3

Environmental Problems Confronting APEC's Members

From Santiago to Seoul, Manila to Mexico City, Bangkok to Beijing, the environmental problems of the Asia Pacific are legion.[1] Across the region, the environmental consequences of economic success—blackened skies, fouled water, sterile land, ravaged forests, depleted fisheries, and destroyed ecosystems—indisputably impose public health and ecological costs, representing real social welfare losses that must be offset against the material gains from economic growth.

Various studies have attempted to estimate the economic costs of environmental harms. Smil (1996) puts the annual economic losses from general environmental degradation and pollution in China—including losses caused by deforestation, degraded land, and destruction of wetlands, as well as health and productivity losses caused by pollution in cities—at between 5.5 and 9.8 percent of GNP. The Chinese Academy of Social Science (Smil 1996) similarly estimates economic losses on the order of 8.5 percent of GNP, or in excess of $30 billion annually. Other studies have found that the economywide costs of environmental harms amount to 3.3 percent of GNP in Mexico and 4.5 percent in India, a potential APEC member (Brandon and Homman 1995). Estimates place the economic costs of particulate and lead pollution in Jakarta alone at 2 percent of Indonesia's

1. Recent reports from APEC countries highlight the severity of environmental degradation across the region. Taiwan's Environmental Protection Agency recently reported, for example, that its environmental ''misery index'' was on the rise (Central News Agency [Taiwan], 17 April 1997), and the Philippines Department of Environment and Natural Resources concluded that the Philippines' environment was in a dismal state (*Straits Times*, 8 June 1997).

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GNP (Ostro 1994; DeShazo 1996), with similar appraisals for Thailand (O'Connor 1994). Costs of this magnitude show that the environmental consequences of economic growth can be significant. Indeed, unless efforts are made to curb these losses, the net effect of development on social welfare, defined broadly, may not always be positive.[2]

Environmental Harms across the APEC Region

Serious environmental degradation and resource depletion are already apparent in many parts of the Asia Pacific. But the visible harms tell only half the story. Because environmental injuries often do not appear until conditions become crowded or certain thresholds have been exceeded, the continuation of current developmental, demographic, and behavioral trends means that further problems will likely emerge and threaten APEC's citizens and environment over time.

The APEC countries thus face a dual environmental challenge. They must attend to their existing set of pollution and resource problems so as to minimize the public health and ecological losses they are already experiencing.[3] And, at the same time, they need to find ways to forecast and mitigate the harms that will emerge as growth proceeds, new patterns of economic activity unfold, and critical thresholds are surpassed.

Land Degradation

In many APEC nations large populations eke out a living from a limited supply of productive land. High population densities in Asian countries—only 0.3 hectares of agricultural land per capita, compared with 1.6 hectares per person in the rest of the developing world and 1.4 hectares per person in OECD countries (ADB 1997, 206)—mean that even under ideal conditions, it would be difficult to produce enough sustenance. And conditions throughout the region are far from ideal. The agricultural productivity of large areas has fallen and some previously productive tracts of land have been rendered completely sterile. Soil degradation problems range from modest in some countries, such as the United States and Canada,

2. Standard economic theory teaches that if there are two distortions (e.g., trade restrictions and environmental externalities) in the global economy, the net effect on global welfare of reducing only one (e.g., trade restrictions, through liberalization) may not be positive (K. Anderson 1996; Daly 1993).

3. Actually, the goal should be to reduce the harms to *optimal* levels, at which further expenditure on pollution prevention or control would exceed the benefits to be obtained.

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Table 3.1 Estimated extent of degraded land in selected APEC countries

Country	Total land (millions ha)	Degraded land (millions ha)	Percentage of total land
China	932.6	280.0	30
Indonesia	181.2	43.0	24
Philippines	29.8	5.0	17
Thailand	51.1	17.2	34
Vietnam	32.5	10.9	34

Source: Dent 1989.

to critical in nations such as China, Thailand, and Vietnam,[4] where, as table 3.1 shows, a third or more of the total land area is degraded.

Land productivity may fall for a number of reasons. In some cases, soil is exposed to wind or water erosion by deforestation, removal of vegetation, or other human activities. In other cases, poorly managed agricultural and industrial practices cause contamination and deterioration of the soil by physical and chemical means. About a third of the total land loss in the Asia Pacific region can be attributed to overgrazing by livestock (Oldeman, Hakkeling, and Sombrock 1990). Poor irrigation practices also account for a significant percentage of land degradation in the Asian region as a whole, resulting in widespread salinization (ADB 1997, 207).

Land degradation has many socioeconomic, public health, and ecological effects. Land degradation exacerbates poverty in many developing economies among communities that are poorly equipped to earn their livelihoods outside agriculture. Land degradation and conversion—in combination with population growth, rising incomes, and an attendant increase in caloric intake and changes in dietary structure (R. Johnson 1997)—are generating large requirements for investment in agricultural research to avoid increases in food prices and pressure on living standards for many poor people. In China, for example, despite strong growth in agricultural yields through the application of better technology and capital investments, grain prices have risen in recent years from well below to somewhat above world prices (Garnaut, Cai, and Huang 1996). Of course, as APEC countries become more integrated into the world economy, they will be able to import increasing amounts of food. Nevertheless, the pressure on a limited supply of land argues for care in managing this scarce resource.

In addition to creating problems relating to the distributional aspects of food supply, land degradation can lead to siltation of canals, reservoirs, and drainage systems across the region, resulting in greater maintenance

4. While not yet an APEC member, Vietnam is expected to be one of the first nations admitted when membership restrictions are lifted.

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Table 3.2 Deforestation in selected APEC countries

Country	Total forest area (1,000 ha) (1990)	Annual deforestation 1981-90		Total area deforested 1981-90 (percentages)
		Area (1,000 ha)	Rate (percentages)	
Indonesia	109,549	1,212	1.1	11
Thailand	12,735	515	4.0	34
Malaysia	17,583	396	2.0	18
Philippines	7,831	316	4.0	34
Vietnam	8,312	137	1.6	15
Papua New Guinea	3,600	113	0.3	3

Source: FAO 1993.

costs and shorter operational life of water projects. Land degradation also results in declining incomes for agricultural populations, increased frequency of natural disasters like floods and landslides, and habitat destruction that translates into a loss of biodiversity (UNESCAP 1995, 17).

Deforestation

There has been a dramatic loss of forest cover in many APEC countries over the past four decades. In fact, Southeast Asia has the dubious honor of having the fastest rate of deforestation in the world, estimated at a 1.2 percent loss per year (FAO 1993). APEC countries also have the fastest rates of commercial logging, the highest volume of fuelwood removal, and the fastest rates of forest species extinction (UNESCAP 1995). As table 3.2 shows, in the period between 1981 and 1990, deforestation claimed more than a third of the forest area in Thailand and the Philippines. While the proportion of total forest cover lost in Indonesia and Malaysia was lower, high absolute levels of deforestation have been apparent. The UN Food and Agriculture Organization (FAO) (1994a) recently concluded that the Philippines, Vietnam, Malaysia, Thailand, and China have all exceeded or nearly exceeded the limits of forest sustainability.

Land clearing for mining and agricultural purposes, commercial logging and timber cutting for fuelwood, livestock grazing, and the construction of roads and dams represent the primary sources of deforestation in the APEC region. In Indonesia and Malaysia, for example, there has been large-scale clearing of forests for rubber plantations. In China, forests have been cleared to support expanded tea cultivation (UNEP/GEMS 1993).

Logging and the sale of forest products provide substantial employment and export revenues in many APEC countries. The Philippines, Malaysia, and Indonesia, for example, are major exporters of timber, with combined exports of $3.1 billion in 1995 (United Nations, *1995 International Trade Statistics Yearbook*). While the United States remains the world's largest

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exporter of logs, it has undertaken major replanting efforts (CEQ 1995).[5] Australia, Canada, and China are also engaged in major reforestation efforts.

Deforestation often causes grave ecological harm. Indiscriminate tree cutting results in hydrological disturbances that can cause inland water problems such as low stream flow and deterioration of water quality. A loss of ground cover also creates greater risk of soil erosion and desertification. Shrinking forests further exacerbate the problem of climate change by diminishing the stock of plant life that can absorb carbon dioxide from the atmosphere and thus partially offset the accumulation of greenhouse gases. Destruction of forest habitat also threatens forest species and can lead to a loss of biological diversity. The FAO estimates that plant species are lost at a rate of 1.0 to 4.3 percent per year because of tropical deforestation (FAO 1993).

Water Pollution and Scarcity

Many of APEC's Asian members suffer from severe problems of water quality and quantity. Pathogens and organic materials, emitted into local streams and rivers with the dumping of untreated sewage, create health hazards ranging from mild intestinal distress to life-threatening outbreaks of cholera. In Bangkok, for example, 10,000 metric tons of raw sewage flow into local rivers every day. As a result, fecal coliform levels in Bangkok sometimes rise to levels thousands of times higher than the World Health Organization (WHO) recommend for safe drinking and bathing water (UNESCAP 1995, 95). In South Korea, as recently as 1991, only a third of municipal wastewater went to sewage treatment plants (Ministry of Environment 1993).

Across APEC, solid and toxic wastes from the industrial, agricultural, and domestic sectors have caused further deterioration of surface water and groundwater quality. In Indonesia, for instance, concentrations of chromium, mercury, and cadmium exceed by more than a hundredfold the allowable limit set by the WHO (IIED 1994), reducing agricultural productivity and destroying fisheries as well as lake and river habitats.

Apart from contaminating water supplies, poor sanitary conditions make for greater exposure to pathogens in everyday life. Epidemics spread more easily and disease becomes commonplace—reducing the length and quality of life for millions and negatively affecting labor productivity. Various epidemiological studies have shown that improved sanitation facilities can cut back on the incidence of feces-borne diseases by more than 20 percent (Esrey et al. 1990). As figure 3.1 shows, the lack of access

5. In the United States, while the decline of primary growth forest remains a problem, timber growth (in secondary forest plantations) actually outstrips timber removal.

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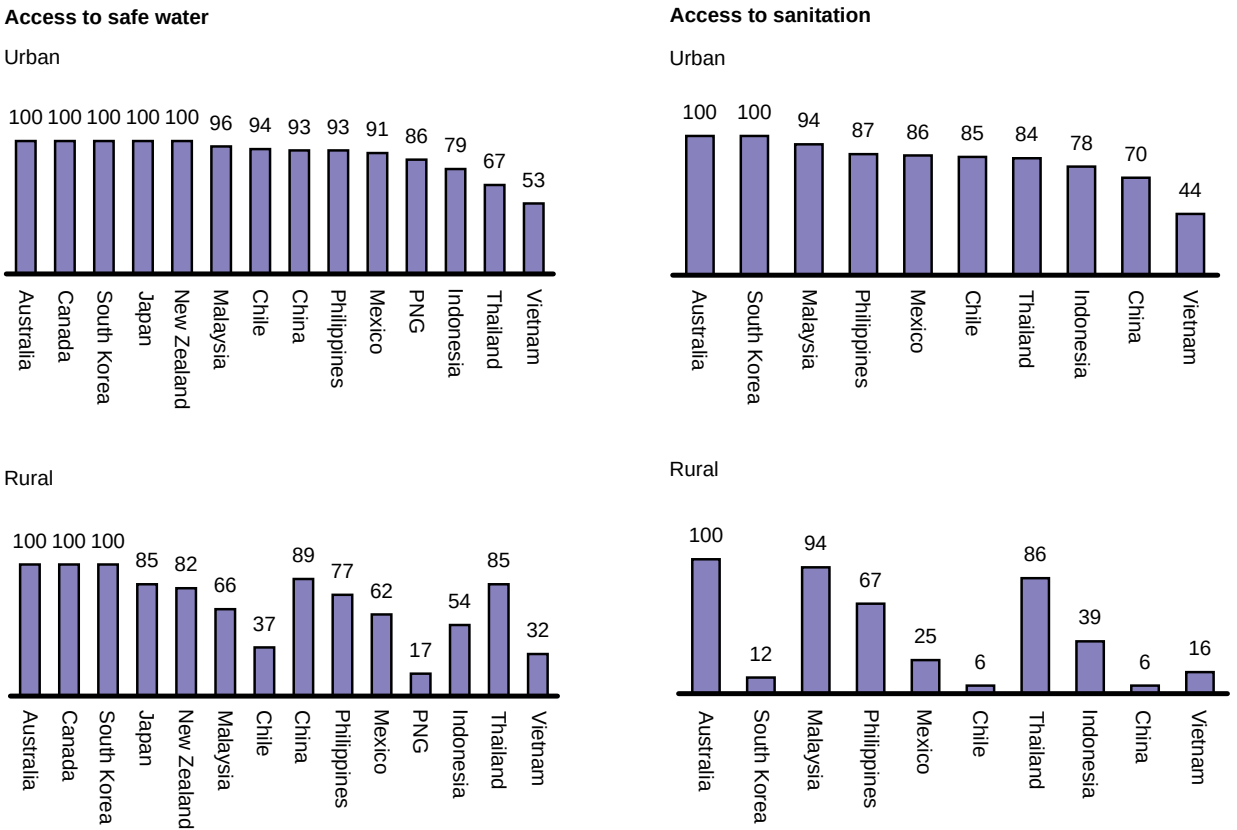
Figure 3.1 Population with access to safe drinking water and sanitation services in selected APEC countries, 1980-95 (percentage)



Note: PNG is the abbreviation for Papua New Guinea

Source: WRI 1996.

to safe water and sanitation services is more severe in rural than urban areas, and in the least-developed as opposed to more-developed countries. In some developing APEC nations, less than half the population has such access (WRI 1996).

Not only is water of poor quality in many parts of the APEC region, but it is also scarce. In many APEC countries, water demand outstrips supply. Engleman and Leroy (1993) suggest that water consumption is not sustainable when water resources fall below 1,700 cubic meters of freshwater per person. By this benchmark, a number of APEC nations will soon be facing water shortages. In particular, China will reach the sustainability threshold by 2025 and could face significant water shortfalls thereafter.[6] Singapore has already reached the Engleman-Leroy limit and has only been able to hold off a crisis by investing in a very elaborate pipeline system to bring supplies from neighboring Malaysia (UNESCAP 1995, 88). Apart from the social hardships it causes, water scarcity also imposes significant economic costs. In China, for example, water shortages cost the Chinese economy up to $1 billion per year (Smil 1996).

Water shortages in the APEC region are exacerbated by poor management of the limited supplies. The Asian Development Bank (ADB 1993) estimates that nearly three-quarters of the water available for public consumption in Hong Kong, Manila, and Jakarta is wasted before reaching the public. In Bangkok, Shanghai, and Singapore, more than one-third of the available water slips out of the supply system.

Air Pollution

Hundreds of millions of Asians and tens of millions of North Americans (particularly Mexicans) breathe highly polluted air. As figure 3.2 shows, 13 of 16 APEC cities surveyed have air pollution levels that exceed WHO guidelines for at least one pollutant. Of those cities, nine are located in developing countries. Not only are air pollution levels serious across the region, but the conditions seem to be worsening in many APEC countries. Particulate and ozone levels are on the rise. And while trends in sulfur dioxide and nitrous oxide emissions are not as uniformly negative, these pollutants remain a problem in most of the Asian members of APEC (Brandon and Ramankutty 1993).

Much of the air pollution problem can be attributed to the increased burning of fossil fuels caused by expanded industrial activity, a rapid increase in the number of cars,[7] and congestion (UNESCAP 1995, 140).

6. Water scarcity in China is ''a function of heightened demand . . ., rapidly escalating levels of pollution, and the geographic patterns of water distribution'' (Economy 1997, 126).

7. The past 30 years have seen a tremendous growth in the number of automobiles on the road in both developed and developing countries. In the United States, for example, total motor vehicle registrations increased from 90 million in 1965 to over 200 million in 1995.

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Figure 3.2 Urban pollution in selected APEC cities, early 1990s

City	SO_2	SPM	NO_2	Pb
Christchurch, New Zealand	○	●	—	—
Los Angeles, US	○	●	●	○
Montreal, Canada	◉	○	—	—
New York, US	○	○	○	○
Sydney, Australia	○	○	—	—
Tokyo, Japan	○	○	○	●
Vancouver, Canada	○	○	—	—
Bangkok, Thailand	○	◉	○	●
Beijing, China	◉	◉	○	○
Guangzhou, China	◉	◉	—	—
Jakarta, Indonesia	○	◉	○	●
Kuala Lumpur, Malaysia	○	●	—	—
Manila, Philippines	○	◉	—	●
Mexico City, Mexico	◉	◉	●	●
Seoul, South Korea	◉	◉	○	○
Shanghai, China	●	◉	—	—

◉ Serious pollution ● Moderate to heavy pollution
○ Low pollution — Insufficient data

Notes: (1) SO_2 = sulfur dioxide; SPM = suspended particulate matter; NO_2 = nitrogen dioxide; and Pb = lead. (2) "Serious" refers to situations in which WHO guidelines are exceeded by more than a factor of two; "moderate to heavy" refers to situations in which WHO guidelines are exceeded by up to a factor of two (short-term guidelines exceeded on a regular basis at certain locations); and "low" means that WHO guidelines are normally met, but that short-term guidelines may be exceeded occasionally.

Sources: WHO and UNEP 1992; Seager 1995.

The problem is made worse by the use of poor quality fuels such as unwashed coal or leaded gasoline, as well as by inefficient energy consumption practices. In many parts of the Asia Pacific region, exposure to indoor air pollution is as serious as exposure to outdoor pollution (UNESCAP 1995, 141). In China, for example, many families heat and cook by burning coal briquettes or biomass in poorly ventilated braziers.

Poor air quality can have devastating public health impacts.[8] Respiratory distress and diseases such as pneumonia, bronchitis, asthma, and

During the same period, registrations in Japan jumped from 6 to 67 million and in Thailand from 140,000 to 5 million; in China registrations increased from 900,000 in 1975 to 10 million in 1995 (AAMA 1997).

8. This fact is recognized in both developed and developing countries. In June 1997, for example, President Clinton decided to sharply tighten US air pollution standards for particu-

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emphysema have reached very high levels in a number of cities in the APEC region. In China, the government estimates that respiratory disease now accounts for 26 percent of all deaths (WRI 1996). In Mexico City, particulates contribute to an estimated 6,400 deaths per year, and almost a third of all children have unhealthy levels of lead in their blood (Bartone et al. 1994). The World Bank has concluded that if particulate levels in APEC's developing countries met WHO standards, between 2 and 5 percent of all deaths in urban areas with excessive particulate levels could be averted (World Bank, *1996 World Development Report*).

Solid and Hazardous Waste

Solid and hazardous waste generation plagues densely populated and fast-growing countries. While high volumes of waste can sometimes be indicative of deeper environmental problems, most waste issues can be effectively dealt with through appropriate management regimes. In APEC's developed countries, municipal solid waste is not an especially critical issue. However, rising volumes challenge even the ability of the most-developed countries to manage their waste. In Tokyo, for example, garbage is building up in mounds in Tokyo Bay, threatening both the shipping and fishing industries (WRI 1996, 23).

Many of APEC's developing countries lack the capacity to dispose of wastes properly. Not only is comparatively little waste collected, but it is disposed of haphazardly. In Bangkok, for example, between 20 and 50 percent of municipal solid waste goes uncollected (Bartone et al. 1994). Uncollected garbage blocks drainage channels in many Asian cities, increasing the risk of waterborne diseases. Poor waste practices can also lead to vermin-generated disease or to air pollution from open burning of garbage. In many APEC countries waste gets sent to poorly designed, unlined landfills, causing ecological degradation and posing health risks to local inhabitants as well as to populations of itinerant scavengers.

Hazardous waste presents a more complex problem due to its highly toxic effects and steeper cleanup costs. The early stages of economic development often seem to be accompanied by rapid increases in the level of toxic wastes generated, while more-developed countries find ways to continue to increase industrial output with declining per capita levels of toxic by-product. China, for example, generates 50 million tons of hazardous waste each year, a much higher level of hazardous waste per person than South Korea or Japan (ADB 1997; UNESCAP 1995). Across the Asia Pacific, large corporations appear to be improving their hazardous waste management and disposal, but small and medium-sized enterprises—unable to pay for appropriate hazardous waste management—

lates and ozone (smog), despite concern over costs, arguing that the more strict rules will bring health benefits to 125 million Americans (*New York Times*, 26 June 1997).

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remain an important source of dangerous waste, particularly in APEC's developing countries.[9]

Finally, despite multilateral efforts (notably, the 1989 Basel Convention) to regulate trade in hazardous wastes, black-market waste dealers continue to operate, taking hazardous materials from countries with strict standards (and high disposal costs) to ones with more lax rules (and lower costs).

Depletion of Fisheries

Pacific fisheries are rapidly being depleted (FAO 1994b). In fact, the World Resources Institute (WRI 1996) estimates that nearly all the Pacific fisheries are overfished and at risk of depletion. As figure 3.3 shows, all of the fish stocks in the northwest Pacific are fully fished, overfished, depleted, or recovering. In the northeast, western central, southwest, and southeast Pacific rates of overfishing and depletion exceed 50 percent.[10]

The APEC region is the world's largest producer of seafood, accounting for 50.6 percent of the world's total marine catch (APEC 1995b). But the dramatic increases in fish landed in the 1980s (hundreds of percent growth in China, Australia, and New Zealand) cannot be sustained (WRI 1996)[11]—there simply are not enough fish in the ocean. Unsustainable fishing practices are also likely to have dramatic economic impacts. A Philippine government-commissioned study recently found, for example, that 120,000 Filipino fishermen would lose their livelihoods by the year 2000 unless access to fishery resources were restricted (*Straits Times*, 28 June 1997).

While one answer to the decline in fisheries on the open seas is aquaculture, this method of seafood production creates its own environmental harms. In particular, coastal mangrove habitats are often destroyed, and in some cases threatened or endangered species are lost. In both Thailand and the Philippines, for example, more than 200,000 hectares of mangrove forests have been cleared in the last 30 years (GESAMP 1993). The loss of these mangroves changes drainage patterns, nutrient availability, and the frequency of tidal inundation, dramatically altering the coastal habitat (UNEP/GEMS 1993).

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9. Along the US-Mexico border, for example, most multinational corporations handle their hazardous waste quite carefully while local manufacturing operations engage in illegal ''backdoor'' dumping (Esty 1996a, 35).

10. A recent sign of the severity of the depletion of the Pacific fisheries is the report that fishing by Taiwan, South Korea, Indonesia, New Zealand, Japan, and Australia has brought southern bluefin tuna to the brink of extinction (Central News Agency [Taiwan], 30 July 1997).

11. Malaysia's recent efforts to improve fishing yields by using fish-attracting devices are indicative of the difficulty in sustaining high-yield growth (*The Star*, 31 July 1997).

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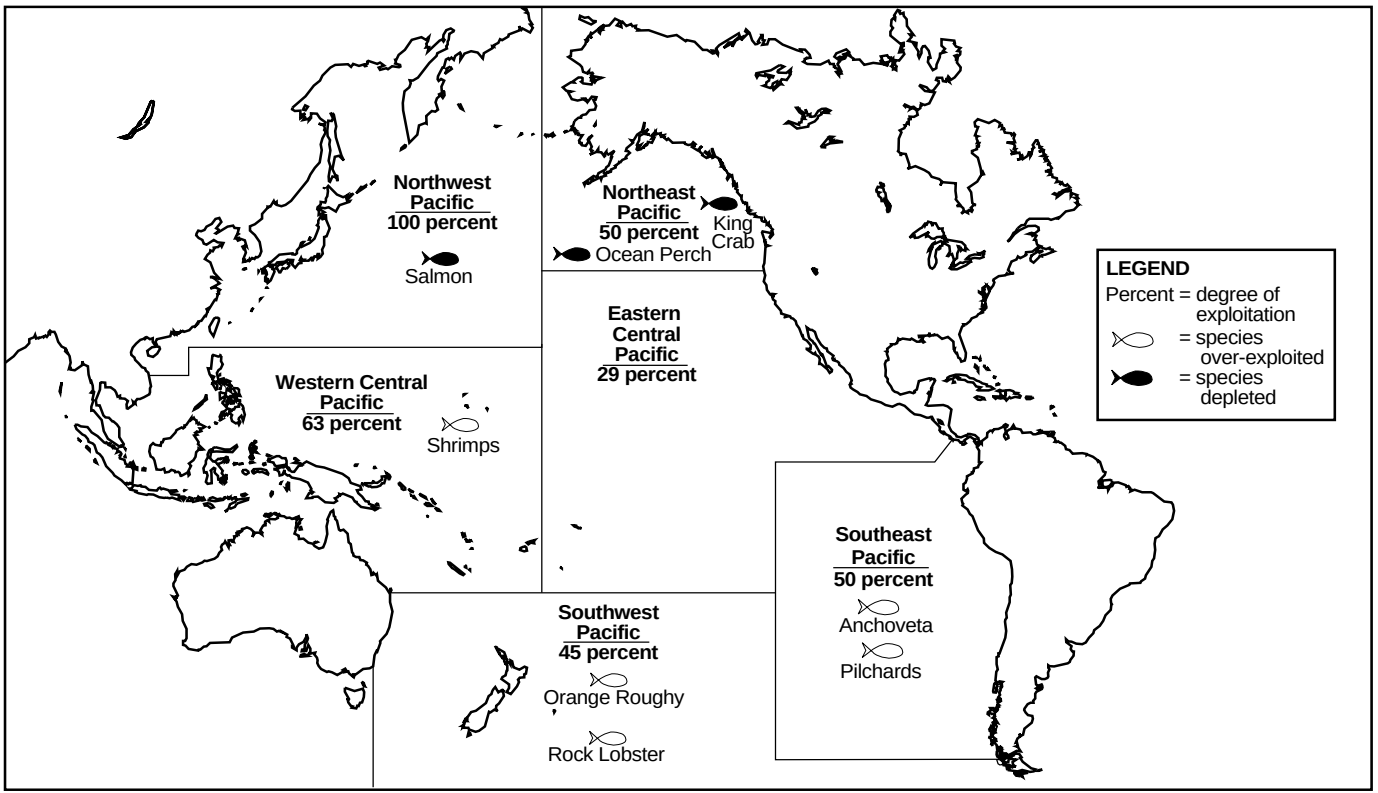
Figure 3.3 State of exploitation of Pacific fisheries, 1992[a]



a. Percentage of stocks fully fished, overfished, depleted, or recovering.

Source: Seager 1995; WRI 1996.

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Marine and Coastal Pollution

Marine and coastal pollution, apart from contributing to the death and contamination of fishing stocks, also causes a host of ecological problems, including habitat destruction and algal bloom. Nearly half of all marine pollution originates from land-based discharges from rivers or direct discharges (Weber 1993).[12] In fact, it is estimated that 80 percent of the pollutants in the Yellow Sea and South Sea off the Korean peninsula come from inland activities via Korean rivers (Government of Korea 1994). Airborne emissions that originate from industrial activity on land are another major source of marine pollution.

Coastal pollution is responsible for significant coral reef damage, particularly in Southeast Asia (Weber 1993). Sometimes called the marine equivalent of tropical rain forests, coral reefs not only support coastal fishing and protect biological diversity, but they are also a protective barrier for coastlines.

''Red tide,'' a form of algal infestation, is also caused by marine pollution. By severely depleting oxygen levels in coastal waters and rivers, red tide causes the mass death of aquatic creatures—at a significant economic cost—and causes shellfish poisoning, which can be hazardous to humans. The economic impact of red tides can be serious. A four-day tide in Manila Bay in 1990 caused fish and shellfish prices to drop by 75 percent, inflicting an estimated loss of $2.4 million on Filipino fishers (UNESCAP 1995, 125). Red tides have also recently caused difficulties in Australia, Hong Kong, and China.

Acid Rain

Acid rain—caused primarily by sulfur dioxide and nitrogen oxides emissions from the burning of fossil fuels—is already a major problem across APEC. Acidification can render lakes and rivers uninhabitable, kill trees and forest ecosystems, and damage man-made structures. Because it traverses national boundaries, acid rain threatens to become a significant source of political and environmental tension among APEC nations.

Large quantities of highly acidic rain spill from the midwestern United States into eastern Canada. Canada has long complained about the acidification of its lakes and forests, the damage to its agricultural produce, and the corrosion of its buildings. But with the signing of an acid rain agreement with the United States in 1992 and the introduction of tradable sulfur dioxide (SO_2) emissions permits under the 1990 US Clean Air Act, SO_2 emissions in the United States have fallen from a recent high of 22.8

12. In the Philippines, ocean pollution as a result of land-based sewage discharges is threatening more than a hundred resorts with closure (Reuters, 9 July 1997).

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million tons in 1989 (CEQ 1995).[13] The opposite pattern holds across much of the Asia Pacific. China's emissions now exceed 20 million tons per year and are rising rapidly (UNEP, *Environment Data Report 1996*). Chinese acid rain not only harms southern and eastern China but also is responsible for significant acid deposition on South Korea and Japan. Until recently, the Chinese rejected any suggestion of their responsibility for acid rain in Korea, Taiwan, and Japan, even though numerous studies have shown that a significant percentage of the acid rain falling in this region can be traced to Chinese power plants and industrial facilities (see figure 3.4). Signs of acid rain problems have also started to emerge in the Philippines, Thailand, and Malaysia.

Without action to reduce acid rain, future Asian prospects are grim. One analysis predicts that SO_2 emissions in Asia will more than double between 1990 and 2010, rising to as much as 76 million tons by the year 2010 (Foell and Green 1990). And another study estimates that in Northeast Asia alone,[14] emissions will rise from 15 million tons in 1990 to 40 million tons by 2020 (Streets 1997). The World Energy Council (WEC) estimates, moreover, that without measures to curb emissions, acid deposition in parts of China and Southeast Asia could soon exceed the critical load limits for most agricultural crops by a factor of 10 (WEC 1993).

Ozone Layer Depletion

A thin layer of ozone gas in the stratosphere approximately 12 to 50 kilometers above the Earth's surface protects the planet from harmful ultraviolet radiation emanating from the sun. This ozone layer is threatened by the release of a family of chemicals, including chlorofluorocarbons (CFCs), that break down ozone molecules. CFCs can persist in the upper atmosphere for hundreds of years (UNEP/WMO 1994); it is estimated that one CFC-derived chlorine atom can destroy up to 100,000 ozone molecules before leaving the stratosphere.

The discovery of a large ''ozone hole'' the size of the continental United States over Antarctica in the mid-1980s galvanized public and political concern over CFCs and the depletion of the ozone layer. Negotiations to limit the release of CFCs and other ozone-layer-depleting chemicals commenced and resulted in the 1985 Vienna Convention on Ozone-Depleting Substances, the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer, and several later amendments to the protocol. Together, these instruments mandate a phaseout of ozone-layer-damaging

13. The 1990 US Clean Air Act mandates a reduction of 10 million tons of SO_2 by 2000.

14. Northeast Asia is defined to include Japan, South Korea, North Korea, and northeast China.

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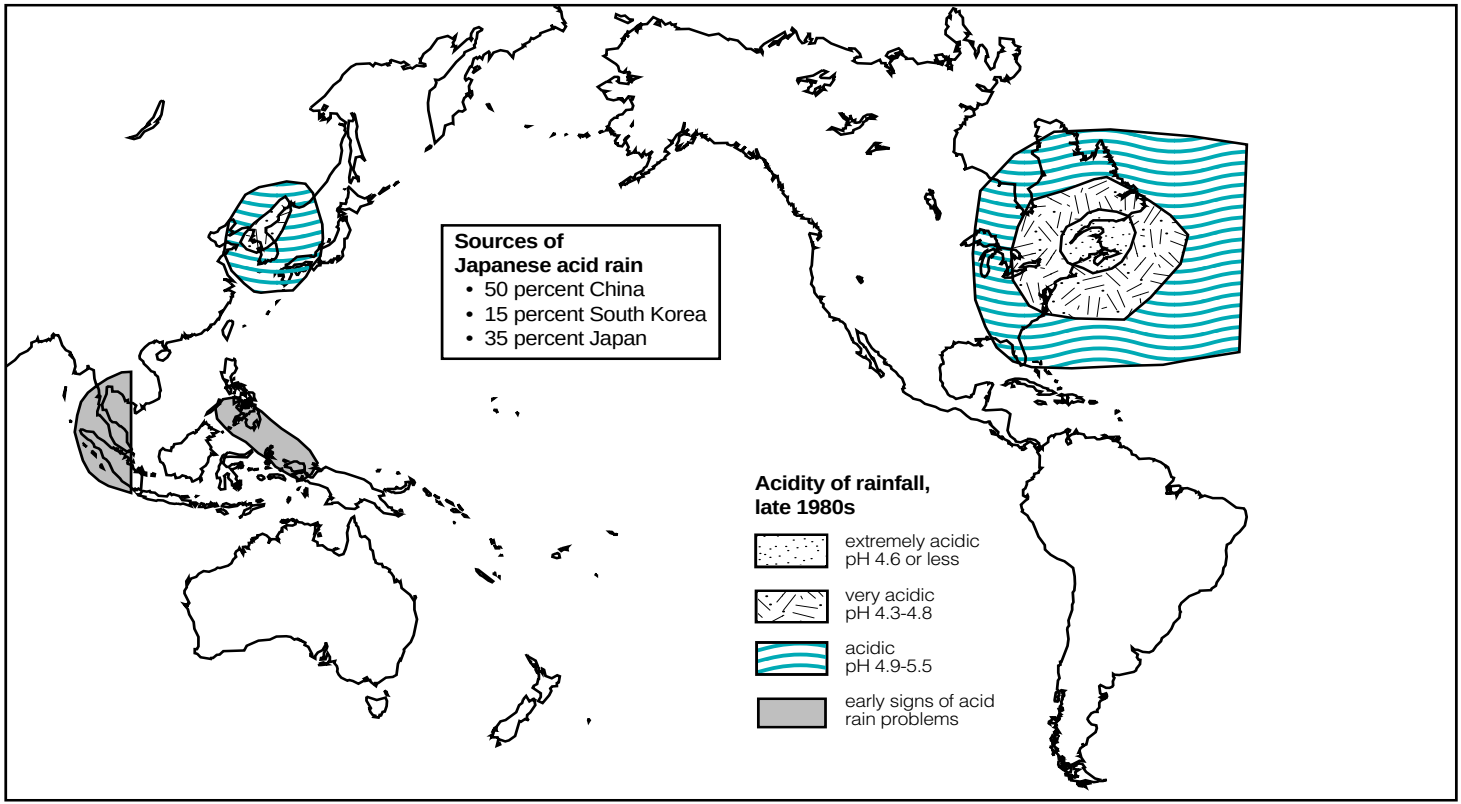
Figure 3.4 Acid rain in the APEC region



Source: Seager (1995).

products that were once widely used in refrigeration, plastic foam production, electronics, aerosol sprays, and a number of other applications.[15]

Heightened exposure to ultraviolet radiation, which occurs with a thinned ozone layer, has been associated with higher incidence of skin cancer, cataracts, weakened immune system responses, and increased outbreaks of infectious diseases (UNESCAP 1995, 144). Studies estimate, for instance, that every 1 percent depletion of the ozone layer increases the incidence of nonmalignant melanoma by 2 percent (WMO 1994). Already, APEC nations near the ozone hole have seen a dramatic jump in skin cancer rates. New Zealand, for example, witnessed a 22 percent increase in cancer incidence from 1980 to 1991 (UNESCAP 1995, 144). In addition, increased ultraviolet exposure could harm the world's agriculture. One recent study predicted that if the Montreal Protocol did not succeed in reversing the trend of ozone layer thinning, wheat crop yields might drop by as much as 5 percent, potatoes by 21 percent, soybeans by 20 percent, and squash by 90 percent (UNEP/GEMS 1992).

As a result of actions taken to meet obligations imposed by the Montreal Protocol, CFC production fell 76 percent between 1988 and 1995.[16] As figure 3.5 shows, CFC and halon consumption has fallen sharply across the developed-country members of APEC. But in most developing countries, CFC production and consumption of ozone-depleting chemicals continues to increase, in many cases significantly. Because of the long atmospheric lifetime of CFCs and because developing-country consumption continues to rise, the hole in the ozone layer has not yet healed. In fact, the ozone hole over Antarctica has increased in size since the mid-1980s, and in 1996 the average size of the hole was 22.3 million square kilometers, larger than the whole of North America (NASA 1996).

While some progress is being made, the verdict on the Montreal Protocol is still out (Brack 1996; Jacobson and Brown Weiss 1997). Reductions in developed-country CFC production and consumption have been achieved, but compliance with the treaty is uneven. In particular, it is not yet clear whether industrializing economies will take the measures required to meet their CFC phaseout commitments.

Climate Change

The accumulation of greenhouse gases (carbon dioxide, methane, and nitrous oxide) in the atmosphere threatens to warm the earth's surface

15. Under the Montreal Protocol, developed countries are required to phase out consumption and production of CFCs, halons, and related compounds by 1996, and hydrochlorofluorocarbons (HCFCs) by 2030. The corresponding dates for developing countries are 2010 and 2040, respectively.

16. Much of the success can be explained by the fact that the cost of the transition to CFC alternatives was less than expected, and indeed in many cases alternative technologies and production processes proved to be less expensive than CFCs (French 1997).

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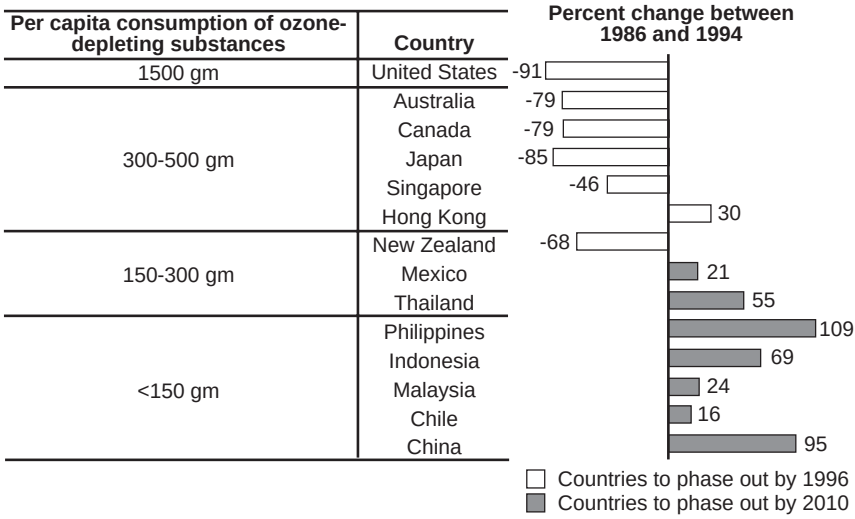
Figure 3.5 CFC and halon consumption in the APEC region



CFC = Chlorofluorocarbon.

Sources: UNEP (*Environment Data Report*); Seager 1995; Brack 1996.

and to produce other climatic changes (IPCC 1995). Although the rate, magnitude, and regional effects of climate change remain uncertain, it is clear that the atmospheric concentrations of greenhouse gases (GHG) have grown significantly—by nearly 30 percent (WRI 1996)—since preindustrial times. The Intergovernmental Panel on Climate Change (IPCC), a UN-sponsored colloquium of scientists from around the world, concluded recently that ''these trends can be attributed largely to human activities, mostly fossil fuel use, land use change, and agriculture,'' and that ''the balance of evidence suggests that there is a discernible human influence on global climate'' (IPCC 1995, 3, 5).

The greatest contribution to GHG emissions is from energy production and use. The burning of fossil fuels alone accounts for 80 percent of CO_2 emissions worldwide. Deforestation adds to the concentration of CO_2 in the atmosphere by reducing the stock of trees, which act as carbon ''sinks.''

As figure 3.6 shows, APEC countries accounted for 46.7 percent of total global GHG emissions in 1992. In fact, four of the six largest GHG emitters are APEC countries. The United States stands today as the world's largest emitter of greenhouse gases, accounting for almost 22 percent of global emissions. China is the second largest with approximately 12 percent of global emissions, and Japan is the fourth largest with approximately 5 percent (WRI 1996).

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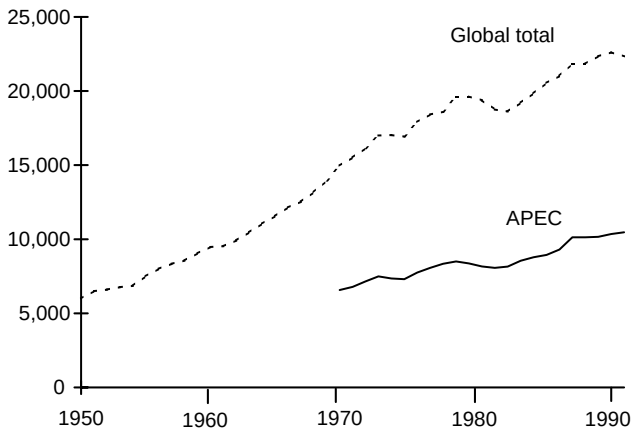
Figure 3.6 APEC's contribution to global CO_2 emissions

Global CO_2 emissions, 1950–92
(Millions of tons)

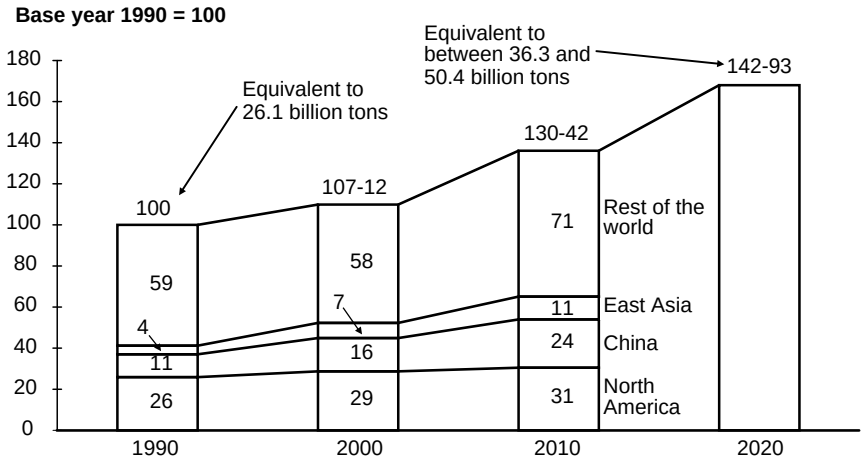


Source: WRI 1996.

APEC country CO_2 emissions, 1992

Country	Emissions (millions of tons)	Percentage of global total	Global rank
United States	4,881	21.8	1
China	2,668	11.9	2
Japan	1,094	4.9	4
Canada	410	1.8	6
Mexico	333	1.5	13
South Korea	290	1.3	16
Australia	268	1.2	17
Indonesia	185	0.8	23
Thailand	113	0.5	31
Malaysia	70	0.3	40
Singapore	50	0.2	50
Philippines	50	0.2	54
Chile	35	0.2	64
New Zealand	26	0.1	68
Papua New Guinea	2	0	118
Total	10,475	46.7	

Figure 3.7 Predicted global CO_2 emissions, 1990-2020



Sources: WEC 1995; IEA 1995b; US Department of Energy 1995.

Global GHG emissions are predicted to rise significantly over the next 25 years (see figure 3.7). Studies by the World Energy Council (WEC 1995), the International Energy Agency (IEA 1995a), and the US Department of Energy (1995) forecast that global emissions will rise by between 30 and 42 percent by 2010 and by as much as 93 percent by the year 2020. China—with its rapid economic growth fueled largely by coal burning—will likely double its GHG emissions by 2010 (WRI 1996) and is expected to surpass the United States as the world's largest emitter by 2020 (Esty and Mendelsohn 1995).

Increased levels of greenhouse gases in the atmosphere could cause a variety of climate change effects. Current modeling suggests that global mean temperatures will rise by between 1°C and 3.5°C by 2100, with a midrange estimate of 2°C (IPCC 1995, 6). The IPCC scientists further predict that thermal expansion of the oceans and melting of glaciers and ice sheets will cause a rise in sea level of 15 cm to 95 cm by the year 2100, with an increase of about 50 cm as the midpoint projection (IPCC 1995, 6). Climate change may also cause changes in rainfall patterns, the frequency and severity of storms, hydrological cycles, and soil moisture (IPCC 1995, 6). These effects could translate into changes in agricultural productivity, the prevalence and patterns of diseases, and the exposure of people to severe weather.

Current greenhouse effect modeling suggests that the regional impacts from climate change may be quite disparate (IPCC 1995). No area of the world seems more likely to suffer adverse effects than Asia. Topping, Quershi, and Samuel (1990) observe that a one-meter rise in sea level would put 126,000 km^2 of land in China under water and would threaten

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coastal environments around the Pacific Rim. Southeast Asia appears especially vulnerable to sea level rise since 70 percent of the population lives in low-lying areas that are susceptible to flooding, and inhabitants of this region depend significantly on fishing and agriculture that may be disrupted by climate change. Moreover, under a number of climate change scenarios scientists predict changes in precipitation from Asian monsoons (IPCC 1995, 6), deeply affecting weather patterns and hence agriculture in the region.

Biodiversity Loss

Biodiversity loss in the APEC region can be attributed to destruction of habitats by farming, infrastructure construction, deforestation, land degradation, and water pollution (ADB 1997, 207). These problems are exacerbated by the pressures of poverty and population growth, and they are especially serious in the region's tropical areas.

Apart from their capacity to ''sequester'' carbon and thus mitigate the effects of climate change, tropical forests are valuable as a source of biodiversity. More than half of all known species live in rain forests, and Harvard biologist Edward O. Wilson (1992, 278) calculates that some 50,000 of these species are becoming extinct annually, largely due to human activity. While there is great debate over how serious a problem the loss of biodiversity is,[17] there is no doubt that Asia is one of the regions most dramatically affected by species loss.

The APEC nations constitute some of the most biologically diverse places on the planet. Of the world's 11 ''megadiversity'' countries (McNeeley et al. 1990), four—China, Malaysia, Indonesia, and Australia—are APEC members. In addition to being biologically diverse, the APEC countries also have among the highest incidences of endangered species. Of the 18 global ''hot spots''—locales where native species are numerous *and* where a large proportion of those species are particularly threatened—identified by Myers (1988, 1990), 6 are in APEC countries: peninsular Malaysia, northern Borneo in Indonesia, the Philippines, southwestern Australia, California and Oregon in the United States, and central Chile.

Table 3.3 shows a country-by-country analysis of the number of endangered species in the region. The greatest number of threatened plants are in Australia and the United States, while the largest number of threatened mammals and birds are in Indonesia and China. It is worth noting that the figures listed in table 3.3 do not include species that have already become extinct. Estimates of plant diversity in the Philippines alone place

17. Cooper (1994) argues that loss of biodiversity is a relatively small problem since most of the species being lost are insects. In contrast, Kellert (1996) argues that species loss is a fundamental threat to human existence and life as we know it.

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Table 3.3 Threatened plants and higher vertebrates in the APEC countries

Country	Number of threatened species						Percentage threatened
	Plants	Mammals	Birds	Reptiles	Amphibians	Total species	
Australia	2,024	38	39	9	3	16,733	12.6
United States	2,262	27	43	25	22	20,591	11.6
New Zealand	232	1	26	1	3	2,699	10.0
Chile	284	9	18	0	0	5,557	5.6
Malaysia	522	23	35	12	0	13,691	4.3
Mexico	833	25	35	16	4	23,472	3.9
Taiwan	95	4	16	0	0	3,883	3.0
Philippines	159	12	39	6	0	9,748	2.2
South Korea	33	6	22	0	0	2,978	2.0
Brunei	40	9	10	3	0	3,662	1.7
China	350	40	83	7	1	34,166	1.4
Japan	41	5	31	0	1	5,827	1.3
Singapore	19	4	5	1	0	2,343	1.2
Indonesia	70	49	135	13	0	25,315	1.1
Thailand	68	26	34	9	0	13,897	1.0
Papua New Guinea	88	5	25	1	0	12,796	1.0
Hong Kong	5	1	9	2	0	2,213	0.8
Canada	12	5	6	0	0	3,664	0.6

Source: WCMC 1992.

the number of currently listed threatened species, 159, as one-tenth of the number of plants that may have already become extinct. Furthermore, it is now estimated that major ecosystems in the Indo-Malayan regions have lost almost 70 percent of their original vegetation. This is especially tragic in Malaysia, where forests are believed to harbor an estimated 25,000 species of flowering plants (UNESCAP 1995, 60).

The tangible benefits of biodiversity are keenly debated. The case for emphasizing the maintenance of biological and genetic diversity can be divided into three strands (Caldwell 1996). First, some scientists argue that our imperfect understanding of life and the interrelationships of various animals and plants makes species preservation imperative. Second, other biodiversity advocates note that ''bioprospecting'' can yield economic benefits, including the commercialization of important scientific advances in chemicals and pharmaceuticals. A more emotionally charged version of this argument suggests that in destroying species, we risk losing a potential cure for cancer or other diseases. Finally, Kellert (1996) argues that human life is defined by and enriched through our connection to nature and, thus, the diversity of the species on the planet represents an important independent virtue. Others emphasize a similar moral aspect of genetic preservation, suggesting that humanity ought to avoid ''playing God,'' and should therefore preserve all species.

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Environmental Harms: A Geographic Taxonomy

The seriousness of the environmental harms that APEC members confront and to which they contribute cannot be dismissed lightly. Later chapters in this study consider the underlying causes of these harms (chapter 4) and the roles that APEC must play to ensure that they are addressed (chapter 6). In this regard, thinking about environmental harms as falling into one of three geographic categories—local/national, regional, or global—proves to be useful.

Local or national harms, for example, include land degradation, pollution of internal water resources, lead and particulates in the air, and problems of waste management. *Regional harms* are those that traverse national borders, spilling over onto neighboring countries or onto the regional commons; they include pollution of shared airsheds and bodies of water. Some regional harms affect all or most APEC members, such as the depletion of the Pacific fisheries. Other regional harms affect a subset of APEC countries. For example, China's sulfur dioxide emissions cause acid rain in South Korea and Japan. Likewise, acid rain from United States industrial emissions affects Canada.[18] Finally, *global harms* arise when emissions blanket the earth affecting all nations regardless of the origin of the pollution. Depletion of the ozone layer and the buildup of greenhouse gases that may cause climate change represent the paradigmatic global issues.[19]

Of course, not all harms fit neatly into these three geographic categories. Some environmental problems have multiple dimensions. Deforestation, for example, has both local and global effects. At a local level, deforestation contributes to soil erosion, land degradation, and water pollution. At the global level, deforestation reduces the world's supply of carbon sinks that can mitigate the effects of greenhouse gas emissions. In addition, some harms do not fit easily into a particular geographic category. For example, there is disagreement about whether species loss is a purely local harm (since species and habitats in other countries remain unaffected) or

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18. Another environmental harm involving just a subset of APEC's members involves air pollution in Malaysia caused by the burning of forests in Indonesia. This air pollution has disrupted Malaysian air traffic and caused health problems in Malaysia and Singapore (*Straits Times*, 5 August 1997 *New York Times,* 25 September 1997).

19. In the case of transboundary—regional or global—harms, a large portion of the harm can often be attributed to a small set of countries that play oversized roles because of their particular demographic heft, resource endowments, or rogue behavior (Esty 1998). These ''pivotal states'' (Chase, Kennedy, and Hill 1996) deserve special attention from policymakers because of their capacity to shape regional or global security. From an ecological perspective, a number of the most important actors—the United States, China, Indonesia, Mexico, and Japan—are APEC members. The presence of a critical mass of states whose behavior can dramatically affect the magnitude of environmental harms (or efforts to abate harms) around the world makes APEC an especially valuable forum for environmental diplomacy.

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whether species should be considered part of the global commons, making their loss a world-scale problem.[20]

Notwithstanding the difficulty of categorizing all environmental harms as falling exclusively within one of the categories suggested alone, a differentiation based on the geographic locus of the harms proves useful for several reasons. First, the optimal policy response and level of required governmental intervention varies depending on the geographic scope of the harm (Esty 1996b). As the discussion in later chapters makes clear, the scope of the jurisdictional response should match the scale of the harm in question.

Second, the geographic scope of the harm is a primary determinant of the attention that national governments pay to a particular harm. As we explain in chapter 4 (under ''structural failures''), the more localized the effects of an environmental harm, the sooner the problem yields to rising income levels as investments in environmental protection become affordable and citizens demand action from their governments. Regional and global harms do not tend to abate as incomes rise, since some part of the pollution costs falls on citizens in other countries about whom national governments care very little. Thus, categorizing harms based on their geographic locus helps us to understand why transboundary environmental harms are difficult to address—and require special efforts at collective action. Indeed, it is in providing a structure for the required overarching cooperation that APEC can play a vital role.

Conclusion

As a recent Asian Development Bank study (ADB 1997, 30) notes, ''Asia's environmental performance has not matched its remarkable economic progress during the past 30 years.'' This conclusion holds true for APEC as a whole, in spite of considerable environmental progress in its developed nations. As a result, public health and ecological costs have become a significant offset against the social welfare gains achieved through economic growth. And the problem is probably worse than it looks since many environmental harms will appear only as conditions become more crowded and critical ecological thresholds are exceeded.

APEC could play Nero and fiddle while Rome burns, but to do so requires an assumption that either the panoply of environmental problems

20. The difficulty in categorizing a particular harm as either local, regional, or global arises when we focus narrowly on the *physical* effects of an environmental harm. In chapter 7 we extend our analysis, arguing that the geographic reach of a harm should be determined by reference not only to its *physical* effects but also to its *economic* and *psychological* effects. Thus, because loss of a species may emotionally affect citizens all around the world—a psychological effect—biodiversity is arguably a global problem.

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identified are not real or serious, or someone else can or should respond. As the data presented in this chapter make clear, a belief that Asia Pacific pollution and resource issues do not deserve attention rests on counterfactual premises and would be irresponsible.

While conceding that environmental problems are real and serious, skeptics might, however, ask why APEC should be called upon to act. Shouldn't national governments be held responsible? Aren't there international bodies already at work on these issues? The answer to these questions is—yes, but only in part. As we explain in detail in chapter 6, APEC is better positioned than any other body to respond with regard to some—particularly regional-scale—problems. On other issues, APEC may be positioned to reinforce actions taken by governments at the local/national or global levels. And to the extent that economic integration creates a demand for coordinated action on noneconomic issues, including environmental policy, APEC's core mission cannot be accomplished without an environmental program.

The opportunity is clear: improved environmental performance will allow the APEC economies to grow while mitigating environmental degradation and the associated social costs of pollution harms and resource depletion. But so too is the risk: inattention to public health and ecological harms will continue to propel fast-growing APEC countries down an unsustainable path toward local, regional, and global pollution and resource crises.

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