–10.23
Northern Africa	146.1	136	131	–6.94	–3.61	–10.3
Western and Central Africa	300.9	284.6	277.8	–5.42	–2.38	–7.67
East Asia (including China)	208.2	225.7	244.9	+8.41	+8.51	+17.63
South and Southeast Asia	323.2	297.4	283.1	–7.98	–4.79	–12.39
Western and Central Asia	43.2	43.5	43.6	+0.79	+0.16	+0.95
Europe	989.3	998.1	1001.4	+0.89	+0.33	+1.22
Caribbean	5.4	5.7	6	+6.65	+4.7	+11.66
Central America	27.6	23.8	22.4	–13.76	–5.98	–18.92
North America	677.8	678	677.5	+0.03	–0.07	–0.05
Oceania	212.5	208	206.3	–2.11	–0.86	–2.95
South America	890.8	852.8	831.5	–4.27	–2.49	–6.65
World	4,077.3	3,988.6	3,952	–2.17	–0.92	–3.07

SOURCE: Food and Agriculture Organization of the United Nations, Forestry Department, http://www.fao.org/forestry/site/fra/en.

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of forests does not guarantee long-term protection. Much of the deforestation across the world has occurred as farmers have cleared their private land for agricultural purposes. In a study of three Amazonian states in Brazil (Acre, Pará, and Rondônia), Indiana University professor Eduardo Brondizio and colleagues used official deforestation data from the Brazilian-based National Institute for Space Research (Instituto Nacional de Pesquisas Espaciais) to study the relative contribution of deforested patches of different sizes to total deforestation in each state.[51] They found that clearings associated with smaller-sized holdings dominate the number of clearings, but the percent of land cleared in areas that are equal to or larger than 2,000 hectares exceeded 85 percent of total deforested area in all three states (85.9 in Acre, 91.2 in Pará, and 94.5 in Rondônia). Thus, policies to reduce deforestation by communities and small-scale owners may not directly affect the extent of damage in this and many other regions affected by large-scale clearing of private land driven largely by commodity markets.

Another recommendation related to both reducing deforestation and decreasing global warming is payment for environmental services (PES) for protecting biodiversity and forests.[52] PES programs charge residents of the developed world for protecting ecologically diverse sites in the developing world. The ecological services of these developing countries serve the entire world, while the costs of preservation are borne by residents of the developed world. Proponents stress that PES policies are strongly related to sustainable development since payments could be allocated to poorer residents of tropical forests who have a financial, as well as a lifestyle, motivation to protect forests.

Like other policies that are good in theory, working out arrangements that actually achieve both protection and increased income to the world's poor residents has been difficult. A study of the distribution of PES payments in Costa Rica, for example, found that payments tended to be allocated to large landowners with high incomes.[53] A second study of the Costa Rica PES experiment based on remote sensing and geographic information systems (GIS) found that deforestation was not significantly less in regions where large allocations of PES payments had been invested.[54] Hopefully, some of the initial experiments will provide some insight on how to achieve these complex goals.

International Regimes for Sustainable Development

Major international problems—such as cross-state rivers and lake pollution, transmission of air pollutants across long distances, and pressures to use outer space and the North and South Poles for imperial and commercial purposes—have challenged scholars and public officials to create international regimes for sustainable uses of these diverse commons.[55] Some large-scale resources have been protected successfully through appropriate international governance regimes such as the Montreal Protocol on stratospheric ozone, which was signed in 1987—the same year the Brundtland report was released. Before then, the atmospheric concentrations of ozone-depleting substances were increasing faster than those of carbon dioxide; the increases slowed by the early 1990s, and the concentration appears to have stabilized in recent years.[56] The international regime to reduce the human impact on stratospheric ozone is widely considered a successful effort to protect a global commons.

The most pressing commons problem at a global level is the need to reduce greenhouse gas concentrations substantially. While no international regime that includes all countries has been implemented yet, a variety of approaches at multiple levels are under way.[57] One of the largest regimes in geographic scope is the European Union Emission Trading Scheme, which is a cap-and-trade program that sets an initial upper limit on emissions levels while assigning tradable property rights to a firm for this limit. In addition, many voluntary programs have been established on multiple scales and generated diverse results.[58] Considerable learning can be achieved from comparative study of their performances.

Peter Barnes of the Tomales Bay Institute and colleagues have proposed an "Earth Atmospheric Trust" where a global cap-and-trade system is created for all greenhouse gas emissions and the funds obtained from auctioning off the permits are deposited in a "trust fund." The fund would then invest in technological development to avert further carbon emissions and would also return some of the revenues to the peoples of the Earth.[59] While this idea may not be accepted, many imaginative concepts need to be seriously discussed in the immediate future or dreams of sustainable development will be defeated by overlooking the threat of carbon emissions.

What Have We Learned Since 1987?

While many environmental and social problems are worse today than two decades ago, the authors of the WCED report should be congratulated for stimulating an essential dialogue among scholars, public officials, nongovernmental organizations, and citizens about strategies for achieving sustainable development. Without an active dialogue, the world would simply continue on the path toward an unsustainable future instead of searching for ways to avert the disaster that may ensue if we do not confront the massive overharvesting of fisheries and forests around the world, as well as the challenge of substantially reducing carbon emissions. As a result of extensive studies, however, we are learning some key lessons that, if applied, may enable the humans living on Earth to improve on their past performance.[60]

No Cure-Alls

The most important lesson that needs wide dissemination is that simple panaceas offered for solving problems related to the commons—whether they are for government, private, or community ownership—may work in some settings but fail in others.[61] As examples have shown, quick fixes may cause more harm than

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Consistent monitoring and measurement of forests not only preserve their integrity, but also provide institutions with accurate, up-to-date information on which to base future decisions.

good.[62] Instead, officials and citizens need to craft institutions at multiple levels built on accurate data gathered at appropriate scales given the type of resource involved. Scholars have learned that ecosystems are diverse, complex, and uncertain, and sustainable management requires substantial investment in acquiring accurate data to learn more about patterns of interaction and adapt policies over time that are better fitted to particular systems.

Further, policies also have to fit with the local culture and institutional environments of those who depend on ecosystems for their livelihood. Thus, specific institutional arrangements that work best in a particular location need to take into account the appropriate spatial and temporal scales as well as the type of interactions that occur on the ground. It is better to induce cooperation with institutional arrangements fitted to local ecosystems than to try to command it from afar.[63] Users need to perceive and understand the rules as legitimate, or they will invest heavily in illegal harvesting. Effective monitoring by officials and users is an essential ingredient of sustainable common-pool resource institutions. The specific rules that facilitate low-cost and effective monitoring vary from setting to setting depending on ecological as well as social variables. Without active monitoring, however, the incentive to freeride on the cooperation of others can generate a tragedy of the commons.

Achieving Adaptive Governance

The National Research Council has convened a series of meetings to assess what the global community has learned since the Brundtland report,[64] Garrett Hardin's classic article,[65] and the extensive research undertaken by scholars from multiple disciplines related to the study of common-pool resources on multiple scales.[66] Many scholars now recognize that simple "ideal" solutions imposed from the outside can make things worse rather than better. The task of designing sustainable, complex, coupled human-resource systems is indeed always a struggle. Five basic requirements, however, have been identified from extensive multidisciplinary studies of failed and successful regimes for governing diverse commons.[67] These include

- *Achieving accurate and relevant information.* Since the ecological, technological, economic, and social factors affecting the performance of any commons regime

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change over time, information about the conditions of the resource and its users also needs to be updated regularly. The challenge is combining accurate scientific understanding of coupled human-environmental systems and expected changes in these variables over time with information available to the users about their own future and the changes they can make in governance as well as use. New challenges arising from the increased speed and spread of human impacts require adaptations using a combination of scientific and local knowledge. New technologies, including remote sensing and GIS, provide more accurate information to localities that can be used for better decisionmaking. Building respectful collaborations between local users, public officials, and scientific experts is a vital requisite of adaptive governance.

• *Dealing with conflict*. In a coupled system that decides how resources are allocated, some conflicts over policies and their administration are highly likely. Governance systems that ignore the possibility of conflict over diverse issues may increase the likelihood of these conflicts, which could eventually erupt into major problems. Setting up strict hierarchical systems may increase the speed of decisions but ignore the interests of some participants who eventually erupt and potentially destroy an operational system. Designing multiple tiers of arenas that can engage in rapid discovery of conflicts and effective conflict resolution is essential.

• *Enhancing rule compliance*. Passing formal rules should not be confused with more informal rules that decisionmakers use day-to-day to manage a common-pool resource. Formal rules may become effective when participants consider them legitimate, fair, enforced, and likely to achieve intended purposes. External arrangements are rarely sufficient in and of themselves to effectively monitor a commons. Rather, the users of a commons, who are frequently widely dispersed, need to take some responsibility for monitoring.

• *Providing infrastructure*. Physical, technological, and institutional infrastructure is an essential investment to increase the effectiveness of internal operations within a commons as well as link any particular resource and its users to larger regimes. An overemphasis on engineered works such as highways, railways, electricity networks, and modern irrigation systems, however, especially if these works are designed without much awareness of the relevant institutional arrangements of a particular regime, may be counterproductive. For example, some modern irrigation systems are constructed without information on farmers' property rights and cause considerable disruption.[68] The diverse types of infrastructure need to work and change together over time.

• *Encourage adaptation and change*. Change is omnipresent. Institutional arrangements that are intended to be sustainable cannot be fixed for the "long term," because they need to change to address past errors and cope with new developments.

No blueprints exist for achieving these requirements. The specific designs of long-enduring governance regimes related to common-pool resources vary substantially from one another because of resource system diversity, as well as the social and economic settings of these resources. Rather, a general set of design principles has repeatedly been found to characterize small- to medium-sized institutional regimes that were sustainable over a long period of time.[69] As the box on this page shows, the design principles do not specify any particular rule. In light of extensive research on the applicability of the design principles, an updated analysis is in process.[70]

The Future of the Commons

The global community has taken a long journey since 1987 in its efforts to under-

DESIGN PRINCIPLES FOR GOVERNING SUSTAINABLE RESOURCES

The following principles are frequently observed in sustainable institutional regimes:

• ***Clearly defined boundaries.*** The boundaries of the resource system, such as irrigation systems or fisheries, and the individuals or households with rights to harvest resource units are clearly defined.

• ***Proportional equivalence between benefits and costs.*** Rules specifying the amount of resource products that a user is allocated are related to local conditions and rules requiring labor, materials, and/or money inputs.

• ***Collective-choice arrangements.*** Many of the individuals affected by harvesting and protection rules are included in the group who can modify these rules.

• ***Monitoring.*** Monitors, who actively audit biophysical conditions and user behavior, are at least partially accountable to users and/or are users themselves.

• ***Graduated sanctions.*** Users who violate rules-in-use are likely to receive graduated sanctions (depending on the seriousness and context of the offense) from other users, officials accountable to these users, or both.

• ***Conflict-resolution mechanisms.*** Users and their officials have rapid access to low-cost, local arenas to resolve conflict among users or between users and officials.

• ***Minimal recognition of rights to organize.*** The rights of users to devise their own institutions are not challenged by external governmental authorities, and users have long-term tenure rights to the resource.

• ***Nested enterprises (for resources that are parts of larger systems).*** Appropriation, provision, monitoring, enforcement, conflict resolution, and governance activities are organized in multiple layers of nested enterprises.

SOURCE: E. Ostrom, *Governing the Commons: The Evolution of Institutions for Collective Action* (New York: Cambridge University Press, 1990), 90.

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stand how individuals cope with managing common resources, as well as other diverse economic and ecological situations as they try to improve their lives, the lives of their children, and lives of their children's children. We are now developing better tools for analyzing how changes in rules, biophysical structures, and community attributes affect resources over time.[71] We must, however, be modest in our claims to understand these complex systems and our attemps to derive the best answers. We are fallible humans studying fallible human behavior within institutional structures constructed by other fallible humans. We should not act as if we know for certain how to achieve sustainable development. We can, however, recognize our growing capabilities and those of the individuals we study to experiment with rules, learn from the experiments, and, if the broader institutional and cultural milieu facilitates, gradually improve outcomes so they are sustainable over time.

If the global community can apply these lessons, invest in adaptive governance, treasure institutional diversity as much as it treasures biodiversity, and see all policies as experiments that need to be evaluated over time based on new information, we may move toward a more sustainable path. Let us hope that the next two decades are more congruent with sustainable development than the two decades since the Brundtland report.

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