DRAFT Background Paper for Working Group 5:

RESOURCES AND ENVIRONMENTAL DEGRADATION AS SOURCES OF CONFLICT

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IN today's world, human pressures on natural resources are increasing, while many resource bases are deteriorating or being depleted, creating an increased potential for competition and conflict between nations or groups within societies. Among the resources that have sources of contention leading or contributing to conflict in the distant or recent past are fresh water, productive land, fisheries, mineral deposits, and fossil fuels. In addition, as environmental pressures rise, the *quality* of certain resources and natural products, such as fresh water, fisheries yields, and forest products, is becoming an important issue connected with scarcity.

INCREASING GLOBAL RESOURCE CONSTRAINTS

IN 1999, the human population passed 6 billion in number, having grown roughly fourfold in the twentieth century - an unprecedented increase in a comparable amount of time. This great expansion has been accompanied by an equally unprecedented rise in the mobilization of resources both to support the growing population and raise living standards. As an indicator, global energy use rose some 20-fold in that time. Since World War II, the world's nations have become increasingly dependent on various industrial minerals and especially on fossil fuels - coal, petroleum, and natural gas. The sensitivity of industrial nations to disruptions in supplies of essential energy resources was demonstrated during the "oil crisis" of 1973-74 and the policy responses that followed, although the shortages had an even heavier impact on developing nations whose mostly poor populations were already significantly dependent on oil subsidies to maintain food production and run their economies. The Gulf War in 1990-91 was clearly a conflict over access to oil resources.

The twentieth century also has seen a profound modification of Earth's productive lands and diversion of surface waters to produce food and serve other human needs. More and more land has been taken over for urban-industrial development, agriculture, livestock grazing, timber harvesting, and recreation.[1] Similarly, surface and underground water sources increasingly have been harnessed for domestic, industrial, and agricultural uses. By the end of the century, all these uses for both land and fresh water are increasingly in competition as unexploited lands and surface water sources have grown scarcer.

As progressively less unexploited arable land remained available in most regions by the late twentieth century, food production became more industrialized and intensified. Modern agriculture is highly dependent on abundant water and synthetic fertilizers and pesticides to produce high yields of staple crops in efficient, mechanized monocultures. Thus, while the need for more cultivable acreage has been eased by intensification, pressures have risen on supplies of fresh water for irrigation. Although much of the rise in food supplies since 1950 have been due to greatly expanded irrigation, the gain may prove temporary as dams silt up, aquifers are depleted, and soils are degraded by accumulating salts from surface sources. Moreover, industrial agriculture is inherently unstable; high-yield crops in monocultures are more susceptible than traditionally farmed crops to pest and crop disease outbreaks and to soil erosion and depletion. While technology compensates for these drawbacks in temperate-zone farm regions, the problems are more serious in the tropics, with no winter cold to kill off pests and diseases, where soils often are thin and poor, and intense tropical rains accelerate erosion and nutrient loss.

Analogous problems have beset forest lands as forests have been removed for timber and pulp, to clear land for agriculture, or replanted in even-aged tree monocultures (with many of the same drawbacks of food crop monocultures). Grazing lands too have been extensively modified, and in many areas desertified, under grazing pressure. As a consequence, significant losses of productivity in agricultural and forest lands from overcultivation, overgrazing, desertification, and deforestation are occurring around the world.[2] Thus, as the human population continues to grow rapidly on entering the twenty-first century, much of the environmental resource base on which it depends is being depleted and degraded. The human takeover of the planet's land surface as well as overexploitation of oceanic resources are leading to losses of biodiversity and impairment of ecosystem services - Nature's services - on which the human enterprise depends for future sustainability.[3] At the same time as this natural capital is being destroyed, global change from the buildup of greenhouse gases resulting mainly from rapid consumption of fossil fuels and deforestation is a further threat to the stability of Earth's life-support systems. In coming decades, largely unpredictable changes in productivity may follow climate change caused by global warming.[4]

Population growth combined with land degradation and other environmental changes, as well as economic factors, can lead to mass migrations, which can themselves engender tensions between groups. Poverty and marginalization interact with these problems and often contribute to further environmental degradation. Marginalization and competition for resources may also be either mitigated or exacerbated by trade and financial arrangements. Marginalized groups who are denied access to resources may resort to conflict if their needs are not adequately addressed by their society, and such dissension may be intensified by ethnic differences. The development of such situations indicates a failure of social institutions to cope with underlying resource problems.

To what extent are all these factors interrelated and how important a role do they play in the generation of conflict? Given that there will be further population growth in this new century and that humanity's resource base is under rising pressure worldwide, might we see an increase in conflicts whose origins are traceable to a local or regional loss of sustainability?

HISTORICAL EXAMPLES

HISTORY shows many instances in which scarce resources and environmental degradation played a role in generating conflict and leading even to collapses of societies and civilizations, some as early as the beginning of written history.[5] Examples include Mesopotamia and parts of the Middle East, the Maya of Central America, the Khmer of Southeast Asia, the Anasazi of the US Southwest, among many others. Environmental degradation can undermine the sustainability of societies in the long term; to ecologists the loss of productivity in areas where civilizations once flourished is painfully apparent.[6] Such long-term degradation can be seen in much of the Mediterranean basin, northeastern Brazil, central and western India and parts of Pakistan, and much of the Middle East.

The history of Easter Island offers a striking example in microcosm of the consequences of overexploiting essential resources, one that was repeated in various forms as Polynesians settled isolated islands and archipelagos throughout the Pacific Ocean.[7] Easter Island was more isolated than most and relatively rich in natural resources. Its Polynesian settlers flourished at first, producing a remarkable culture featuring the giant stone statues for which it is best known. Yet, some 1200 years after the Polynesians first arrived on the island, they had completely deforested it and degraded its natural resources. Native birds, mammals, reptiles, local seafood, and most of the native plants were gradually pushed to extinction through hunting or habitat destruction. The only domestic animals were chickens. The loss of the forest caused springs and streams to dry up and accelerated soil erosion, which reduced crop harvests. With no more wood available to build

canoes, the islanders could no longer fish offshore, let alone depart for greener pastures on other, distant islands. The result was famine and social breakdown that included the formation of rival clans, warfare, and cannibalism. The population had shrunk from a maximum of as many as 20,000 to scarcely 2000 by 1722, when the first Europeans arrived.

It has long been understood that population pressures were part of the impetus leading to western European exploration and colonization of other regions in the world, especially the New World. A scarcity of land was key in this case; changes in rules of inheritance were one indication of the rising pressure. During the centuries following Columbus's of the Americas, not only did thousands and, later, millions leave Europe for the Western Hemisphere, but within Europe itself agricultural practices were intensified, and urbanization increased, especially as manufacturing became more centralized and industrialized. Europe's history is one of almost constant warfare, and control over land and resources was probably a causative factor along with ideological or religious differences, though rarely explicitly so.

In the twentieth century, resource issues again became matters of concern for large and growing continental societies. Hitler appealed to a need for "lebensraum" (living space) as partial justification for his attempt to conquer Europe. At the same time, restricted access to oil and minerals were a cause of Japanese aggression. The result was World War II, the largest, most farflung conflict the world has ever seen. That war caused enormous damage to industrial infrastructure in Europe and Asia and an estimated 60 million deaths.

The second half of the twentieth century was marked by an unprecedented global population expansion (from 2.5 billion in 1950 to 6 billion in 2000), a widening of a technological and wealth gap between industrial and less developed nations, and by the Cold War. The Cold War's principal antagonists were NATO and the Soviet Union, both consortiums of many nations, adversaries primarily in political ideology. The two rival entities never progressed beyond sabre-rattling (albeit with extremely deadly sabres) themselves, but numerous wars and battles were fought by less developed surrogates equipped only with conventional arms. Still, many of the local and regional wars had resource scarcities as well as political differences contributing to their conflicts. The alliances of the combatants with one or the other major power (or sometimes playing them off against each other) often only exacerbated their problems.

THE CHANGING NATURE OF VIOLENT CONFLICT

ALTOGETHER, the twentieth century was the most violent in human history, with armed conflict estimated to have killed more than 100 million people and political violence accounting for an additional 170 million deaths.[8] Hidden within those dismal statistics are some important recent trends that illustrate the changing nature of violent conflict. The total number of violent conflicts around the world has declined slightly since the early post-Cold War period. According to data compiled by the Department of Peace and Conflict Research at Uppsala University, there were 36 armed conflicts in progress during 1998, down from a peak of 55 in 1992.[9] A second important trend is the increasing violence of armed conflict. There has been a steady increase over time in the ratio of civilian to battlefield deaths. Estimates from the late 1990s put the global number of refugees at as many as 35 million, with the majority of these fleeing some form of violent conflict.

One of the most important trends has been the shift away from interstate violent conflicts involving the standing military forces of two or more countries, and toward "internal" or intrastate" war and armed conflict, involving armed factions or contending social groups (sometimes receiving direct or indirect international assistance). Of 108 armed conflicts taking place in the period 1989-1998, only seven were of the interstate variety; of the remaining 101, 92 were intrastate conflicts and nine were intrastate conflicts with foreign intervention.[10] These intrastate conflicts include, but are by no means limited to, "ethnic" or "ethno-national" conflict (which, despite increasing attention in the 1990s, has actually been rising steadily since the end of World War II).[11]

The rise in intrastate conflict cannot be taken simply as turbulence resulting from regime transitions at the end of the Cold War. Most do involve authority struggles as opposed to traditional territorial or geopolitical dimensions; of the thirteen armed conflicts that produced 1000 or more battlefield deaths in 1998, only three could be classified as primarily "territorial" conflicts, while nine were categorized as primarily "governmental" contestations.[12] But authority crises are not limited to the post-Socialist world; more than two-thirds of the violent conflicts of the post-Cold War era have taken place in established states as opposed to states in transition as a result of the collapse of the socialist bloc.[13] Nor can these conflicts be explained simply as the result of longstanding enmity between different ethnic or social groups. According to the Carnegie Commission on Preventing Deadly Conflict:

The words "ethnic," "religious," "tribal," or "factional" - important as they may be in intergroup conflict - do not, in most cases, adequately explain why people use massive violence to achieve their goals. These descriptions do not, of themselves, reveal why people would kill each other over their differences. To label a conflict simply as an ethnic war can lead to misguided policy choices by fostering a wrong impression that ethnic, cultural, or religious differences inevitably result in violent

conflict and that differences therefore must be suppressed.... In the Commission's view, mass violence almost invariably results from the deliberately violent response of determined leaders and their groups to a wide range of social, economic, and political conditions that provide the environment for violent conflict, but usually do not independently spawn violence.[14]

These trends suggest important themes for understanding and responding to problems linking resources and environment to conflict. The trend away from interstate war and toward intrastate violence, as well as the complex character of the latter form of conflict, underscore the importance of moving beyond simple models of resource scarcity and geopolitical rivalry, important though that dynamic may remain. It becomes critically important to pay attention to the relationship between, on the one hand, potential triggering events of environmental degradation or resource scarcity and, on the other hand, such "intervening variables" as pre-existing social, political, or cultural cleavages, regime types, economic circumstances, and the incentives and disincentives elites face regarding the use of violence.

CONFLICTS OVER RESOURCES

THERE are many different ways to categorize the connections between resources and conflicts. Following is one approach that helps clarify these connections, but others can also offer insights. Resources have been military and political goals. Resources have been used as weapons of war. Resources and systems for managing or using resources have been targets of war. And inequities in the distribution, use, and consequences of resources management and use have been sources of tension and dispute.[15]

It is important to note distinctions between the scales at which resource conflicts may occur. Such conflicts can occur at local, subnational, and international levels -- indeed, one of the most important changes in the nature of conflicts over the past several decades has been the growing severity and intensity of local and subnational conflicts and the relative de-emphasis of conflicts at the "superpower" level.

Resources as Military and Political Goals

Where resources are scarce, competition for limited supplies can lead groups, communities, and even nations to see access to resources as a matter of highest concern. This aspect falls into the most traditional Cold War/realpolitik framework where resources can be a defining factor in the wealth and power – and in the economic and political strength – of a nation. In the past, much of the security

literature has focused on energy resources and, to a less extent, mineral resources, as potential sources of tensions and disputes. Access to resources may serve as a focus of dispute or provide a justification for actual conflict. While it may never be the sole reason for conflict, history suggests that it has at times proven to be an important factor.

Four important conditions influence the likelihood that resources will be the object of military or political action:

1. the degree of scarcity;
2. the extent to which the supply is shared by two or more groups;
3. the relative power of those groups; and
4. the ease of access to alternative sources.

Resources are unevenly distributed throughout the world. Known reserves of fossil fuels are concentrated in a few areas. Water resources are unevenly distributed by the natural hydrological cycle, with some regions receiving enormous amounts of rainfall or river flow, while others are extremely dry. Human factors, such as high population densities or intensive industrial development may cause conditions of "relative" scarcity.

The problem of shared resources complicates the problem of scarcity. When a resource base extends across a political border, misunderstandings or lack of agreement about allocations are more likely. Oil was the ostensible cause of the Iraqi-Kuwaiti conflict. Fresh water is very widely shared because political borders rarely coincide with watershed boundaries. At the international level, over 260 river basins are shared by two or more nations.[16] But even countries with few or no internationally shared rivers or aquifers often have internal water disputes among states, ethnic groups, or economic classes trying to gain access to additional water supplies.

If there are great disparities in the economic or military strength of the parties involved, unilateral and inequitable decisions are more likely. A weaker party will rarely provoke or initiate military action - and even more rarely prevail - against a stronger adversary, but if a weaker nation either controls a resource or is dependent on resources from an outside source, disputes and conflicts may occur. The heavy dependence of the industrialized nations on imports of petroleum has always been a source of political and military concern. When adversaries are equally matched economically or militarily, negotiation and cooperation are more common outcomes.[17]

Finally, if there are few technologically or economically attractive alternative sources of supply, the potential for conflict is higher. If an energy or water resource is scarce and shared, but alternative sources exist, such as renewable energy systems, alternative suppliers, other rivers, groundwater aquifers, or even

expensive desalination, conflicts are less likely to occur. There is a high economic, social, and political cost to conflicts; they are likely to be avoided if acceptable substitutes can be found.

History provides a wide range of examples of this kind of conflict in the area of shared water resources. Forty-five hundred years ago, the control of irrigation canals vital to survival was the source of conflict between the states of Umma and Lagash in the ancient Middle East. Twenty-seven hundred years ago, Assurbanipal, King of Assyria from 669 to 626 B.C., seized control of wells as part of his strategic warfare against Arabia. In the modern era, the Jordan River Basin has been the scene of a wide variety of water disputes. In the 1960s, Syria tried to divert the headwaters of the Jordan away from Israel, leading to air strikes against the diversion facilities.[18]The 1967 war in the Middle East resulted in Israel winning control of all of the headwaters of the Jordan as well as the groundwater of the West Bank. In these cases, water was certainly not the sole issue precipitating conflict, but it was an important factor in both pre- and post-1967 border disputes.

Water remains an important factor in the politics of the region. The multilateral and bilateral peace talks conducted in the 1990s, which led to the interim agreement between the Israelis and the Palestinians and to the peace treaty between Israel and Jordan, explicitly included negotiations and agreements on the shared water resources of the Jordan River. Israeli and Syrian concerns over the Banias, which originates in the Golan Heights, remain an important unresolved issue. Jordanian concerns about Syrian dams on the Yarmouk, the major tributary to the Jordan, are still unanswered.

Disputes over the allocation of water occur at the subnational level as well, and have the potential to turn violent. In California in the mid-1920s, farmers repeatedly destroyed an aqueduct taking water from their region to the urban centers of southern California. The governor of Arizona called out the local militia in the 1930s to protest the construction of water diversion facilities on the Colorado River between Arizona and California.[19] That dispute was eventually resolved in court.

Court decisions do not always successfully end disputes. An interim court decision in India to allocate additional waters from the Cauvery River - which originates in the state of Karnataka - to Tamil Nadu actually precipitated violent conflicts resulting in the deaths of over 50 people.[20] In 1997, the World Court issued a decision in the dispute between Hungary and Slovakia over the Gabcikovo-Nagymaros project on the Danube, effectively refusing to decide and returning the dispute to the two parties for more negotiation.[21] As populations continue to grow, regional water scarcity may lead to more frequent examples of this kind of dispute and conflict.

Resources as an Instrument or Tool of Conflict

The usual tools and instruments of war are military weapons. But the use of resources, such as water, as both offensive and defensive weapons has a long history. One of the earliest accounts is an ancient Sumerian myth from 5,000 years ago, which parallels the biblical account of the great flood. In this myth, the Sumerian deity Ea punishes humanity's sins by causing a great flood. In 695 BC, Sennacherib completed the destruction of Babylon by diverting irrigation canals to wash over the ruins of the city. Herodotus wrote in 400 BC about Cyrus the Great's successful invasion of Babylon in 539 BC by diverting the Euphrates River into the desert and entering the city along the dry riverbed. In 1503 Leonardo da Vinci, in one of history's oddest collaborations, worked with Machiavelli on an unsuccessful project to divert the Arno River away from Pisa during the war between Florence and Pisa.[22]

In recent years, newer examples suggest that the use of water as a weapon continues to be considered. North Korea announced plans in 1986 to build a major hydroelectric dam on the Han River upstream of South Korea's capital, Seoul. The project would provide electricity to the North, but is viewed by South Korea as a potential weapon. South Korean hydrologists calculated that the destruction of the dam by the North and the sudden release of the reservoir's contents would destroy most of Seoul. While the project currently remains on hold due to serious political and economic difficulties in North Korea, South Korea has built a series of levees and check dams above Seoul to defend against any such threat.[23]

Another use of a large dam and reservoir as a weapon of war was proposed during the Persian Gulf war. The allied coalition arrayed against Iraq discussed the possibility of using the Ataturk dam in Turkey on the Euphrates River to shut off the flow of water to Iraq, which is highly dependent on flows in the Euphrates for water supply. No formal request to Turkey was ever made, and Turkey subsequently stated that it would never use water as a means of political pressure, but the possibility remains a concern in the region.[24] Both Syria and Iraq continue to have an ongoing dispute with Turkey over the operation of Ataturk and the level and quality of flows in the Euphrates reaching both downstream countries.

In 1997, a fresh dispute arose between Singapore and Malaysia. Singapore has never been self-sufficient in water because of its high population density and small size, and it depends on piped water from Malaysia for nearly half of all its needs.[25] In addition, Singapore imports water from Malaysia that it then treats and sells back under an agreement signed in 1965.[26] Relations between the two countries have long been clouded by economic competition, and religious, political, and ethnic differences that have flared periodically since their separation in 1965. In early 1997, these relations soured again after comments were exchanged by senior politicians about mutual concerns, leading to Ahmed Zamid Hamidi, the head of the youth wing of Malaysia's ruling party urging the government to review the basis of water agreements with Singapore.[27] Chief Minister of Johor state in Malaysia went further, suggesting that they appropriate

two of the three water-purification plants operated by Singapore in Johor.[28] (Jayasankaran and Hiebert 1997). Singapore is clearly worried that Malaysia might use water as a political and strategic weapon against Singapore - a point made to Malaysian Prime Minister Mahathir Mohamad by Singapore's Prime Minister Goh Chok Tong: "an agreement by Malaysia to meet Singapore's long-term water needs beyond the life of the present water agreements would remove the perception in Singapore that water may be used as a leverage against Singapore."[29] Singapore has also launched a campaign to increase water supplies and to reduce consumption through an aggressive conservation program. Among their supply plans are new desalination plants that would produce water at about eight times the cost of current supplies.[30]

Resource Systems as Targets of Conflict

Where resources and resource-supply systems have economic, political, or military importance, they become targets during wars or conflicts. The city of Babylon in ancient times was often a subject for conquest, and around 720 BC Sargon of Assyria destroyed the irrigation systems of the Haldians of Armenia. In modern times, energy plants, dams, and hydroelectric facilities have regularly been bombed as strategic targets. The United States targeted irrigation levees in North Vietnam. Syria tried to destroy Israel's National Water Carrier while it was under construction in the 1950s. The Persian Gulf war saw several examples of this problem: the Iraqis intentionally destroyed the oil-production system and water desalination plants in Kuwait and in turn suffered from the destruction of their energy- and water-supply systems by the allied forces assembled to liberate Kuwait. In February 2000, for tactical or strategic reasons that are not entirely clear, Israel destroyed three power plants in southern Lebanon in response to attacks on northern Israel from members of Hezbollah.[31]

Inequities in Resource Distribution, Use, and Development

Tensions and conflicts may also result from such indirect factors as the inequitable distribution, use, and development of resources. Energy, water, food, minerals, and other resources are shared by two or more nations, unevenly distributed, or inequitably used. Water provides a good example. Approximately half the land area of the world, and perhaps 70 percent of the inhabitable land area, is in an international watershed, where river flows or lakes are shared.[32] These include the Nile, Jordan, Tigris, Euphrates, and Orontes rivers in the Middle East, the Indus, Mekong, Ganges, and Brahmaputra rivers in Asia, the Great Lakes, and the Colorado, Rio Grande, Amazon, and Paraná rivers in the Americas, and Lake Chad and the Congo, Zambezi, Lake Chad, the Niger, Senegal, Okavango, and Orange rivers in Africa, to name only a few. This geographical fact has led to the geopolitical reality of disputes over the uneven distribution of shared waters.

Equally uneven is the level of water use. Many industrialized nations and nations with extensive irrigated agriculture withdraw more than 1,500 cubic meters of water per person annually for all uses. At the other extreme, nations with limited supplies or low levels of economic development may use fewer than 100 cubic meters per person per year. Table 1 lists the fifteen countries that use the most water per capita and the fifteen countries that use the least. A low level of water use has direct and undesirable human consequences, including adverse impacts on health, the inability to grow sufficient food for local populations, and constraints on industrial and commercial activities. In all fifteen countries with low levels in Table 1, domestic water use falls below the basic water requirement of 50 liters per person per day.

One of the most important water constraints facing many regions is insufficient water to grow food. Sandra Postel suggests that, as annual water availability drops below 1,700 cubic meters per person, domestic food self-sufficiency becomes almost impossible and countries must begin to import water in the form of grain.[33] Table 2 lists countries where annual renewable water supplies are below 1,700 cubic meters per person per year, in many cases less than half that amount. The number of countries in this category will continue to rise with population growth, and overall dependence on grain imports will deepen and spread. Food insecurity is a political concern and can lead to economic weakness and other regional problems.

Finally, there are often adverse consequences of water development and use, and people who do not receive the benefits from water projects may feel these consequences. Examples include contamination of downstream water supplies or groundwater aquifers, dislocation of people because of dam construction, and the destruction of fishery resources that support local populations.

What is the connection between these issues and conflict? For the most part, inequities will lead to poverty, shortened lives, and misery, but perhaps not to direct conflict. But in some cases, they will increase local, regional, or international disputes, create refugees that cross or try to cross borders, and decrease the ability of a nation or society to resist economic and military aggression.[34] Even local governments may experience unrest and controversy over equity-related issues. In February 2000, one person was killed and over 30 hospitalized in Bolivia when public protests over water privatization and increased costs of service were met by 1000 police and army units.[35]

SCHOLARLY RESEARCH ON ENVIRONMENTAL CHANGE AND VIOLENT CONFLICT

THE question of whether and how environmental change leads to violent conflict has received a great deal of scholarly attention in recent years. There is no question that environmental concerns can trigger protests and social conflicts with the potential to turn violent. In South and Southeast Asia, the spread of shrimp aquaculture with its devastating impact on coastal mangrove forests has provoked increasingly violent clashes between shrimp farmers and those whose livelihoods depend on the forests. The forced resettlement of local communities to make way for large dams has provoked mounting resistance around the world, sometimes leading to violent clashes between local authorities and affected peoples. In settings as diverse as Amazonia, Indonesia, and the Pacific coast of the United States and Canada, forest disputes have led to tense confrontations among different stakeholders and between forest peoples and state authorities, occasionally with violent results.

Some scholars have seen in these recurring episodes of low-grade, localized violence the emergence of a new form of conflict, which might be termed environmentally-induced violent conflict. Research on environmentally-induced violent conflict has proceeded in stages: a first wave of comparative case-study projects theorizing about the causal pathways linking environment and violent conflict and assembling evidence that the environment has played a role in several cases; quantitative studies seeking to test whether the observations of these cases can be generalized; and second-generation case studies paying more attention to the political, economic, and social conditions that cause the potential for environmentally induced violent conflict to become actual outcomes of violence.

First Generation Case Studies

Probably the most influential and widely cited research on environmentally induced violent conflict is the work of the Project on Environment, Population, and Security of the University of Toronto, led by Dr. Thomas Homer-Dixon.[36] This work has identified cases in which natural resource depletion, ecosystem disruption, and other forms of environmental degradation appear to be linked to various types of intergroup conflict. According to Homer-Dixon:

Decreases in the quality and quantity of renewable resources, population growth, and unequal resource access act singly or in various combinations to increase the scarcity, for certain population groups, of cropland, water, forests, and fish. This can reduce economic productivity, both for the local groups experiencing the scarcity and for the larger regional and national economies. The affected people may migrate or be expelled to new lands. Migrating groups often trigger ethnic conflicts when they move to new areas, while decreases in wealth can cause deprivation conflicts such as insurgency and rural rebellion. In developing countries, the migrations and productivity losses may eventually weaken the state

which in turn decreases central control over ethnic rivalries and increases opportunities for insurgents and elites challenging state authority.[37]

To examine these propositions, the project undertook detailed case studies of environmental change and violence in five cases: Gaza, Haiti, Pakistan, Rwanda, and South Africa. Among its principal findings:

1. Under certain circumstances, scarcities of renewable resources such as cropland, fresh water, and forests produce civil violence and instability. However, the role of this "environmental scarcity" is often obscure. Environmental scarcity acts mainly by generating intermediate social effects, such as poverty and migrations, that analysts often interpret as the conflict's immediate causes.
2. Environmental scarcity is caused by the degradation and depletion of renewable resources, the increased demand for these resources, and/or their unequal distribution. These three sources of scarcity often interact and reinforce one another.
3. Environmental scarcity often encourages powerful groups to capture valuable environmental resources and prompts marginal groups to migrate to ecologically sensitive areas. These two processes - called "resource capture" and "ecological marginalization" - in turn reinforce environmental scarcity and raise the potential for social instability.
4. Societies can adapt to environmental scarcity either by using their indigenous environmental resources more efficiently or by decoupling from their dependence on these resources. In either case, the capacity to adapt depends upon the supply of social and technical "ingenuity" available in the society.
5. If social and economic adaptation is unsuccessful, environmental scarcity constrains economic development and contributes to migrations.
6. In the absence of adaptation, environmental scarcity sharpens existing distinctions among social groups.
7. In the absence of adaptation, environmental scarcity weakens states.
8. The intermediate social effects of environmental scarcity - including constrained economic productivity, population movements, social segmentation, and weakening of states - can in turn cause ethnic conflicts, insurgencies, and coups d'etat.
9. Environmental scarcity rarely contributes directly to interstate conflict.
10. Conflicts generated in part by environmental scarcity can have significant indirect effects on the international community.

Another major research project involving comparative case studies is the Environment and Conflict Project (ENCOP) of the Swiss Federal Institute of Technology, Zurich and the Swiss Peace Foundation. This project theorized a different pathway to environmentally-induced violent conflict. Rather than emphasizing ecological and social processes of scarcity, as the Toronto researchers

have done, the emphasis in this work has been on processes of underdevelopment and social changes linked to marginalization and discrimination in access to resources and resource use.[38] They also deployed a different set of cases to test their core propositions (Bangladesh, Central Asia, Rwanda, Middle East, Sudan, Nigeria). Nevertheless, the conclusions reached were broadly similar: Environmental degradation sets in motion or interacts with social changes that can lead to or contribute to violent conflict. According to project director Günther Baechler:

Developing and transitional societies or, more precisely expressed, marginalized areas in these countries are affected by an interplay among environmental degradation, social erosion and violence that intensifies crises. Crisis areas prone to conflict are found in arid and semi-arid ecoregions, in mountain areas with highland-lowland interaction, areas with river basins sub-divided by state boundaries, zones degraded by mining and dams, in the tropical forest belt, and around expanding urban centers. Historically situated, culturally bound societal relationships to nature are subjected to upheaval and put acutely at risk in subregions of Africa, Latin America, Central and Southeast Asia and Oceania.[39]

Critics of research on environmentally induced violent conflict have pointed to the difficulties of showing a direct causal link between environmental change and violence. In settings such as Chiapas, Rwanda, or apartheid-era South Africa, it is not clear that environmental change is the key variable in the violence that resulted, as opposed to merely being associated with violence caused by social injustice, inequality, or unequal power relations. The models in both projects involve long causal changes with many intervening social variables, making it difficult to establish a direct linkage between environmental change and violence. Critics have also argued that there is a problem of case-selection bias in this work. Rather than choosing cases in which comparable environmental stresses are present and then asking why some yield violent outcomes while others do not, the approach has been to choose cases with violent outcomes and then search upstream for environmental causes of the violence. This may be a useful way to generate hypotheses or identify potential causal pathways, but it says little about the likelihood of violent outcomes in any given case; the handful of cases given careful treatment may be exceptions or involve special circumstances.

Quantitative Studies

In principle, quantitative studies offer a useful way to test the merits of these criticisms, because they make it possible to test very large numbers of cases and to control for other potential causes of conflict. In practice, the quantitative approach is plagued by problems of data quality and causal inference. Studies tend to be based on fragmentary and incomplete environmental data which may not be comparable across different societies. There is little choice but to use national-aggregate data, which masks the internal variations and inequalities that case-study

research suggests are of central importance. Key social and political variables such as "state capacity" are difficult to capture with off-the-shelf quantitative indicators. And quantitative analysis alone sheds no light on why certain relationships may appear in the data. For example, is the level of economic development significant because the more affluent countries of the OECD may have better social mechanisms of conflict resolution, as much of the case-study literature presumes? Or, given the extensive ecological shadows cast by the high-throughput societies of the West and the outsourcing of large segments of their extractive and manufacturing sectors, does part of the explanation lie in their ability to export problems of scarcity and environmental degradation to the global South?

One effort to test propositions linking environmental degradation and violent conflict is the work of Hauge and Ellingsen, which was published in *Journal of Peace Research* in 1998.[40] Their findings provided some support for theses of environmentally-induced violence. They found a positive effect of environmental degradation on conflict, particularly at lower levels of violence. However, the effect was not as strong as that of either the level of economic development or regime type. One way to interpret these results is that environmental change can be associated with violent outcomes, but that these effects are mediated by fundamental economic and political conditions in society.

A project illustrating both the usefulness and limitations of the quantitative approach is the work of the State Failure Task Force. Organized at the instigation of U.S. Vice President Gore and funded by the Central Intelligence Agency, the goal of this research was to test a wide array of economic, social, and political variables that might be associated with "state failure."[41] (State failure is not synonymous with violent conflict, but rather refers to certain extreme forms of violence, including revolutionary war, ethnic war, adverse or disruptive regime changes, and genocide.) The study tested the explanatory power of 75 different social, political, and economic variables for the set of 113 state failures occurring between 1957 and 1996 (as well as a randomly selected control group of non-failures during the same time period). In other words, the goal was to develop a model that could accurately identify cases of both state failure and non-failure. Examples of the variables tested include economic growth rate, type of governmental regime, the availability of arable land, openness to international trade, urbanization rate, the structure of the economy, and quality of life indicators such as literacy and infant mortality. Indicators of environmental degradation tested included deforestation, soil degradation, change in agricultural land, freshwater access, sulfur dioxide emissions, the fraction of available freshwater withdrawn, and population density.

The study found no direct relationship between environmental degradation and state failure. Among the indicators tested, the best model for predicting state failure involved three variables: infant mortality, openness to international trade, and the level of democracy. (The model employing these three variables allowed

correct classification for two-thirds of the episodes in the study). The study did, however, find two potentially indirect connections between the environment and state failure. First, a strong link was found between environmental degradation and infant mortality. The researchers took the link between infant mortality and state failure as evidence of a "quality of life" effect. If so, then the strong correlation between environmental degradation and infant mortality suggests that one pathway from environmental degradation to violent outcomes is through effects on the quality of life. Second, the researchers also tested the two environmental indicators for which they felt they had the best data (deforestation and soil degradation) in a more complex model that incorporated measures of state vulnerability and state capacity. In this model, they found a statistically significant effect for one of these two environmental indicators (deforestation). In other words, for a given level of state vulnerability and state capacity, a higher deforestation rate meant a greater likelihood of state failure. This finding was interpreted to mean that the problem is not environmental change per se, but rather environmental change in the context of high vulnerability and a low capacity to respond.

Keeping in mind the limitations of the quantitative approach, the message of this work appears to be that the key is not simply to look at the presence of environmental stresses but rather at social institutions such as those related to governance, property rights, conflict resolution, political culture, and the legitimacy of authority.

Second Generation Case Studies

More recently, a wave of "second-generation" case-study projects has begun to appear. A study at the International Peace Research Institute, Oslo (PRIO) contrasts violent and nonviolent outcomes among cases selected for similarly high levels of environmental degradation (using soil erosion data as the key indicator of environmental stress).[42] The set of cases (Bangladesh, Guatemala, Haiti, Madagascar, the Philippines, Rwanda, Senegal and Tunisia) share similar environmental stresses, but involve societies at varying levels of economic development, and have produced both violent and nonviolent outcomes. Swiss researchers have launched follow-up studies to the ENCOP project, stressing the management of environmental conflicts in the Horn of Africa and the Nile River Basin.[43] A follow-up study on "Environmental Scarcities, State Capacity, and Civil Violence" is also underway at the University of Toronto. The focus of this work, which includes detailed case studies of China, India, and Indonesia, is on societal responses to ecological stress.[44] The hope is that this next generation of research will shed light not simply on whether environmental degradation plays a role or what the pathway to violence might be, but also on the circumstances in which those potential pathways actually lead to violent outcomes.

TRANSNATIONAL ENVIRONMENTAL LINKAGES

HISTORICALLY, concern over links between resources, environment, and violent conflict have focused mainly on critical natural resources for industrial growth and state power – oil, strategic minerals, agricultural land, and in some cases, fresh water. Of particular concern here are shared resources such as fisheries and river basins. There have been several episodes of international tension over fishing disputes in recent years, for example. More recently, scholars have emphasized dangers resulting not from struggles over resources but rather from problems related to environmental quality and environmental degradation. Again, perhaps the most obvious such dangers exist in circumstances of direct transboundary linkages, as in the case of international river basins, regional airsheds, cross-border toxic dumping, or Chernobyl-style regional nuclear hazards.

However, the potential for conflict results not simply from the immediate, physical character of ecological interdependence as in the case of a shared river basin, but also from the social dimensions of global interconnectedness. In a world that is increasingly tightly coupled socially and economically as well as ecologically, even the most localized forms of environmental degradation or resource scarcity must be thought of as potential triggers for violent conflict. As people, money, goods, symbols, and ideas move across borders with ever greater speed and frequency, both the causes and consequences of 'localized' environmental damage become increasingly transnationalized.

Consider the problem of soil degradation (a catch-all concept that includes erosion, salinization, compaction, nutrient depletion, and other negative impacts on soils). In globally cumulative terms, the problem is immense, encompassing more than a third of the world's croplands. In purely physical terms, soil degradation manifests itself on the localized scale of specific watersheds and landscapes; the primary culprits are the use and abuse of agricultural practices (such as irrigation, mechanical tilling, intensive cropping, and modern agrochemicals) as well as deforestation. But the tendency to view the problem as a local one, and thus a lesser concern as a trigger for large-scale violent conflict, ignores the powerful transnational economic, political, and social forces that contribute directly to soil degradation. Damaging practices are often the result of pressures to service external debt and boost exports via cash-crop monocultures, and are often facilitated by international development assistance. Many of the social effects of soil degradation also transcend the local. According to one estimate, soil degradation between 1945 and 1990 reduced potential world food production by roughly 17 percent, putting upward pressure on world food prices and exacerbating national-scale food insecurity.[45] Threatened livelihoods and undermined communities can generate border-crossing environmental refugees. These social reverberations of ecological change are felt far from the point of soil degradation, and with increasing force.

FROM ENVIRONMENTAL CONFLICT TO ENVIRONMENTAL PEACE MAKING

T HE argument and focus of debate over concepts of "environment and security" has now shifted from "whether" there is a connection to "when," "where," and "how" environmental and resource problems may affect regional and international security. There is a long way to go before nations or regions produce a common policy agenda or set of initiatives that truly incorporate environmental and resources issues into approaches to reduce the risk of regional and national conflicts. Nevertheless, construction has begun on a new framework that will permit scholars and policymakers to apply new tools, set new priorities, and organize responses to a range of environmental threats to peace and security.

This framework is particularly well developed in the area of water resources. In the past several years, considerable progress has been made both in understanding the nature of the connections between water resources and conflict and in evaluating regional cases where such connections may be particularly strong.[46] There has also been progress in trying to identify policies and principles for reducing the risks that disputes over freshwater sources will lead to conflict, as well as in better understanding mechanisms for promoting cooperation and collaboration over shared freshwater resources.

Progress here has been more than academic. In October 1994, for example, Israel and Jordan signed a peace treaty that explicitly addressed water allocations, sharing of water information, and joint management policies for the Jordan River Basin. In 1996, India and Bangladesh signed a formal treaty that moves toward resolving their long-standing dispute over the Farraka Barrage and flows in the Ganges/Brahmaputra system. In 1997 the International Law Commission, after nearly three decades of negotiations, drafting, and discussion, finalized the Convention on the Non-Navigational Uses of Shared International Watercourses.[47] And countries like Brazil, South Africa, and Zimbabwe are incorporating mechanisms and principles for resolving conflicts over shared waters in their new water laws.

Environmental degradation presents more difficult and complex problems than the resolution of disputes over resources, however. Yet, if environmental degradation can trigger violent conflict, it stands to reason that environmental cooperation becomes a critically important tool in forestalling such conflicts. It may also be the case that environmental cooperation has broader value for peace, in the sense of being an effective catalyst for reducing tensions, broadening cooperation, fostering demilitarization, and promoting peaceful norms of dispute resolution. Such claims are difficult to test empirically; the spread of environmental and other forms of

international cooperation in recent decades and the rise of peaceful norms of dispute resolution may or may not be related, and the relationship may be one of cause or effect. In other words, it may be that environmental cooperation helps to build peace – but it could just as easily be that peace is a *prerequisite* for environmental cooperation, not a result.

Despite the difficulty of showing an empirical connection, there is a good deductive foundation for the idea that environmental collaboration can promote broader forms of peaceful cooperation. Environmental cooperation may provide opportunities to change aspects of the "contractual environment" identified as important by cooperation theorists. Several avenues are possible here. First, the technical complexity of many environmental problems creates opportunities for joint efforts to extend knowledge, reduce uncertainty, and refine understandings of underlying causal mechanisms. Such cooperative knowledge-based ventures could have the effect of breaking down mistrust or suspicion of strategic motives behind environmental concerns.[48] Second, the creeping, incremental, and non-linear character of environmental degradation might be used to draw governments into seeing a longer "shadow of the future," raising the perceived value of cooperation as longer-term costs and benefits are taken into account. Third, because environmental cooperation often takes the form of a joint investment promising future gains, it may make governments more comfortable with more diffuse forms of reciprocity (as opposed to demanding an immediate *quid pro quo* for any actions taken).

None of this is to suggest that cooperation in environmental or resource management is easy, will occur automatically, or will inevitably have the effect of pushing governments towards peaceful cooperation. But it does suggest that environmental problems may have useful properties that can be exploited as part of broader peace-making initiatives. This is particularly likely at a time when governments in so many different world regions - from post-Soviet Central Europe to post-apartheid Southern Africa to post-revolutionary Central America - are already groping their way toward new understandings of security and cooperation.

Clearly, however, it is not enough to render states less wary and suspicious of one another, important though that task may be. Beyond tweaking the incentives governments and other actors perceive in the direction of peaceful interactions, peace demands the broader transformation of existing institutions and practices, particularly those that reproduce the zero-sum logic of the national security state. An international system based on anarchy is not an immutable property of global human affairs but rather, to quote Alexander Wendt, "what states make of it."[49] What they have made of it, far too often, is a domain of violence and insecurity that becomes a self-fulfilling prophecy in interstate relations and a justification for violence and repression in the domestic sphere. The challenge is thus to transform institutions of governance and forge healthier, cooperative trans-societal relationships.

Here too, environmental cooperation may have an important role to play: incorporating norms of peaceful dispute resolution, softening understandings of sovereign prerogatives to also include notions of sovereign responsibility, stimulating an increasingly robust global civil society, and drawing closed institutions into processes of informational exchange, greater transparency, and performance-based accountability. Again, not all forms of environmental cooperation have these effects. But it suggests once again that environmental cooperation may be well positioned to generate positive spin-offs for peace.

Skeptics might suggest that the very problems targeted by this notion of environmental peace making - suspicion, mistrust, uncertainty, short planning horizons, and a zero-sum logic of traditional security thinking - are likely to prevent peace-enhancing forms of environmental collaboration from getting off the ground. The rejoinder to this pessimistic view is the enormity of the stakes. Environmental problems may be the first genuinely global test case in which the stakes are high enough and the logic of cooperation strong enough to promote the sort of positive, cooperative spillover envisioned by global-governance advocates since the end of World War II.

Table 1: **Countries with the Largest and Smallest Reported Per-capita Water Withdrawals** [a]

(a) These data include only reported water use. Data on rainfall used in agriculture and unreported water use are not available.
(b) These numbers are reported by FAO but may be in error.

Country	Withdrawals (m³/p/yr)	Country	Withdrawals (m³/p/yr)
Congo, DR (formerly Zaire)	9	Suriname	1,181
Bhutan	15	Pakistan	1,277
Guinea-Bissau	17	Australia	1,306
Solomon Islands	18	Bulgaria	1,600
Comoros	18	Chile	1,625
Burundi	20	Madagascar	1,638
Congo	20	Korea DPR	1,649
Uganda	20	Afghanistan	1,702

Country	Withdrawals (m³/p/yr)	Country	Withdrawals (m³/p/yr)
Papua New Guinea	25	Canada	1,752
Central African Rep.	26	Tajikistan	2,065
Benin	28	United States of America	2,162
Togo	28	Iraq	2,367
Gambia	29	Kyrgyzstan	2,527
Cameroon	31	Turkmenistan	6,346 [b]
Equatorial Guinea	31	Guyana	7,616 [b]
Lesotho	31		

Table 2: **Countries with Per-Capita Water Availability Below 1,700 m³/p/year (as of the mid-1990s)**

Countries with less than 1,700 cubic meters per person per year will be unable to maintain full domestic food self-sufficiency reliably.

Country	Per-capita water availability m³/p/year
Kuwait	10
Malta	46
United Arab Emirates	94
Libya	132
Qatar	143
Saudi Arabia	170
Jordan	219
Singapore	221

Country	Per-capita water availability m³/p/year
Bahrain	223
Yemen Dem Rep	350
Israel	467
Tunisia	504
Algeria	573
Oman	657
Burundi	658
Djibouti	732
Cape Verde	811
Rwanda	870
Morocco	1,197
Kenya	1,257
Belgium	1,269
Cyprus	1,286
South Africa	1,417
Poland	1,463
Korea Rep	1,542
Egypt	1,656
Haiti	1,690

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