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Toward an Environmental Strategy for Asia

Carter Brandon
Ramesh Ramankutty

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FOREWORD

During the past decade, the developing countries of Asia have exhibited vigorous economic growth unmatched elsewhere in the industrial or developing world. This impressive record, however, has been marred by significant deterioration of the environment. Rapid growth—especially in the region's cities and industries—has combined with high population densities and widespread poverty to produce excessive environmental degradation. Pollution of air, water, and land exceeds WHO safety guidelines in many Asian cities. Land degradation, deforestation, and loss of biodiversity are widespread.

The environment in Asia is one of the greatest development challenges in the world today. The reason is not only the complexity of environmental issues themselves but also the complex linkages between growth, population, poverty, and the environment. Asia has already dramatically shown that economic growth can reduce population growth rates and the incidence of poverty. However, to sustain the recent economic gains, greater priority will need to be given to the development of sound environmental policies and of public and private institutions capable of implementing these policies.

Although the environmental challenge is formidable, there are also opportunities in Asia that do not exist in many other parts of the world. First, of course, is the high rate of growth itself, combined with a high rate of domestic savings, which provides public and private capital to invest in the necessary technologies. Second, in East Asia the incidence of poverty is falling dramatically—from 30 percent of the population in 1970 to only 10 percent today. Third, Asian countries have generally embraced the principles of sound macroeconomic management. Good economic policies are, by and large, environmentally sound. In addition, the economic management skills demonstrated in Asia form the basis for additional policies that will be required to safeguard the environment. Finally, Asian countries have shown a commitment to health and education. This commitment not only helps create a popular base for environmental activism but also lays the foundation for building capacity in the region's environmental institutions.

At this point, what is most needed is the political will, commitment, and action—in the form of investments, education, and policy reform—to reverse the alarming environmental degradation still being observed. The World Bank is committed to providing analytical, financial, and educational assistance to help shape these environmental actions over the next several critical years. This Discussion Paper is part of the Bank's effort to assist countries in Asia in developing environmentally sound development strategies. The Executive Summary was published as a separate booklet (under the same title) to encourage wider distribution.

Toward an Environmental Strategy for Asia is intended to stimulate discussion on important environmental policy and investment issues. It stops short of giving definitive recommendations for any particular country, as this is beyond the scope of the exercise. By building on the World Bank's experience and analytical work in Asia, it offers a set of principles and priorities for addressing key environmental problems in Asia. In addition to being informative, it is our hope that this document contributes to the debate on environmental priorities, the role of the World Bank and other donors, and the need for concerted action across several fronts.

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ABSTRACT

This paper addresses the need arising from both within and outside the World Bank for a document that discusses the nature and magnitude of environmental problems in Asia, explores technical and policy approaches to solving these problems, and documents World Bank experience in assisting Asian countries to deal with environmental problems. The paper does not set out specific strategies for any particular country, as that would be beyond its scope. It does, however, make a clear statement on World Bank principles and priorities for the near future.

Economic growth and population densities have had severe negative impacts on the Asian environment. Pressure on the region's resources is intense and growing. There are serious problems in the areas of urban environmental degradation; industrial pollution; atmospheric emissions; soil erosion and land degradation; water resource degradation; deforestation; and loss of natural habitat. The real costs of environmental degradation are mounting in the form of increasing health costs and mortality, reduced output in resource-based sectors, and the irreversible loss of biodiversity and overall environmental quality.

The answer to these problems does not lie in trying to stop the trends toward greater urbanization and industrialization in Asia. Rather, these fundamental economic trends can be made far more sustainable through targeted environmental policies and investments. In fact, Asia's achievements—its relatively high levels of growth, economic efficiency, human resource development, and declining levels of poverty—give many Asian countries greater latitude to address their environmental problems than others.

The paper proposes a framework for accomplishing improved environmental management. The first of its five components is the need to set priorities—an obvious but difficult step imposed by shortages of financial and administrative resources. The paper then addresses the four key components of national environmental strategies: designing cost-effective policy instruments; improving institutional capacity; increasing public and private sector investments; and improving technology, even in areas not fully supported by the market. This framework is then applied to specific sectoral issues in the urban, industry, energy, agriculture, forestry, biodiversity, and water sectors. The report emphasizes that there are real institutional and resource constraints in all sectors and that any strategy to achieve greater sustainability must be continually updated as these constraints change.

The last section of the report outlines the World Bank's role in assisting Asian countries to address environmental issues. The environmental focus of the Bank's lending program and analytical work has grown over the last several years, and is expected to grow further. The strategies employed vary by country, as do the relative areas of emphasis (such as natural resource management vs. pollution abatement), partnerships with other donors, NGOs, and the private sector, and the role of technical assistance. Still, there remain areas in which there is potential for the Bank to do more, as outlined at the end of the report.

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ABBREVIATIONS, ACRONYMS AND DATA NOTES

ADB	Asian Development Bank
BAPEDAL	Environmental Impact Management Agency (Indonesia)
BATEA	Best Available Technology Economically Achievable
BOD	biochemical oxygen demand substance
BPT	Best Practicable Technology
CD	Country Department (World Bank)
CFC	chloroflourocarbon
CGIAR	Consultative Group for International Agricultural Research
CO	carbon monoxide
CO_2	carbon dioxide
COD	chemical oxygen demand substance
DSM	demand-side management
EA	environmental assessment
EGAT	Electricity Generating Authority of Thailand
EOP	end-of-pipe
EPA	Environmental Protection Agency (U.S.)
ESCAP	Economic and Social Commission for Asia and the Pacific
ESW	economic and sector work (World Bank)
FAO	Food and Agriculture Organization
FGD	flue gas desulfurization
FY	fiscal year (July-to-June in the World Bank)
GDP	gross domestic product
GEF	Global Environment Facility
GHG	greenhouse gas
GNP	gross national product
ha	hectare
IAEA	International Atomic Energy Agency
ICDP	integrated conservation and development project
IEA	International Energy Agency
IFAD	International Fund for Agricultural Development
IPPS	Industrial Pollution Projection System
IPM	integrated pest management
LPG	liquified petroleum gas
LRMC	long-run marginal cost
MEIP	Metropolitan Environmental Improvement Program (UNDP and World Bank)
MITI	Ministry of Trade and Industry (Japan)
ml	milliliter
NEAP	National Environmental Action Plan
NGO	Nongovernmental Organization
NIC	Newly Industrialized Country
N_2O	nitrous oxide
NO_2	nitrogen dioxide
ODA	Official Development Assistance
OECD	Organisation for Economic Co-operation and Development
OECF	Overseas Economic Cooperation Fund (Japan)
O&M	operation and maintenance
PFI	participating financial institutions
R&D	research and development
SAL	Structural Adjustment Loan
SAR	Staff Appraisal Report (World Bank)
SMI	Small- and Medium-Scale Industries
SO_2	sulfur dioxide
SPM	suspended particulate matter
TA	technical assistance
TRI	toxic release inventory
TSP	total suspended particulates
TSS	total suspended solids
TVEI	Township and Village Industrial Enterprises (China)
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNCED	United Nations Conference on Environment and Development
USAID	United States Agency for International Development
WDR	World Development Report (World Bank)
WHO	World Health Organization
WRI	World Resources Institute

DATA NOTES

All dollar figures ($) refer to current US dollars unless otherwise noted.

Billion is equal to one thousand million.

EXECUTIVE SUMMARY

This report is intended to serve three purposes: (a) to assess the trends and impacts of environmental problems in Asia, (b) to synthesize policy and technical approaches to solving these problems, and (c) to provide a clear statement on World Bank principles and priorities for environment-related assistance in the near future.

After briefly summarizing the nature and magnitude of environmental problems in Asia, the report presents the key components of a strategy to improve environmental management. The proposed strategy is clearly general and emphasizes that local decisionmaking on priorities and types of interventions is required. The report also emphasizes that achieving sustainability is a *process–a* process that must work within real institutional and resource constraints, and therefore must be continuously updated as these constraints change. Although the environmental emphasis of the World Bank's lending program and analytical work has grown over the last several years, this report outlines areas in which the Bank can potentially do more.

The State of the Environment in Asia

Economic and population growth has led to severe negative impacts on the Asian environment. Pressure on the region's resources is intense and growing. There are serious problems in the areas of urban environmental degradation, industrial pollution, atmospheric emissions, soil erosion and land degradation, degradation of water resources, deforestation, and loss of natural habitat. Questions about the sustainability of current economic growth are more than an abstraction concerning limits to growth. The real costs of environmental degradation are mounting, taking the forms of increasing health costs and mortality, reduced output in resource-based sectors, and irreversible loss of biodiversity and overall environmental quality.

These are strong statements about the state of the environment in Asia, but they are supported by available (though incomplete) data. The most reliable data on existing levels of degradation are on specific locations and are not geographically comprehensive. More comprehensive data, such as national vehicle registration and total industrial emissions, do not address ambient conditions directly but help illustrate worrisome trends that will continue to worsen without targeted efforts to change the direction of the trend.

There are several underlying causes of environmental degradation in Asia. The first—which Asia shares with most of the world—consists of fundamental market and policy failures concerning natural resources and the environment that have received little corrective action. These failures vary by resource and location, but are found in all sectors. A second cause is the strain on the resource base imposed by Asia's large and growing population, which is projected to rise from 2.8 billion today to 4.3 billion in 2025—and will represent over 50 percent of the total world population by that time. This strain is exacerbated by the 700 million people currently living in absolute poverty. A third underlying cause is rapid urbanization and industrialization, which impose complex demands on the assimilative capacity of the environment, as well as on human and institutional abilities to respond. A fourth cause is the common perception (caused, in part, by lack of information) that there is a direct tradeoff between environmental protection and economic growth. This paper argues that there is, in fact, no tradeoff: rational policies will cost less

to implement than the resulting reduction in external costs, leading to a net increase in economic efficiency and social return on investment.

The environmental strategy presented here does not directly address population growth, although decreasing the rate of population growth would reduce a major source of environmental pressures. Similarly, the report does not question Asia's steady urbanization and industrialization, which reflect fundamental economic trends that can be made far more sustainable. Rather, the strategy proposes a framework for taking steps to minimize the environmental impacts of these major economic trends.

A Framework for Improving Environmental Management

The range of actions required to improve environmental management in Asian countries is extremely wide, from using innovative policy analysis and implementation to securing large amounts of new investment. The complexity of the actions required, combined with real financial and institutional constraints, means that the first element of any framework must be to set priorities.

Actions Required

Priority Setting. Priorities for action are ideally based on the collection and analysis of available data, careful valuation of the costs and benefits of various types of interventions, assessment of the administrative burden of alternatives, and participatory decisionmaking. Unfortunately, it is much easier to analyze the symptoms of nonsustainable development than to make difficult choices concerning priorities for intervention. How should countries set priorities between local and global pollutants, and between policy reform and capital investment? A full cost-benefit comparison of alternative scenarios is unrealistic because it requires too much data and covers too many hypotheticals. In practice, priorities are best set as the result of a process involving both technical and public inputs and taking into account scientific, economic, and medical evidence as well as the intensity of public concern over risk.

Ultimately, governments must decide on the basis of these inputs what level of environmental quality is politically and economically feasible and what instruments should be employed in achieving those environmental goals. The framework proposed in this report highlights four key areas for consideration when shaping national environmental strategies: adopting cost-effective policy instruments, improving institutional capacity, increasing public and private sector investments, and fostering improved technology, even in areas not fully supported by the market.

Policy Reform. The second element in the framework is to design cost-effective policy instruments that minimize costs and economize on scarce administrative skills. Environmentally appropriate policies are not inconsistent with policies that foster growth and trade, but they do attempt to correct the bias of market and policy failures that lead to overexploitation of nonpriced and underpriced environmental resources. Although the exact descriptions and intensities of environmental problems vary by country, the underlying causes of the degradation vary little. The causes can be traced to both market failures (such as lack of information, price externalities, public goods and free riders, and inadequate property rights) and policy failures (concerning pricing or trade policies).

Policy reforms used to achieve improved sustainability can be clustered into three distinct but complementary groups:

- Market-based policies, which use pricing, taxes or marketable permits to modify behavior
- Regulatory or administrative policies that impose quantitative restrictions, enforce property rights, and screen investments (both public and private)
- Extraregulatory approaches to pollution control, such as the introduction of public disclosure requirements and the increased use of court systems in environmental liability suits. Most Asian countries have developed envi-

ronmental policies that draw heavily on the second group—which is consistent with the traditional path taken by the industrial countries as well—but less so on the more innovative approaches of the first and last groups. The emphasis on regulatory policies has had relatively high administrative costs, as well as relatively low economic efficiency. For both reasons, efforts to encourage reform in the other two groups promise both greater cost-effectiveness and better use of scarce administrative skills.

The most important type of market-based policy reform is pricing reform. "Full-cost" pricing (that is, removing subsidies and internalizing the externalities imposed by the resource use or pollution emitted) is fundamental to reducing the consumption of resources in virtually all sectors. Taxes or tradable permits levied on pollution and congestion are equivalent to raising the price on air, water, and land resources. Depending on the relevant elasticities, tax-based policies will lead to some increase in financial flows to the "owner" of the resource—which is often the government. These revenues can be reinvested in the resource itself, particularly in the case of investments in public infrastructure (for example, in water supply and energy) and public goods (such as air and forests). In addition, both price increases and fiscal instruments can help stimulate technological adaptation that favors greater efficiency and reduced pollution.

Non-market-based policy reforms—including regulatory, legal, and administrative reforms—are required to complement market-based ones. No country has relied solely on market-based environmental policies to reduce pollution. The "command and control" approach to pollution control, in which governments specify allowable factory emissions and often even specify the technologies to be used, is very common. Examples of other types of non-market-based reforms are nontax methods to reduce transport emissions and congestion, such as emissions standards, aggressive vehicle inspection programs, traffic management, tighter zoning, and investments in public transit alternatives to private cars. (These steps have all been taken in Singapore.) Further examples for both the transport and energy sectors are programs to upgrade technologies and fuels, such as the introduction of unleaded gasoline in Malaysia and Thailand, switching from coal to natural gas in Seoul, and upgrading to higher grade coal in China. For the agricultural and forestry sectors, investments in technology development, information dissemination, and extension are required to introduce more sustainable practices. Improved land titling and resource tenure also show positive correlation with environmental management.

Although interest is rising, Asian countries have turned only recently, when at all, to innovations in the area of extraregulatory approaches to pollution control. For example, requirements for public disclosure of point-source pollution data can lead to direct negotiations between polluters and communities, consumer boycotts or liability court cases. Disclosure is relatively low cost, requires relatively little direct government involvement, and invokes the power of the market into the environmental arena. (Increased local participation, however, is not a substitute for more comprehensive environmental policies.) Although specific examples of direct community participation in industrial pollution control have arisen across Asia, no country has formalized the right of communities to know.

Strengthening Public Institutions. The third element in the framework is to build sufficient institutional capacity to accomplish the important steps of priority setting and policy reform. Institutions constrain the choice of policies. The policy mix must be weighed not only against an analysis of the efficiency of the approach but against a country's ability to implement. Weak institutions typically lack both the technical skills and political authority to change the behaviors of firms, households, and farmers. Weak enforcement agencies often lack both the information (such as emissions data) and the means (such as consistent and fair enforcement capabilities) to implement policy. Weak le-

gal and administrative procedures undermine the government's ability to enforce resource tenure, particularly in agriculture and forestry.

Political commitment to protecting the environment is increasing throughout Asia. It is at the level of implementation—monitoring environmental impacts and enforcing regulations—that government institutions are weakest. For donors, an emphasis on institutions must mean more than working with environmental agencies: it also means commitment to the notion that environmental lending cannot be divorced from national policy and investment planning. Unfortunately, the countries most in need of environmental assistance are often those with the least absorptive capacity.

The technical areas in which Asian environmental institutions need strengthening range from the ability to set standards and analyze policy at the national level to the ability to perform actual monitoring and enforcement at the local level. Most environmental institutions would benefit from inviting broader participation—by the private sector, parastatals, nongovernmental organizations (NGOs), and community groups—in environmental assessments and other activities. Also, decentralization is a well-established trend in Asia. The decentralization of monitoring and enforcement authority for urban environments and industrial pollution can be positive for the environment, but only if local agencies have adequate resources, central support, and local accountability for achieving their mandates. Similarly, the decentralization of fiscal and planning authority for local infrastructure investments can bring public expenditures more into line with local environmental concerns. However, decentralization is a particularly multifaceted issue, and there are few successful Asian case studies from which to draw convincing lessons.

Increasing Public and Private Sector Investment. The fourth element in the framework is to mobilize private sector investment, in line with more sustainable pricing policies, and public sector investment, in line with environmental priorities. The overall costs of sustainable policies have been shown to be large in absolute numbers but small in relative terms: the World Bank estimates that developing countries need to expend 2 to 3 percent of gross domestic product (GDP) per year to achieve greater sustainability. In Asia this translates into about $38 billion per year by 2000, two-thirds of which would be in East Asia. The most financially viable environment-related investments are those that are good for both economic development and the environment, including energy conservation, waste minimization in industry (as opposed to end-of-pipe investments), recycling in the urban sector, fuel efficiency in the transport sector, soil conservation, and sustainable forestry.

Increased private sector investments should be promoted through pricing and policy reform and through improved access of the private sector to commercial loans, to supplier credits and, under special circumstances, to government incentives. Public sector investment decisions should incorporate shadow prices that reflect the full social cost of resource use. In the case of public infrastructure investments, donor support should be contingent on financial plans that encourage project cost recovery to the extent possible. When public investments address cross-border or global problems, such as global warming, ozone depletion, biodiversity, and pollution of the seas, strong arguments exist for international cost-sharing.

Improved Technologies and Technology Transfer. The last element of the basic environmental management framework is the need to foster technological improvements and efficiency gains, even when the research, development, and demonstration costs are not fully borne by the market. Improvements in productivity and efficiency are essential to making continued economic growth possible at a time of growing populations, urbanization, and industrialization, and of an increasingly degraded resource base.

Economic and trade openness is fundamental to technology transfer. In the polluting sectors (urban, transport, industry, and energy), "clean"

technologies will be most available in those Asian countries with open trade regimes and business climates that foster foreign investment. Since many high-efficiency industrial and transport technologies pay for themselves over a few years, relatively little public sector intervention is required (except for, perhaps, information dissemination to smaller firms). However, in the "green" sectors (agriculture, forestry, and natural resources), public sector involvement in technical issues has a much higher priority, especially for devising sustainable production technologies for marginal agricultural lands and forests.

The Impact of Improved Environmental Management on the Poor

Strategies for achieving sustainability that use pricing and regulatory measures to reduce overexploitation of natural resources have direct and often inequitable impacts. Concern about the impact on the poor of improved environmental management is particularly great in South Asia, which has more than half the world's poor.

This concern is similar to that of ensuring social equity during periods of structural adjustment. For both structural and "environmental" adjustment, efficiency considerations should be paramount. Nevertheless, adverse impacts for certain population subgroups should be identified and addressed separately—and in a manner complementary to, not substituting for, the underlying efficiency measures. For example, in cities the most important adverse impacts on the poor from full-cost resource pricing are likely to be in the areas of water, electricity, and fuel (including biofuels). Through the combination of market differentiation (a lower level of service for the poorest communities) and financially strengthened utilities, achieved, in part, through pricing reform, the option of cross-subsidization of the poorest communities becomes available.

The measures required to offset inequitable impacts of environmental policies will be very different in urban and rural areas. The urban poor are, disproportionately, victims of urban environmental degradation: they are less buffered than the nonpoor from water pollution, toxic wastes, solid wastes, high traffic, and air and noise pollution. Urban environmental investments will probably help the poor more than middle- and upper-income city-dwellers. Therefore, investments in urban environmental cleanup can be considered to be socially progressive.

However, in rural areas the poor are often disproportionately, and usually inadvertently, the perpetrators of environmental degradation. The environmental policies required to bring about increased sustainability involve both positive and negative impacts on the poor. Reforms in land tenure, to the extent that the poor gain tenure, would be positive. The truly landless, however, would be increasingly cut off as others gain title. Solutions to the landless poor have to be site and area specific. One trend that may help to relieve some of the pressure in East Asia is that the rural population is actually decreasing as urban populations grow. A second trend that should be supported through government and donor programs is the diversification of rural employment into nonfarm activities. Nonfarm employment is usually less resource-intensive than farming, and therefore has less environmental impact. Finally, expanded intensification on irrigated lands and higher value-added through mixed cropping on marginal lands should help to absorb the labor surplus of the rural landless poor.

Urban Environmental Management

Rapid urbanization, one of the most important demographic and social changes of the century, has both positive and negative environmental impacts. In Asia, eighty-seven cities have more than 1 million inhabitants; of these cities thirty-eight are in China and twenty-three in India. By 2005 more than half of the population in East Asia will live in urban areas. In South Asia the urban population will overtake the rural population by 2025 (see figure 1.7). The negative environmental impact of cities comes from the high levels of pollution they engender. The positive impacts—which need to be

more fully realized—are that pollution is more concentrated and can potentially be addressed more cost-effectively and that pressure on rural lands is reduced to the extent that urban growth reduces rural population growth.

Urban pollution is caused by high population densities, rising urban income and consumption levels, and large industrial concentrations. Infrastructure and services are unable to keep up with these trends. Local governments lack the capacity to collect and dispose of municipal sewage and solid wastes, or to control emissions and toxic wastes. The concentration of wastes overwhelms the assimilative capacity of natural ecosystems. Human health is threatened by the highly concentrated discharges of pollutants in urban areas.

The cost to Asian economies of urban environmental degradation has not been calculated, but initial estimates show that the environmental costs of air and water pollution in Jakarta and Bangkok exceed $1 billion and $2 billion per year, respectively. Costs in Asia's other large cities are comparable. Furthermore, these costs are rising as safety thresholds for a large number of pollutants and toxics are exceeded in increasingly large geographic areas. These costs would be 10 to 40 percent higher if vehicle costs and the value of time lost in traffic congestion were included.

In general, four environmental problems need to be addressed in Asian cities: water pollution, air pollution, solid waste management, and inappropriate land use. Of the four, water and air pollution issues (including congestion) will require the greatest investment expenditure.

Water Pollution

Water pollution is largely caused by domestic sewage but is compounded by industrial wastes. Surface water contaminants such as fecal coliform and dissolved mercury often exceed recommended standards many times over. Groundwater resources also are increasingly polluted, both from industrial wastes and from salination due to overpumping. Given the lack of water treatment or alternative clean water sources, water contamination is a major health threat. Comprehensive water resource management, which encompasses the specific problems of urban water pollution but takes a far broader view of all demands (urban, industrial and agricultural) on a nation's water resources, will be one of the most difficult set of issues to be faced in Asia in coming years.

The health and welfare impacts of urban water pollution have to be tackled on two fronts: provision of safe water supply and reduction of effluents. On the water supply side, actions are required to improve cost recovery, conserve water, maintain infrastructure, establish financially strong and commercially oriented delivery institutions, and establish independent and effective regulatory institutions. On the pollution control side, the problem can be divided into municipal waste and industrial waste (which is discussed separately below). There is evidence of increasing public willingness to pay for sanitation services, although research is needed in more cost-effective and community-based approaches to sewerage and sanitation. Although the public sector is expected to continue to play an important role in water supply, treatment and disposal, it is important to encourage private sector and community participation—which may require that water and sewage tariffs be raised. Such efforts are already beginning in Asia.

Air Pollution and Congestion

Urban air pollution is at critical levels. Data from the World Health Organization (WHO) show that twelve of the fifteen cities with the highest levels of particulate matter, and six of the cities with the highest levels of sulfur dioxide, are in Asia. Of the seven cities in the world with the worst air pollution, five are in Asia: Beijing, Calcutta, Jakarta, New Delhi, and Shenyang. The trends for suspended particulate matter—the air pollutant with the most serious health impacts—are rising in virtually all Asian cities (except in the Republic of Korea), regardless of income level.

Urban transport is the largest cause of air pollution in most tropical and subtropical Asian cities. Vehicle populations are doubling every

seven years (see figure 3.3), and a large share of these are high-polluting two-stroke and diesel vehicles. Furthermore, fuels in Asia are among the dirtiest in the world, especially with regard to sulfur in diesel fuel and lead in gasoline. Industry and building heat sources are the other major sources of air pollution, particularly in the colder climates of northern India and northern China.

Reducing emissions in the urban transport sector requires attention to vehicles, fuels, and alternative modes of travel. (Air pollution strategies are described separately, below, for the industry and energy sectors.) Investment in unleaded fuels, taxes on leaded fuels, and tightened standards for vehicles are among the most important and cost-effective short-term changes to be made. Unleaded fuels are being introduced in Thailand and Malaysia. Low-cost responses to congestion include traffic management, bus lanes, and demand management (such as parking fees, staggered office hours, and carpooling). However, without the provision of transit alternatives to private vehicles, higher taxes and traffic management will simply make transit more costly but not much less congested. In other words, both carrots (transit alternatives) and sticks (taxes and traffic management) are required to reduce congestion and air pollution.

In East Asia capital-intensive investments in public transit are becoming increasingly viable because of massive congestion, rising incomes, and exponential growth in the numbers of vehicles. In South Asia the emphasis should remain on low-cost modes of public transit, except where congestion is extremely high.

Solid Waste Management

Asian cities have invested relatively little in solid waste management to date, and they tend not to recover costs. Recycling is limited to "ragpickers" in the informal sector. Newer solid waste management approaches pursue opportunities for greater participation by private sector and community groups. Contracting out the management of transfer stations, treatment plants, landfills, and special industrial waste facilities is a feasible option. Given the general lack of attention to solid waste issues in Asia, donor attention could be catalytic.

Inappropriate Land Use

In many Asian cities urban sprawl has grown at the cost of ecologically sensitive areas. The availability of good land for expansion on the urban fringe lags behind population growth. Also, the poor typically move to marginal lands such as waste dumps, hillsides, and sites adjacent to industries close to the city center, with environmental and health consequences. Given the scarcity of land in most Asian cities, high-density development should be encouraged. Urban zoning and related regulations (such as the Urban Land Ceiling Act in India) should be adjusted to allow greater private sector initiative in land development, but with tighter public oversight and environmental assessments of new developments. Careful placement of public infrastructure is fundamental, followed by reform of land titling and transfer procedures. Finally, government or environmental NGOs need to ensure that environmentally sensitive land is set aside for conservation use.

An Urban Strategy

To improve urban environmental management in these areas, the top priority is to strengthen the capacity of local governments. One broad area for work is increasing the capacity for planning and implementation. Most local governments in the region lack the capacity to carry out effective urban environmental planning and management and have an impossible task of brokering between national, provincial, and local agencies and interests. World Bank and United Nations Development Programme (UNDP) experience in six Asian cities has demonstrated the value of a collaborative approach—in which government agencies, the private sector, NGOs, and community representatives strive to achieve a consensus on priorities and strategies—provided that local governments are sufficiently strong to broker disagreements and execute decisions. The details of institutional roles, dispute resolution, and urban management techniques, however, are very city specific.

A second large area for urban capacity building is municipal financial management. In the context of tariff reform for local services, decentralization, and increased investment in infrastructure, the creditworthiness of cities and local utilities has become extremely important.

Although urban pollution problems are widespread across Asia, World Bank urban environmental lending is more concentrated in East Asia because of the region's relatively higher urban concentration and overall prosperity. The Bank has recently doubled its lending for urban environmental management (to a total of $1 billion between 1993 and 1995), but it is still active in only twelve of Asia's eighty-seven largest cities. Expanding the Bank's work on institutional strengthening is probably as important to urban environmental quality management as its lending and should receive high priority.

Approaches to Industrial Pollution

The industrial sector in East Asia is now more than nine times its size in 1965, and in South Asia, four times larger. The total pollution load contributed by the industrial sector has grown exponentially. Estimates of industrial pollution in Asia indicate that between 1975 and 1988 emissions of sulfur dioxide, nitrogen dioxide, and total suspended particulates increased by factors of ten in Thailand, eight in the Philippines, and five in Indonesia (see figure 4.1; note that these are increases total pollutants, not ambient levels). Toxic pollutants, measured by an index of airborne, waterborne, and solid toxic wastes, also increased several times during this period. (It should be noted that these estimates are not based on direct measures of Asian pollution but are estimates derived from applying U.S. pollution coefficients to Asian industrial production data.) The public health impacts of these pollutants are compounded by the high geographic concentration of industry (especially in East Asia) and the water shortages in industrial areas (particularly during dry seasons) that often lead to high concentrations of pollutants in surface and groundwater.

To reduce industrial pollution in Asia, a multipronged approach is required. This must start with government commitment and a demonstrated will to clean up the most polluting industries. Effective pollution control systems require the removal of economic distortions (subsidies) and the definition of clear standards, followed by a combination of incentives, regulations, and monitoring activities to enforce the standards. This is already an enormous challenge, and some targeting will be required—for example, toward the most polluting subsectors or the most polluted regions.

If there is sufficient institutional capacity to implement industry-specific programs, some governments may also provide information and other incentives to encourage the adoption of clean technologies. Still, two difficult areas remain that require additional public resources and technologies: common treatment facilities for small and medium industries, and facilities for the treatment and disposal of toxic and hazardous wastes. Public sector leadership is required in both areas. Avoidance of these particularly difficult issues will only lead to higher mitigation costs in the future.

It is easier to clean up industrial pollution in a growing economy than in a stagnant one. Because of the magnitude of investment required, higher growth allows for more rapid turnover of aging technology, more rapid restructuring of industry and its product mix, greater opportunities for attracting foreign partners and technology, and higher public revenues. In Indonesia it is projected that by 2010 new investment will account for 85 percent of total industrial capacity.

The World Bank has initiated three "first-generation" industrial pollution control projects in Asia, each of which takes a different approach. The Industrial Pollution Control Project in India focuses on the worst chemical sector polluters in four states; the Beijing Environmental Project takes an integrated approach to citywide industrial and urban pollution; and the BAPEDAL project in Indonesia focuses on strengthening the national environmen-

tal protection agency. Although the projects have different areas of emphasis—a subsector in India, a metropolitan area in China, and an institution in Indonesia—they all give top priority to strengthening government pollution control agencies. Building on this experience, the Bank is planning industrial pollution studies and projects in China, India, Indonesia, Malaysia, the Philippines and Thailand. While it is appropriate that more of the Bank's industrial pollution projects are located in East Asia than in South Asia, more work is needed in South Asia, particularly in Pakistan.

Minimizing Energy Sector Impacts

With Asia's high population and economic growth, energy demand there is doubling every twelve years (the world average is every twenty-eight years). The demand for electricity is growing even faster: two to three times faster than GDP for most of the newly industrializing East Asian countries and up to two times faster for most of South Asia (see figure 5.1). The amount of investment planned in the Asian power sector during the 1990s ($290 billion) is two-thirds of all new power investment being made in developing countries and would double Asia's capacity by 2000. Given that the energy intensity of Asian economies is among the highest in the world, about 20 percent of this planned investment could be avoided through aggressive energy efficiency programs.

The negative environmental impacts from the Asian energy sector are primarily attributable to high growth in energy use, inadequate pollution standards for thermal power plants, and high dependence on coal. Although Asia's emissions are small in relation to its population, the projected increases will have regional and global consequences. In absolute terms, Asia could easily exceed Europe in sulfur dioxide emissions by the year 2000 and surpass Europe and the United States combined by 2005. By 2015, Asia is expected to catch up with all the industrial countries in carbon dioxide emissions caused by the burning of fossil fuels.

Energy use in Asia is heavily dominated by China and India. China alone consumes 55 percent of all energy in Asia, and India another 20 percent. Coal accounts for 92 percent of energy reserves for all of Asia, and China and India account for 94 percent of annual coal consumption. Both Chinese and Indian coals are fairly high in ash content, and some Indian coal is also relatively high in sulfur.

The least-cost approach to reducing the impending growth in emissions is to increase both supply-side and demand-side efficiency, while simultaneously promoting clean, renewable energy technologies. These goals will not be achieved unless energy subsidies are reduced. Many Asian countries show a pervasive bias toward low energy prices in certain markets, including coal in India and China, electricity in South Asia, and kerosene and diesel in significant markets across Asia. (Cross-subsidy issues complicate the picture, but only rarely should energy sources be offered at below cost, which is now common.) Assuming an average energy price demand elasticity of minus 0.5, even a 10 percent price change in the direction of removing subsidies would immediately reduce all emissions by 5 percent—without allowing for the effects of price reform on supply-side efficiency.

After price reform, operational improvements and institutional strengthening in both regulatory agencies and utility companies will help foster energy efficiency and adherence to environmental standards. Not only would full-cost pricing serve efficiency and emissions objectives, it would also have a major impact on strengthening the power sector and encouraging private sector participation. One crucial benefit of increased commercialization of the power sector is the potential for tapping the private sector for investment capital needed to expand capacity.

Efficiency gains in Asia, on both the supply and demand sides, can realistically achieve a savings of 20 percent of the amount of raw energy being converted to electricity and can do so at higher rates of return than for investments in new generating capacity. A 20 percent efficiency gain by 2000 would reduce the level of new capital in-

vestment required by $90 billion (50,000 megawatts). Not only are these savings very large, they are three times the cost of installing cleaner technologies on the facilities still to be constructed.

In addition to efficiency gains, additional measures for reducing the negative environmental impacts of existing and future plants are required. As mentioned, the required capital expenditures for additional power capacity in Asia are $290 billion for the 1990s, to be concentrated in China and India. This figure includes an estimated $50 billion for necessary pollution control equipment. Unlike in industry, where many clean technologies and processes lead to significant savings, the cost of clean coal-fired thermal technology is almost entirely add-on. Therefore the highest priority in Asia is strategies to reduce the most damaging pollutants with the least possible expenditure for add-on technologies.

The first priority for pollution control equipment should be curbing emissions of particulates, which is important for human health. Particulate reduction is relatively cheap—1 to 2 percent of the total capital costs of thermal power. The second priority should be on finding the most cost-effective solutions for reducing sulfur emissions, which is usually coal beneficiation. More medium-term strategies include investments in expanding natural gas networks, hydropower, small rural renewable energy systems, and cost-effective wind, solar, biomass, and geothermal installations that are large enough to be connected to the national power grid. All of these alternatives would become more viable with the full-cost pricing of fossil fuels.

World Bank policy requires government commitment to improving energy sector efficiency as a precondition for World Bank energy sector loans. This is important, since the main areas of sector reform—pricing reforms, transparent regulations, increased commercialization and corporatization of the energy sector, and supply-side technical efficiency—complement pollution abatement. However, additional Bank support is recommended in the areas of demand-side energy efficiency and renewable energy. Finally, the necessary large-scale investment in pollution control technologies will not be made unless Asian governments are convinced through clear economic and social analysis that they will realize commensurate benefits. An important role for the World Bank is to assist the efforts of Asian countries to analyze their energy-related environmental costs, benefits, and priorities and to help put in place regulatory systems designed to achieve their target pollution standards.

Natural Resource Management: Land, Forests, and Biodiversity

Arable land resources in Asia are facing intense pressure from farmers seeking to maintain food self-sufficiency. Forests and marginal lands are suffering from serious degradation for a variety of reasons, including excessive conversion to agricultural land, commercial logging, and excess demand for firewood and fodder. Asia faces the difficult problem of trying to secure production increases in agriculture and forestry without destroying remaining land, forest, and habitat resources.

Land degradation is a significant problem across virtually all agro-ecological zones in Asia, although the nature and scale of this degradation vary widely among and within countries. Land degradation occurs in a variety of ways: nutrient depletion, structural decline and compaction, biological decline, chemical deterioration (for instance, through acidification or salinization), and soil erosion. Data on land degradation and soil loss are not widely available for Asia, and figures cited by international organizations are often contested by governments as too high. With this caveat, United Nations data suggest that erosion is particularly severe in India (where 50 percent of the total land area is considered degraded, although estimates of human-induced degradation are much lower), Viet Nam (also 50 percent), Thailand (34 percent), China (30 percent), and Indonesia (24 percent). Localized soil waterlogging and salinity is most severe in India (27 percent of irrigated land), Pakistan (20 percent) and China (15 percent).

Among all tropical regions, East Asia experienced the highest rates of deforestation during 1981–90 (1.4 percent per year; see figure 6.2). Furthermore, deforestation rates in East Asia increased during the 1980s, in contrast to other tropical regions of the world. Once-dominant exporters such as Philippines and Thailand have exhausted their forests, and the remaining forest-surplus countries—Indonesia, Lao People's Democratic Republic (Lao P.D.R.), Malaysia, Myanmar and some of the Pacific Island nations—are facing excessive deforestation. South Asia has lower deforestation rates (0.6 percent) because of far fewer forest reserves. China and most of South Asia are net importers of wood and wood products, and by 2000 imports may cost nearly $20 billion per year.

The underlying causes of land degradation, deforestation, and biodiversity problems include: (a) market and policy failures—such as underpricing of resources, input subsidies, and lack of information about viable technologies on marginal lands—that lead to resource-degrading externalities; (b) a rapidly growing population that exerts pressure on land resources for both subsistence and commercial needs; (c) resource tenure structures that encourage short-term exploitation rather than longer-term conservation; and (d) institutional weaknesses that encourage mismanagement of resources. The mix and influence of these factors vary widely from location to location, given the wide diversity in Asia.

A strategy for addressing natural resource degradation in Asia should address both the short and long terms. The immediate strategic objective should be to stabilize areas of rapid land, forest, and habitat degradation. The longer-term objective is to minimize the underlying causes, including causes in areas broader than agriculture and forestry, through such broader social reforms as land reform, population planning, and poverty alleviation. A sixfold strategy for breaking out of the current patterns of natural resource degradation is suggested:

- Aggressive promotion of locally relevant technical innovations that promote sustainable resource management, primarily through better-targeted research (see below), extension services, and expanded roles for farmer and community groups in these areas.
- Modification of policy and regulatory frameworks that encourage inappropriate resource use (for example, sector reforms in agriculture and forestry). Forestry pricing reform is particularly important, given the trade bias in some Asian countries that encourages excess logging.
- Strengthened land tenure. Tenurial rights and investments in conservation measures are correlated (although in South Asia the importance of communal lands makes the link less direct than in the land-surplus countries of Southeast Asia). Clarification of property rights, through expanded programs in land registration and titling, is more critical as population pressure increases, as open access and communal property rights systems break down, and as land values increase.
- Improvements in public sector capacity to design, target, implement, and ensure compliance with resource management programs, especially in forestry.
- Encouragement of public participation in decisionmaking through the promotion of education, mass-media coverage, NGO involvement, consultation with community-based farmer and land management groups, and local-level conflict resolution.
- Promotion of social programs in education, health, and population planning to help settle rural populations, and provide options that enable them to take a longer-term perspective in managing their family and land resources.

From the outset, it should be said that this strategy will fail if there is not a strong political commitment to rural sustainability. The agenda is too complex (requiring, for example, long-term commitment to introducing new production technologies) and politically charged (because of the high political cost of reducing "rents" in the forestry sector, of addressing community conflicts in

protected areas, of facing the equity aspects of strengthened land tenure, and so on) to succeed otherwise.

To undertake this ambitious strategy, serious weaknesses and biases in public institutions must be addressed. Examples of shortcomings include irrigation authorities with a bias toward investment over management, and forestry institutions with a bias toward short-term commercial exploitation. It is not recommended that the powers of public sector agencies involved in agriculture, forestry, and park management be greatly expanded. Rather, existing institutions need to be recast and made more responsive to the wider range of issues at hand, including extension and other forms of information dissemination, applied research, decentralization, and participation.

Underlying this strategy are a number of difficult technical issues concerning natural resource management that impede the adoption of sustainable practices. The technical agenda for research and demonstration in Asia should extend in several directions:

- High-yield technologies and management practices for intensified agriculture that is environmentally sound. In the absence of surplus arable land, continued agricultural intensification is Asia's highest agricultural priority. Continued intensification can also help reduce pressure on marginal lands and is therefore a strong environmental priority as well. Specific environmental concerns related to intensification are soil waterlogging and salinity, and adverse impacts from agrochemical use.
- Viable strategies for crop diversification on marginal lands that do not degrade land resources and could even rehabilitate them. (The priority strategy does not generally include the more expensive process of reclaiming heavily eroded lands.) Various models exist for developing agriculture on marginal lands, usually involving systems of diversified combinations of shrub, tree, and other crops with greater drought tolerance and better soil conservation characteristics than annuals. The difficulty of this strategy is that such cropping models are highly site-specific and need to be tested and adopted locally—preferably as part of a strengthened extension system working directly with farmers.
- Sustainable techniques for commercial forestry, natural forest management, and social forestry, with careful consideration of tenure and community organization issues.
- Management techniques for public and communal lands, especially forest lands in need of rehabilitation and forest reserves in need of protection.
- Preservation techniques, both physical and financial, for parks and protected areas. Physical techniques involve including communities on the perimeter of protected areas in integrated conservation and development projects (ICDPs). Financial techniques include broadening the financial base to support parks and protected areas, through such channels as direct fundraising, NGO support, and ecotourism.

In sum, reducing natural resource degradation involves more uncertainty and technical unknowns than do most areas of pollution abatement. The underlying causes of land degradation are all long-term problems with long-term solutions. Pricing reform and the strengthening of land markets and tenure systems will help, but even these must be combined with strong government and donor commitment to institutional reform and technical research, demonstration, and extension.

Water Resource Management

Problems related to water quality and quantity in Asia will worsen with economic, urban and population growth. Competition between users will increase; availability will constrain growth in areas such as northern China and southern India; and surface and groundwater quality will decline as it has in many areas, such as Bangkok, Jakarta, Jiangsu Province (China), Karachi, and Madras. The combination of surface water pollution and large with-

drawals for agriculture is adversely affecting both river fisheries and coastal ecology. Finally, water resource development projects (such as dams, transfer schemes, flood control, and groundwater withdrawals), while having undisputed economic benefits, often have adverse environmental and social impacts. These impacts are often preventable, mitigable, or compensable—although with more effort than is commonly accorded today.

Improved water resource management and environmental protection of water resources are mutually reinforcing. Concern for both water quality and efficient use (that is, quantity) is implicit in improved water resource management. Similarly, the need to preserve water quality and to minimize alterations to water-dependent ecosystems is imperative in environmental protection. The integrated water resource management approach adopted at the Dublin International Conference on Water and the Environment in 1992 and endorsed by the World Bank recognizes these complementarities and forms the basis for environmentally sound use of water resources.

On the basis of this emerging consensus, a five-element strategy is suggested for better and more environmentally sound water resource management in Asia:

- Immediate and low-cost actions to prevent further irreversible damage to water resources. Examples are enforcement of watershed and protected area designations; temporary storage for toxic wastes (while more permanent solutions are being sought); and tightened industrial zoning in areas of groundwater recharge.
- Water sector policy reform, with explicit recognition of water as an economic good. Water pricing can be used to signal users, promote efficiency, reduce pollution, and foster cost recovery. Market-oriented valuation can also help in resolving conflicting uses and in integrating water policy with land, industrial, agricultural, and environmental policies. Linking water policy with national development objectives also helps ensure that water resource management and price reforms recognize the needs of the poor.
- Legislative and institutional reform. Institutional reform should reflect the findings that (a) water sector institutions function more efficiently as they are decentralized to river-basin and subbasin levels, and (b) water service providers function more efficiently as they become more commercialized, with performance-based accountability. Both principles have broad implications for legislative reform, institutional strengthening, planning methodologies, water quality monitoring and enforcement, and the role of local groups.
- Improved water planning, project preparation and implementation, and maintenance. Market failures concerning upstream-downstream problems argue for adoption of the river basin as the basis for planning. Planning priorities include identifying, promoting and implementing nonphysical measures; repairing and upgrading existing infrastructure; improving real-time operations and maintenance; and planning and implementing projects that reflect multisectoral economic, social, and environmental priorities. In deciding between water development options, full environmental and social costs must always be incorporated.
- Increased institutional capacity. Reform of the water resource sector will also require improved analytical capability for planning, management, and regulatory functions, especially as the system is decentralized. In this regard, improvements in data collection systems and data-sharing arrangements, both within and across river basins, are recommended.

Through country dialogue, technical assistance, and lending, the World Bank can be of great help in promoting the strategy outlined above. Although some Bank projects already incorporate elements of this strategy, the more broadly integrated approaches—such as multisectoral and market-oriented approaches—have not yet been widely

adopted in Asia. A specific analytical area in which the Bank is placing immediate emphasis is incorporating full environmental and social costs into water resource planning. Decisionmakers are often deterred from making appropriate decisions because these costs are not included in the analysis. In the case of protecting watershed areas and water quality, the costs of doing nothing are underestimated, particularly in comparison with other sectors.

Real or impending water crisis areas should also receive priority World Bank attention. The examples are well known. China has long discussed a major transfer scheme between the Yellow and Yangtze rivers—a project whose economic and environmental costs and benefits need to be carefully assessed. Water conflicts exist in the Ganges–Brahmaputra delta between India and Bangladesh, and both countries are engaged in uncoordinated water resource development programs. There are current or potential water shortages in southern India and around the Mekong delta.

Most major Asian cities have severe resource constraints. As a result of these and other water resource stress points, the World Bank is actively promoting its comprehensive water resource strategy.

The World Bank Environmental Strategy

Setting Priorities

This report has emphasized a framework for improving environmental management in Asia. The first step in that framework is for countries to establish priorities—a process that is analytically and (sometimes) politically difficult. The World Bank, through its analytical work and policy dialogue, can help countries set priorities, accept the consequences of policy reform, narrow the terms of their environmental strategies, and implement selected instruments. To better support this process, the World Bank has stepped up its environmental lending, policy dialogue, and research.

Project Lending

Traditional World Bank lending has not addressed the full range of environmental problems. This is not surprising, since many environmental problems have only become widely recognized within the past decade. In response to these problems, the Bank has significantly increased its lending for the environment and has redesigned some of its approaches.

There are several substantive areas on which the Bank places high priority and in which it is pushing to expand its activities (see box 1). In the "brown" sectors, these areas are urban and industrial pollution, energy sector efficiency (as an initial priority within a larger energy sector environmental agenda), and urban transit. In the "green" sectors, these areas are soil protection and rehabilitation (each requiring dramatically different strategies depending on local conditions) and improved management of remaining forest resources. Comprehensive water resource management—which cuts across the brown and green sectors—is also a high World Bank priority, since the approach has only recently been introduced in Asia. The final area, institutional strengthening, underlies progress in virtually all sectors.

The recommended priorities are substantially but not fully represented in the 1993–95 World Bank planned lending program. The largest gaps concern definition of the fiscal and administrative details of cost-effective approaches to urban and industrial pollution; investment in energy efficiency and urban transit (two "win-win" approaches with economic as well as environmental benefits); lending that incorporates integrated approaches to water resource management; projects that address fundamental resource tenure issues in rural areas; and a long-term commitment to strengthening environment-related institutions in Asia. Obviously, the World Bank cannot adequately cover all of these areas single-handedly, but it can make greater efforts to work with other donors and to provide intellectual leadership to its borrower countries.

Environmental lending in Asia will roughly

double between 1990–92 and 1993–95, from nearly $600 million to $1.2 billion per year, and from 6 or 7 percent of total lending to 12 percent (see figure 8.2). The fiscal 1995 estimates probably understate the eventual size, since the program will be partly based on analytical work now being done. Two-thirds of the Bank's Asian environmental lending will occur in East Asia. There, the level of lending in the brown sectors is more than double that in the green sectors, although both are growing rapidly. In South Asia brown-sector lending also exceeds green-sector lending; while both are expanding, they are doing so at a slower rate than in East Asia. The sectors of lending reflect, to a large extent, the development priorities in the two regions. Not included in the above estimates are areas of Bank lending that indirectly help the environment, through such intermediate interventions as population planning, health and education programs, poverty alleviation, agricultural research, and sector reform. Also, the Global Environment Facility (GEF) is not included in these totals.

Investing in institutions is potentially the most cost-effective component of the Bank's environmental strategy, since the basic policies and institutional characteristics of Asia's fledgling

Box 1: World Bank Priorities for the Environment

Sector	Status and Needs
Urban Environmental Management	Bank lending addresses urban pollution in only twelve of the eighty-seven cities in Asia with populations over 1 million. Incremental investment is especially required in India and East Asia. However, activities designed to help improve urban environmental *management*—and to benefit more cities than those receiving Bank loans—should proceed in tandem with investment.
Industrial Pollution Control	Of the twenty-six countries in Asia, eight have serious industrial pollution problems. All need technical and financial assistance to address the problems, particularly in the areas of policies, enforcement, small scale industry, and hazardous wastes. World Bank analysis may be as important as funding.
Energy Pricing and Efficiency	Energy subsidies are still pervasive in Asia and are a barrier to sectoral efficiency and emissions reduction. In addition, only three Asian countries are actively promoting energy efficiency strategies. Efficiency strategies are underinvested on both the supply and demand sides. Again, World Bank analysis may be as important as funding.
Urban Transit	Vehicle emissions and urban congestion are growing exponentially across Asia. Only strategies that increase the cost of using private cars *and* provide alternatives can address both issues simultaneously. Asian investments in public transit, cleaner fuels, and vehicle standards are all increasing. There is a need for more World Bank involvement in these areas—including in mass transit, where viable.
Water Resources Management	Water quality is worsening in Asia generally, with major public and ecologic health costs. Increasing agricultural, industrial, and urban demands are difficult to meet, given the deteriorating quality. Rising costs force efficiency improvements and policy and institutional reform. Bank support for appropriate policies, multisectoral planning within riverbasins, and decentralized management are all recommended.
Sustainable Agriculture	Agriculture on both irrigated and marginal lands is leading to excessive soil degradation. No country in Asia has the techniques and financing necessary for a concerted effort against soil degradation. Pricing reform and strengthening of land tenure will help but must be combined with strong commitment to institutional reform and technical research, demonstration, and extension.
Forest Management	The World Bank has defined forest-surplus and forest-deficit countries in Asia, with different strategies for each. In forest-surplus countries, pricing and trade policy reform are critical, along with improved management of public lands and research on more sustainable commercial and social forestry. In forest-deficit countries, management, tenure, pricing, protection of remaining reserves, and reforestation are important.
National and Local Institutions	Except for Japan and Korea, no Asian country has successfully implemented its approved standards and enabling legislation. Long-term support (five or more years) for policy implementation, monitoring, and enforcement—using innovative means—are of the highest priority.

environmental agencies will be largely shaped in the next five to eight years. Given that past experience with traditional technical assistance shows it to be the weakest part of the Bank's portfolio, innovative approaches to institutional strengthening are needed, involving longer time horizons and more sustained resources.

Beyond Project Lending

Much of the World Bank's strategy for the environment extends beyond investment projects. The following areas require broad-based emphasis.

Active Policy Dialogue. As mentioned, the World Bank—better, perhaps, than other donors—can help countries analyze and accept the consequences of policy reform, model scenarios for more sustainable growth, and refine the economic and administrative details of policy instruments.

Integrating National Environmental Action Plans (NEAPs). An important part of NEAPs is to merge environmental and development concerns. Priorities for the World Bank are not only to assist countries to complete their NEAPs, but also to provide the ongoing support necessary to get NEAP recommendations implemented. NEAPs could also be used as a common framework for coordination of donor-funded, environment-related activities. In the future, planning exercises that are more targeted, geographically or sectorally, may be less unwieldy and less political than the first round of NEAPs.

Strengthening Environmental Assessments (EAs). There is need to provide more sector-specific training on environmental assessment for task managers and borrower country officials. Increasing the capacity of key agencies in borrower countries to improve all EAs—whether tied to World Bank lending or not—is an important long-term goal.

Strengthening Consultation and Participation. The quality of project design, EAs, and implementation can be considerably improved by increased consultation with and participation by those affected by the project. Consultation refers to the process in which interested groups can express their opinions at discrete points during project design. Participation suggests a broader involvement by affected parties in both project design and implementation. (Participation can lead to the sharing of decisionmaking authority, whereas consultation does not.) For both, there is a need for improved field-oriented guidelines for Bank task managers and borrower country officials.

Establishing Appropriate Environmental Standards. The environmental standards applied by the Bank in the assessment of urban, industry, and energy sector projects are being updated in order to make them more flexible and appropriate to project environmental assessment. There is a role for the Bank to assist Asian countries in adopting new standards, especially in shifting from concentration-based standards to load-based standards in the industry and energy sectors.

Encouraging Private Sector Involvement. Private sector involvement is essential in advancing the key elements of an environmental strategy. A one-sided "punitive" regulatory approach will be less effective than one in which industry is actively consulted on standards and engaged in self-monitoring. A favorable business environment will also help facilitate the mobilization of required capital, technologies, and service industries.

Strengthening Internal Processes. The World Bank can do more to improve its internal processes, especially on projects with environmental or social impacts. Four areas are:

- Strengthening the Bank's role in project implementation. Without adequate supervision, the conditions imposed by environmental assessments may not be enforced, and the EA process itself will be marginalized.
- Strengthening the Bank's role in policy implementation. The Bank should increasingly address the "nuts-and-bolts" issues as-

sociated with policy implementation—taking into account the compromises necessitated by institutional weaknesses, corruption, and lack of data. Examples of ways to do this are: helping countries calculate optimal levels of pollution taxes, by pollutant; suggesting operational approaches to improved pollution monitoring, auditing, and enforcement; and introducing cost-effective approaches to data collection and use. As mentioned above, institutional strengthening and policy implementation go hand-in-hand and must be viewed as a long-term prospect.

- Expanding the Bank's analytical work program. There are gaps in the Bank's research program related to the environment. A few key areas for expansion are (a) learning from the experience of others, on both macro and sectoral levels; (b) valuation of environmental costs and benefits, for the purpose of setting investment priorities; (c) practical regulatory and institutional guidelines on approaches to urban and industrial pollution; and (d) innovative financing mechanisms for large sewerage and urban transit investments.
- Drafting detailed strategy or guidance documents for projects that address brown-sector pollution. The World Bank has recently completed strategies for Asian forestry, water resource, watershed management, and biodiversity projects. Similar work remains to be completed in the areas of urban environmental lending, industrial pollution, and energy.

Conclusion

Pursuing environmental sustainability in Asia is crucial in light of what is at stake. Both urban and rural problems are approaching thresholds of unacceptably high social and economic costs. The future environmental balance in Asia is also critical for the global environment, particularly for greenhouse gas emissions, forestry, and biodiversity. Although economic growth in Asian countries has given these countries some room to address environmental issues, the financial and technical resources required are beyond the capacity of any individual country or donor.

The World Bank's role, as described above, is to assist Asian countries to determine environmental priorities, identify sustainable economic policies, estimate full project-level costs and benefits, and increase administrative skills for implementing the recommended policies and projects. As was emphasized at the outset, the Bank's strategy is to support a process for achieving sustainability—a process that must involve every government and most donors active in Asia. This document is only one element of the broader set of World Bank activities designed to contribute toward achieving greater sustainability in Asia.

INTRODUCTION

This report was prepared to address the need arising from both within and outside the World Bank for: (a) an assessment of the trends and impacts of environmental problems in Asia, (b) a synthesis of the World Bank's experience in assisting Asian countries with environmental management, and (c) a clear statement on World Bank principles and priorities for environment-related assistance in the near future. The report is intended for several audiences:

- For readers inside the World Bank, it provides an analysis of current environmental issues in Asia and a systematic treatment of topics that are appropriate to the Bank's future lending, research, and policy dialogue.
- For interested readers in Asia and elsewhere, it summarizes World Bank analysis of environmental issues in Asia, and suggests a broad strategy for achieving environmental sustainability.

The report has three sections. The first section (chapters 1 and 2) describes the nature and magnitude of environmental problems in Asia, and outlines a framework for improving environmental management. The emphasis of this section is on a *process* for achieving sustainability—a process that must work within real institutional and resource constraints, and therefore must be continually updated as these constraints change.

The first step of the framework is to set realistic priorities for immediate action. This report cannot do this in detail for any one Asian country, as the local situations, priorities, and starting points vary tremendously across Asia. Rather, the report lays out elements of economy-wide and sector-specific strategies that are applicable to most Asian countries and identifies areas where local decision-making on priorities and types of interventions is required.

As is made clear throughout the report, institutional constraints are as binding as financial constraints. Even the first step of the proposed framework—setting priorities—is extremely difficult in any open political system, especially when environmental problems span most economic *and* geographic sectors, and when the pressures to try to do too much are great. Therefore, one of the greatest challenges in the environmental area is to help countries establish detailed priorities and to expand their institutional capacities to act on these priorities.

The second section of the report (chapters 3 through 7) addresses each of five sectors in greater detail (urban, industry, energy, natural resources and water resources). The technical and policy approaches to environmental problems that are proposed are clearly general and must be tailored to the needs of any given country.

Although this report emphasizes priorities, it does not advocate that some sectors require attention while other do not. Priorities across sectors are not a "zero-sum" game, in which attention to industrial pollution implies that reforms in forestry should be deferred. It is more important, within the resource constraints of each sector, to identify sector-specific priorities and to start acting on those. No line ministry should be oblivious to the fundamentals of cost-effective policy reform—which may actually cost very little. The central government can and will, of course, alter the overall thrust of its economy-wide policies and the sectoral allocation of public resources. However, not all components of an environmental sustainability are "top-down" or capital-intensive. Local-level and

institutional components are equally important.

The last section (Chapter 8), outlines the World Bank's potential role in assisting Asian countries to address environmental issues. The environmental focus of the Bank's lending program and analytical work has grown over the last several years, and is expected to grow further. However, there remain areas in which there is the potential for the Bank to do more, as outlined in this report.

This report is not a detailed blueprint for achieving sustainability in Asia. Neither is it a detailed blueprint for World Bank commitments in this area. By focusing on a process, the report highlights areas in which the World Bank can offer analytical and financial assistance to countries grappling with the fundamental elements of their environmental strategies.

To assist those interested in researching sectoral topics, an extensive bibliography is provided at the end of the report, organized by chapter. The listings for Chapter 1 are the most general references, and the listings for the other chapters are more specialized. All citations in the main text can be found in the bibliography *for that chapter*.

1

THE STATE OF THE ENVIRONMENT IN ASIA

Trends and Impacts of Environmental Degradation

The most serious problems in Asia are urban environmental degradation; industrial pollution; atmospheric emissions; soil erosion and land degradation; water resource degradation; deforestation; and loss of biodiversity. These problems are caused by a variety of activities: pollution from rapid urbanization, industrialization, and increasing energy use; land degradation due to deforestation and unsustainable agricultural practices; unsound management of water resources and watersheds; ecological damage attributable to large infrastructure projects; and loss of biodiversity due to widespread developmental and population pressures. Environmental problems are cross-cutting in nature, and impacts of activities in one sector often have cascading effects across other sectors.

This chapter contains a non-technical overview of environmental issues and trends in Asia. Data is not equally available across all sectors: for example, urban air pollution is much better documented than rural land degradation attributable to human factors. Many problems are highly localized and highly seasonal. In the absence of comprehensive data, the report uses data from specific sites, such as the incidence of water pollution in selected cities. It also presents well-documented trends, such as the growth in vehicle registrations and energy demand. The site-specific data is meant to illustrate the magnitude of costs in areas where inadequate actions were taken. The trend data is meant to illustrate how current situations will worsen without targeted efforts to change the direction of the trend. Although all such data must be subjected to more country-specific analysis before priorities for action are determined, one lesson re-emerges often: the cost of early action is less than the cost of rehabilitation.

Water Pollution

Water pollution is the most widespread environmental problem in Asia. The demand for water continues to rise rapidly across all sectors, lock-step with the growth in urban areas, industry, and irrigation systems and hydroelectric power. Also, the associated costs of long-term water resource cleanup and sustainable management are most likely the highest of any resource. Water pollution is responsible for substantial mortality and sickness in Asia, particularly among children. The overall impacts of water pollution in urban areas are especially telling on the poor (see chapter 3).

Water pollution comes from three main sources: domestic sewage, industrial effluents, and run-off from activities such as agriculture and mining. Domestic sewage is the primary source of water pollution in Asia, especially in and around large urban centers. Sewage treatment is very limited or non-existent in most cities, and most domestic sewage is dumped untreated into surface water. Asian rivers have high levels of fecal contamination,[1] that in the absence of good water treatment, present a major threat to human health and aquatic life (box 1.1). In addition, groundwater is polluted by cesspools, septic tanks, leaking sewers and landfill sites.

Industrialization compounds the water pollution from domestic sources, because most industries are located in or near cities and discharge their wastes into the same water bodies. As the region's industrial structure shifts into highly polluting sectors such as chemicals, electronics, electroplating and machinery, industrial effluents increasingly

Box 1.1: Water Pollution in New Delhi

In the Jamuna River the coliform count is 7500 organisms per 100 ml when entering New Delhi, and a staggering 24 million per 100 ml leaving the city. In addition, 5 million gallons of industrial effluent, including 125,000 gallons of DDT waste, are picked up by the river every day as it passes through the city.

Source: ESCAP 1992.

contain heavy metals and non-degradable toxic and hazardous waste, posing high health risks. For example, the level of dissolved mercury in Asian rivers far exceeds the recommended standard, especially during times of low flow.[2] Groundwater sources are also increasingly contaminated by leaching from industrial wastes. In some countries in East Asia, the pollution of water sources from industrial effluent is responsible for serious losses to fisheries and tourism.

Water resources are also contaminated by non-point pollution, such as run-off of agrochemicals from farms and leaching of tailings from mining activities. Increased use of both fertilizers and pesticides has polluted surface water and groundwater in many agricultural regions, with complex impacts on aquatic life and other animals higher in the food chain. In addition, increased use of pesticides has led to growing pest resistance, precipitating futile spirals of ever higher applications. Contamination during pesticide application and ingestion through food and water also pose threats to human health and welfare.

Excessive withdrawal of groundwater has lead to the lowering of groundwater tables, loss of water pressure, and salt water intrusion. These problems are widespread in China, India, Indonesia, Korea, Sri Lanka and Thailand. For example, increased pumping of groundwater near Bangkok caused a decline of about 50 meters in groundwater levels during the period 1955–82, and has led to land subsidence of about 60 centimeters over the last 25 years, aggravating the flooding problem. Since a large part of Asia's population lives in cities along coastal areas, increased use of groundwater for domestic and industrial purposes has increased the incidence of another problem—saline intrusion into groundwater, making it unfit for consumption. The problem is particularly severe in Bangkok, Manila, Jakarta and Madras.

Air Pollution

World Health Organization data indicates that twelve of the fifteen cities with the highest levels of particulate matter, and six of the fifteen cities with the highest levels of sulphur dioxide, are in Asia (table 1.1). Of the seven cities worst ranked for air pollution by the Population Crisis Committee, based on a range of physical indicators, five are in Asia. In addition, Asia is rapidly emerging as a major contributor to acid rain and global warming gases.

The major sources of air pollution in Asia are the transport, energy and the industrial sectors. Transport contributes the most to air pollution in many Asian cities, and this contribution is rapidly growing (see figure 1.1 for Bombay).[3] While Asia has a small population of motor vehicles compared to world totals, the vehicle population has been rapidly expanding—at rates above 10 percent per annum in several countries—and studies indicate a doubling of the vehicle population by 2000 (see

Table 1.1: Air Pollution in Asian Cities

Highest levels of particulate matter	Highest levels of sulphur dioxide	Worst ranking by the Population Crisis Committee
Shenyang	Shenyang	Calcutta
Xian	Seoul	Jakarta
New Delhi	Xian	New Delhi
Beijing	Beijing	Beijing
Calcutta	Manila	Shenyang
Jakarta	Guangzhou	
Shanghai		
Guangzhou		
Illigan City		
Bangkok		
Bombay		
Kuala Lumpur		

Source: WRI, IIED and UNDP 1988.

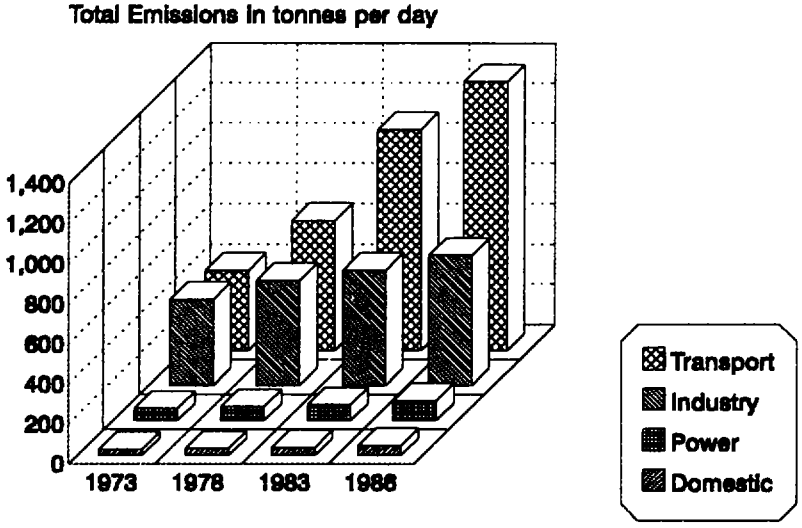
chapter 3, figure 3.3). Diesel vehicles and motor cycles powered by two-stroke engines, both highly polluting technologies, make up a large share of the vehicle population. Also, many of the vehicles have no pollution control, and the fuels used are among the dirtiest in the world, especially with regard to sulphur and lead.

Air pollution is further exacerbated by pollution from industry, energy generation and domestic sectors. While air pollution loads from industry are often significant in large cities, there are also large numbers of small cities in Asia that have very severe air pollution problems resulting from their development as industrial centers close to raw materials—such as the Singrauli region in India and Illigan City in the Philippines. In some cities, especially those in China, pollution from coal uses for domestic cooking and heating is a major source of air pollution. In addition, burning of biomass for cooking creates severe indoor air pollution problems in lower income urban households and in rural areas throughout Asia.

Both outdoor and indoor air pollution causes considerable sickness and death. The links between respiratory diseases and air pollution are fairly well documented, and recent studies have also linked mental dysfunctions to lead poisoning in children. "Dose-response" functions (that is, probabilistic functions that estimate the incidence of sickness and death due to a given level of ambient pollution) are being applied to Asian cities, with estimates of the costs of health and productivity impacts measuring in the hundreds of millions to billions of dollars per year, per city (see chapter 3, table 3.3). The health impacts of indoor air pollution are less quantified, but evidence indicates that pollution levels are often higher in rural households using biofuels than in even the most polluted urban environments (see chapter 5).

The Asia region contribution to global warming or greenhouse gases (GHGs) is rapidly increasing (figure 1.2), led by China and India. The region accounted for about 20 percent of the worldwide emissions of GHGs in 1985, and this share is expected to rise to 25 to 30 percent by the year 2000. Incremental growth of anthropogenic[4] carbon dioxide in Asia by the year 2000 is expected to more than offset any savings to be achieved by limiting emissions in OECD countries to 1990 levels. (These numbers do not reflect, of course, the enormous cumulative contribution to GHGs by OECD countries.)

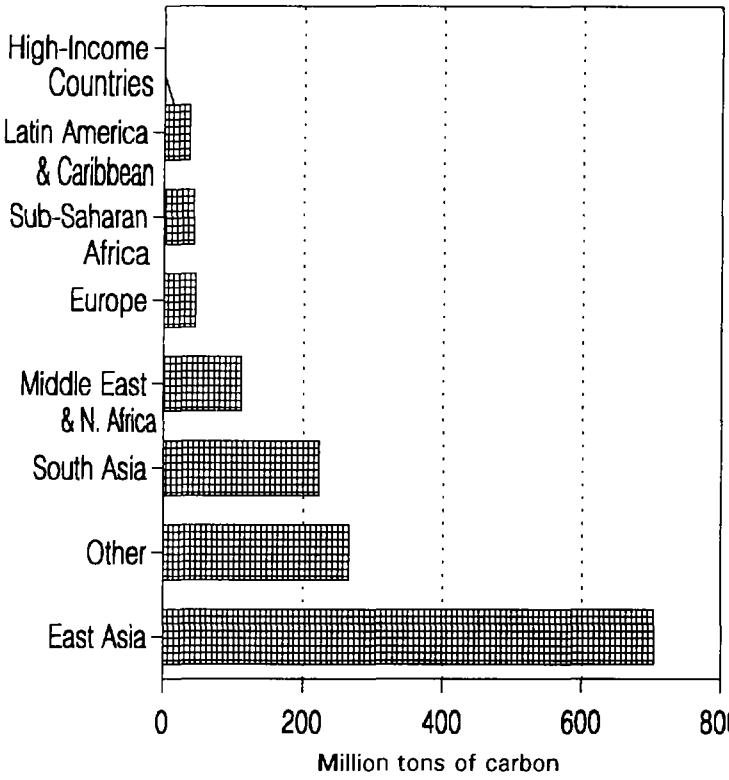
Figure 1.1: Emissions in Greater Bombay



Source: Municipal Commission of Greater Bombay

The threat of acid rain is growing rapidly in the region. Although data on sulphur dioxide emissions for the Asia region is incomplete, it is estimated that the region emits approximately 35 million tons (1990) per year, with more than half the emissions being accounted for by China. Two-thirds of the emissions originate from coal-fired power and industrial plants, with the rest coming

Figure 1.2: Incremental Carbon Dioxide Emissions 1990–2000



Note: Incremental carbon dioxide emissions from high-income countries are held at zero, according to the UNCED ceiling.
Source: World Bank 1992a and World Bank staff estimates.

from residential sources. Given the projected growth of energy consumption, sulphur dioxide emissions are expected to increase to 53 million tons by the turn of the century, and Asia will surpass both Europe and the United States in sulphur dioxide emissions (figure 1.3).

Solid Waste

While the per capita amount of solid waste generated in Asian cities is small, the total amount of waste generated is significant (figure 1.4). Currently, large metropolitan areas in Asia generate over a million tons of waste per year, and this is expected to increase rapidly with economic growth and continuing urbanization. The growth of solid wastes has strained the capacity of cities to collect and dispose of them. Uncollected solid waste presents major health hazards to populations, particularly the poor.

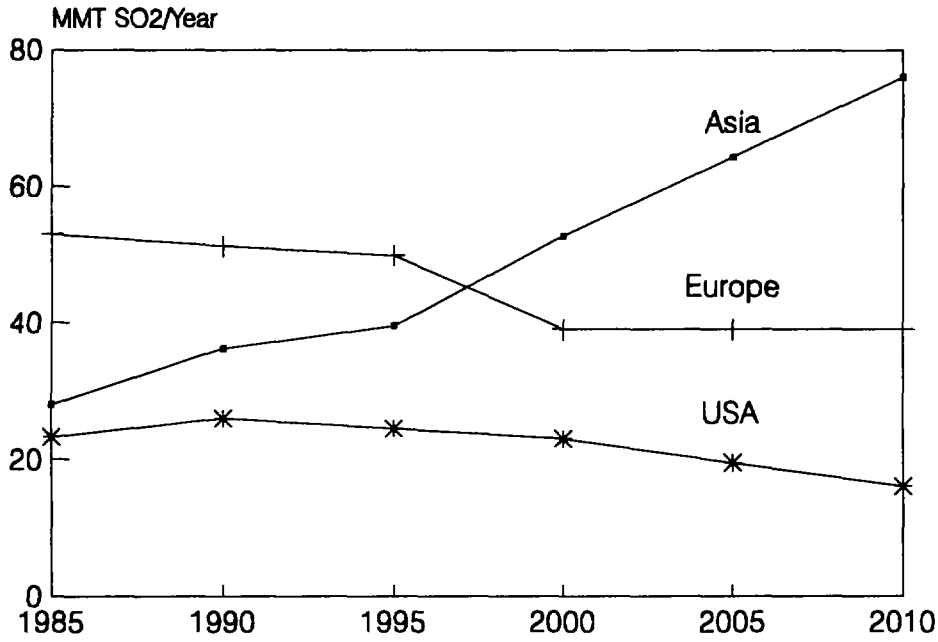
Toxic and Hazardous Waste

Toxic releases from industry include heavy metals, cyanides and pesticides, and can be discharged into the air, water, or as solid wastes. The only estimates to date of the toxic wastes generated in Asia are based on the production parameters of OECD countries (see chapter 4). Monitoring is typically done only for the conventional pollutants of biochemical oxygen demand (BOD), chemical oxygen demand (COD) and total suspended solids (TSS) in the effluent stream; and there is very little monitoring of toxics. Hence, even in the most industrialized Asian nations, regulators and industrial managers are largely ignorant of the extent and range of pollutants being released into the environment. Nevertheless, the rapidly increasing trend lines in the volume of toxic wastes are clear. In addition, many cities dump industrial toxic and hazardous waste along with domestic waste, further aggravating health problems and increasing the cost of future cleanup—as toxics require special handling and treatment.

Land Degradation

Data on land degradation are not widely available for Asia, but it is estimated that nearly 20 percent of the vegetated area in Asia was affected by human induced land degradation between 1945 and 1990. Soil degradation is a broad term that includes not only erosion, but also loss of soil fertility (due to loss of vegetation, nutrient depletion, waterlogging and salinization), and structural decline (such as compaction). Although it can be safely generalized that soil degradation is a significant problem across virtually all agro-ecological zones in Asia, both the nature and scale of this degradation var-

Figure 1.3: Current and Projected SO_2 Emissions



Source: World Bank and ADB data.

ies widely among and even within countries in the region. In India, for example, it is estimated that about 27 percent of the total land area is degraded, and up to 50 percent is susceptible to erosion (see chapter 6).

For erosion, the most widespread hazard is water erosion, caused mainly by excessive exposure of bare soil (due to poorly managed logging operations, indiscriminate land clearance, widespread use of annual crops in farming systems, bare fallowing, overgrazing, and thinning of vegetation by stripping the land of fuelwood) and inadequate management of runoff. Wind erosion hazards are restricted mainly to Mongolia, western China, and the drier parts of India and Pakistan. Soil erosion can cause considerable on-site and off-site costs. Agricultural production data do not yet reveal absolute declines in output due to soil erosion, partly because very little work has been done to measure the impacts of soil erosion. However, one detailed study in Java, Indonesia,[5] estimated the total of on-site and off-site costs of soil erosion at $340–400 million per year in 1989.

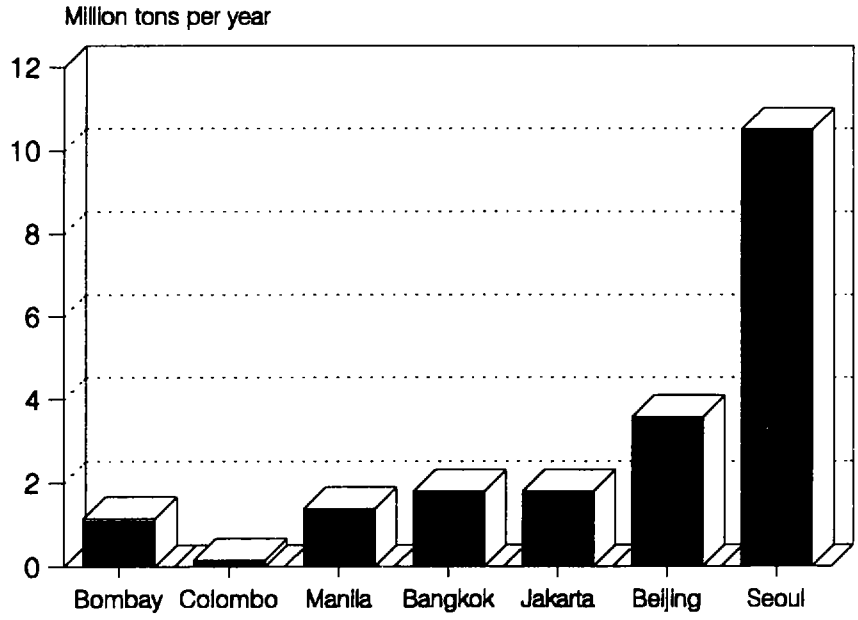
Waterlogging and salinity are particular problems in China, India and Pakistan. India has the highest amount of land affected by salinity (estimates vary, but range from 10–20 million hectares), followed by China (7 million hectares) and Pakistan (3 million hectares). Increased waterlogging and salinity in soils leads to reduction in output, loss of irrigated cropland, and increased salt loadings on return flows and aquifers. Also, standing water provides a breeding site for vectors that transmit diseases such as schistosomiasis and malaria.

Deforestation

The forest resource base in Asia is being rapidly depleted. Once dominant exporters such as the Philippines and Thailand have virtually exhausted their forests; India, historically self-sufficient, has become a major importer; and the remaining forest surplus countries (Indonesia, Lao People's Democratic Republic, Malaysia, Myanmar and some of the Pacific Island nations) are facing excessive and nonsustainable rates of deforestation.

During 1981–90, the highest deforestation rates in the world were in continental southeast Asia (Cambodia, Lao P.D.R, Myanmar, Thailand, and Vietnam), followed by insular Southeast Asia (Indonesia, Malaysia, and the Philippines). Deforestation rates in both these sub-regions increased by more than 50 percent over the previous decade. In Indonesia, more than 500,000 hectares are deforested annually. In India, Lao P.D.R., Malaysia,

Figure 1.4: Solid Waste Generated in Asian Cities



Source: UNCRD 1989.

Myanmar, and Thailand the extent of deforestation exceeded 100,000 hectares per annum in each country.

Deforestation is caused by a variety of factors: conversion to agricultural land, demand for fuelwood and fodder, and commercial logging for timber, although it is difficult to assign proportionate blame to these factors. It is estimated that between 30 and 80 million people are involved in shifting cultivation, affecting between 75 and 120 million hectares of land. Fuelwood and charcoal production accounts for nearly 77 percent of the total wood production in the region. In poorer countries (Bangladesh, Bhutan, Cambodia, India, Lao P.D.R., Nepal, Pakistan and Sri Lanka) fuelwood production accounts for more than 90 percent of the roundwood production.

Controversy surrounds the effects of logging on deforestation. While sustainable logging methods may not lead to serious forest depletion, such methods are rarely used. Logging also has cascading effects that can lead to deforestation. For example, opening up of access roads is an attraction for migrant settlers and for the shifting cultivation that follows in the wake of logging.

The economic impact of deforestation can be partially measured in terms of the loss of income due to inefficiency, over-exploitation of resources, and loss of future production. A natural resources accounting framework estimated the costs of forest depletion in Indonesia, Papua New Guinea and the Philippines at nearly $50 billion in the six years between 1980 and 1985 (in 1985 prices). An even more immediate indicator of the impact of deforestation is the estimate of future import requirements by countries that have traditionally been wood exporters. Based on current trends, imports of timber and forest products will cost Asian countries nearly $20 billion a year by 2000.[6]

There are other indirect economic impacts of deforestation and degradation, most of which are not easily quantifiable. Deforestation impoverishes rural populations dependent on nearby forests for their basic needs (including nonwood products like protein and shelter in addition to fuelwood and fodder). Deforestation in upper watersheds has been associated with increasing soil erosion, dam siltation, and increased flooding in the wet season followed by droughts during the dry season. Forests play an important role in sequestering carbon, and hence mitigate global warming. It is estimated that the destruction of tropical rainforests in Asia has increased the global atmospheric loading of carbon by 6 percent. Finally, deforestation is the most important cause of habitat loss leading to loss of biodiversity.

Loss of Biodiversity

Deforestation is the major cause of habitat loss in Asia, threatening the region's extraordinary range of biological diversity. About 20 to 25 percent of the earth's plant species and the greatest number of fauna in the region is found in the rainforests of Southeast Asia. Biological diversity in the wet forests of southwestern Sri Lanka, forests of eastern Himalayas, and the moist deciduous forests of the Western Ghats in southern India are under serious threat, as well as some low-diversity systems such as the mangroves in the Sunderbans, Bangladesh. In addition, biodiversity is also threatened by loss of wetlands, degradation of marine resources, loss of grasslands, and a variety of other indirect mechanisms such as introduced species, over-exploitation of plant and animal species, pollution of soil, water and air, and global climate change.

Nearly three-quarters of the natural habitat in the region has been lost or irreversibly degraded. Within individual countries, natural habitat loss has been very acute in India, Bangladesh, Sri Lanka, coastal Myanmar, south China, Java and the central island of the Philippines. It is estimated that Asia will lose a higher proportion of its species and natural ecosystems than any other region during the next twenty-five years.

The Underlying Causes of Environmental Degradation

A multitude of complex and interacting root causes are responsible for the environmental problems in Asia. The *first* and most important, which Asia shares with most of the world, is the fundamental market and policy failures concerning natural resources and the environment that have received little corrective action. These failures—which vary by resource and location—underpin most other causes, including population pressures. A *second* is the strain on the resource base imposed by Asia's large and growing population, which is projected to rise from 2.8 billion today to 4.3 billion in 2025—over 50 percent of the projected world total. This strain is exacerbated by the 700 million people currently living in absolute poverty. A *third* underlying cause is rapid urbanization and industrialization, which impose complex demands on the assimilative capacity of the environment, as well as on human and institutional abilities to respond. A *fourth* is the common perception (caused, in part, by lack of information) that there is a direct trade-off between environmental protection and economic growth. There is, in fact, no trade-off: rational policies will cost less to implement than the resulting reduction in external costs, leading to a net increase in economic efficiency and social return on investment.

Market/Policy Failures and Institutional Weakness

Market failure. Markets worldwide fail to reflect the full economic and social cost of environmental problems, or the full value of conserving natural resources and biodiversity. For example, industries are allowed to spew solid, liquid, and gaseous wastes into the environment without having to incur the costs for doing so; households, to dispose of garbage in the neighborhood without taking into account the social costs that result; cities, to discharge untreated municipal waste into rivers without having to account for the impact on water resources; farmers, to farm marginal lands for short-term gain in disregard for the resulting erosion and desertification; farmers, to use excessive pesticides without concern for the downstream environmental impacts, the resistance created in pest populations, or the health impacts to humans; and deforesters, to clear forests in disregard for the non-market benefits of forest cover (such as biodiversity, non-timber products, carbon sequestration, protection of watersheds, and some protection against flash flooding).

Policy Failure. Market failures are further aggravated by government actions or policy failures that encourage inefficient resource use—such as the subsidized provision of water, sanitation, electricity, and agricultural inputs. For example, provision of water at subsidized prices encourages excessive

water use in the agricultural sector, with potential negative impacts on cropland due to waterlogging and salinization, and negative impacts on fisheries and estuaries downstream due to reduced flow. Similarly, low water tariffs encourage industries and households to use too much water. Data from the Indian pulp industry indicate that water consumption in water-scarce regions is several times higher than in water surplus regions elsewhere in the world. Other policy failures are tied to inappropriate tax incentives, trade policies and exchange rates that can lead to environmental problems (see chapter 2).

Institutional Weakness. Related to policy failure is the lack of strong environmental institutions capable of formulating, implementing, and enforcing environmental policies. Weak institutional capacity is further weakened by jurisdictional complexity, insufficient information, and lack of broader participation. While all Asian countries have some environmental legislation, most governments lack the capacity to carry out effective environmental planning and management. Regulations, guidelines and standards are often not well developed, nor do they reflect the institutional capabilities and scientific knowledge available within the country.

Institutional weakness is acute at the level of local governments and agencies who are responsible for monitoring and enforcement. These agencies usually have low status in the bureaucracy, have inadequate powers, and lack adequate staff, skills and equipment. A multiplicity of actors (national and regional sector agencies, state or provincial governments, local governments) with overlapping, uncoordinated, or poorly defined responsibilities aggravates institutional weaknesses and hampers the development and implementation of a broader environmental management strategy.

Environmental management is further constrained by the lack of environmental information and analytical frameworks for understanding the problems. Most governments are not fully aware of the magnitude of the problems or the impacts on the population. Although they are shackled by their lack of capacity, most public institutions rarely involve the private sector, local community, or other interested actors in environmental activities. This lack of user participation usually results in inadequate support for environmental management activities.

Population and Poverty

Asia, with the two most populous countries in the world (China and India), is home to about 2.8 billion people, or over half the global population. The huge size of the population and the large proportion of youth ensures great momentum for continued growth. Despite recent declines, fertility remains over replacement levels: total fertility is above four children per woman in most Asian countries, with the exception of China, Indonesia, Korea, Malaysia and Thailand. By 2025, Asia will have added another 1.5 billion people to its population (figure 1.5). In 1985, more than 35 percent of Asia's population were children under 15 years of age. Although the percentage of young dependents to total population is expected to decline by the year 2000, the absolute number will increase. The old age dependency ratio is also expected to increase from 7 percent in 1985 to about 9 percent in year 2000.

South Asia contains half of the world's poor, and nearly half of the region's population lives in poverty (figure 1.6). In East Asia, nearly a fifth of the population live in poverty, most of them in China. Further economic growth is necessary to sustain the gains already made in poverty alleviation and to make further advances.

Population growth contributes directly to environmental damage, as economic, social and political systems fail to keep up with the growing demands. Market and policy failures have already been mentioned. Social and political rigidities, in the face of tangible human needs and at times of rapid change, also lead to nonsustainability. In rural areas, traditional land and resource management systems fail as population increases and land parcelization leads to overuse. Skewed land distri-

bution often compels the poor to survive by cultivating marginal land—erosion-prone slopes and cleared forests—leading to erosion and other environmental problems. Without tenure, and often with only passing claims on the land they cultivate, the poor are less likely to make investments to protect natural resources. Governments also have difficulty keeping up with the infrastructural and human needs of a growing population. The lack of adequate public investment in human capital has limited the productivity of the poor, and hence reduced their options for livelihood. Even the richer segments of the population in both the poorer and richer countries, being fully aware of economic and social trends affecting the resource base, exhibit short-sightedness and greed.[7]

Already, the region is facing heavy resource pressures. Fourteen of the twenty-six countries in the region have population densities of over 100 persons per square kilometer. Though food production has historically risen faster than population, this has been due to intensified agriculture, bringing its own set of environmental problems (chapter 6). Further expansion of the area cultivated is barely possible, as it would have to be at the expense of increasingly marginal forests, rangelands and wetlands, offering limited agricultural returns and contributing to cumulative environmental degradation.

The lack of non-farm employment opportunities for the rural poor and scarcity of agricultural land encourage migration by landless families.[8] Some migrate to the cities, seeking employment, where they contribute relatively little to the major sources of urban degradation (due to low per capita consumption). The rest migrate to other rural destinations, and occupy parcels of marginal land often cleared by others (such as lumber companies exploiting government concessions). It is in the rural areas—where land markets do not function well, labor productivity is low (due to marginal and decreasing land productivity), production risks are high, and investment time horizons are very short, that poverty and environmental degradation are most closely linked.

Urbanization and Industrialization

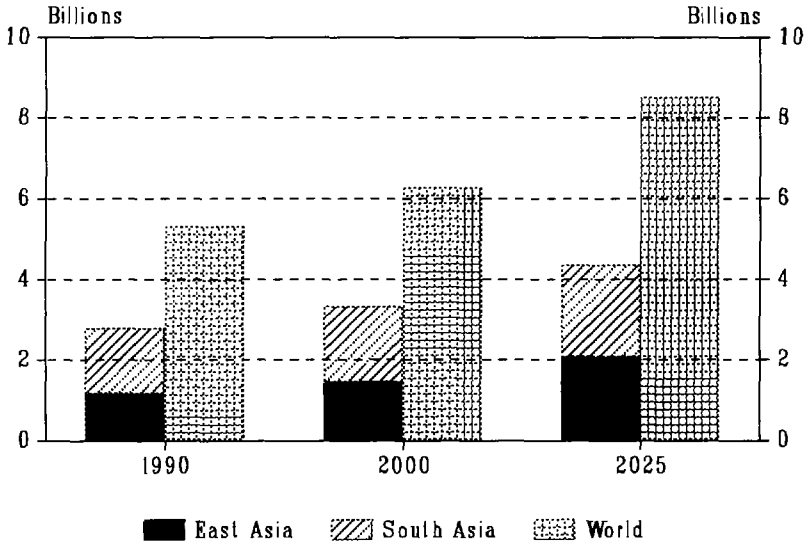
In urban areas, environmental problems are largely caused by the high concentration of domestic and industrial wastes that, in the absence of adequate collection, treatment and disposal, overwhelms the assimilative capacity of the environment. In addition, ecosystems are destroyed as urban and industrial development consumes land in environmentally sensitive areas. The urban-industrial pollution problem is largely a "sink" capacity problem, though there is an element of "source" extraction problem in terms of demand for raw materials.[9] Also, the urban-industrial sector can have an adverse impact on the rural sector through the extraction of natural resources and through the downstream impact of polluted rivers, creating problems for rural domestic and agricultural use.

Nearly a third of Asia's population currently live in cities and towns. Urban population growth accounted for 45 percent of total population growth since 1960, tripling the number of city dwellers from 266 million to 840 million.

This dramatic demographic shift is continuing unabated—the urban population is expected to triple again to 2.5 billion by 2025, when nearly 60 percent of Asia's population will be living in cities and towns (figure 1.7). This will account for more than 100 percent of total population growth over the period, implying some net reduction in the rural population. In fact, the net decline in rural population may have already begun in East Asia; and the East Asian urban population is projected to exceed the rural population by the year 2005. In South Asia, the surge of urbanization is not expected to exceed the rural population until 2025.

The rapid population explosion is concentrated in a few cities in the region. Megacities (cities of more than 8 million people) are growing rapidly in size and number in Asian countries. In 1950, there were no megacities in Asia; by 1990, there were nine, accounting for nearly half the megacities in the world. By the turn of the century, there will be thirteen in Asia, again accounting for nearly half of the worldwide total (box 1.2). Bombay, Calcutta and Shanghai will each have more than

Figure 1.5: Population Growth



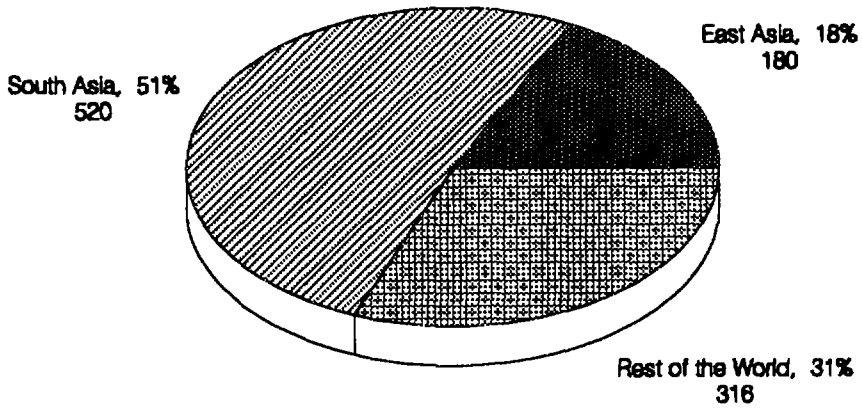
Source: UN projections.

15 million inhabitants.

With further rapid urbanization in the region, even with lower incidence of poverty in urban areas, increasing numbers of the poor will be found in the cities and towns of Asia. It is estimated that nearly half the households in poverty will be living in cities by the turn of the century. By then, rural poverty is expected to show a slight decline, while urban poverty will increase to match the level of rural poverty. Already the poor account for 60 percent of the populations of Calcutta and Jakarta, 45 percent of Karachi and Madras, and 35 percent of Manila.

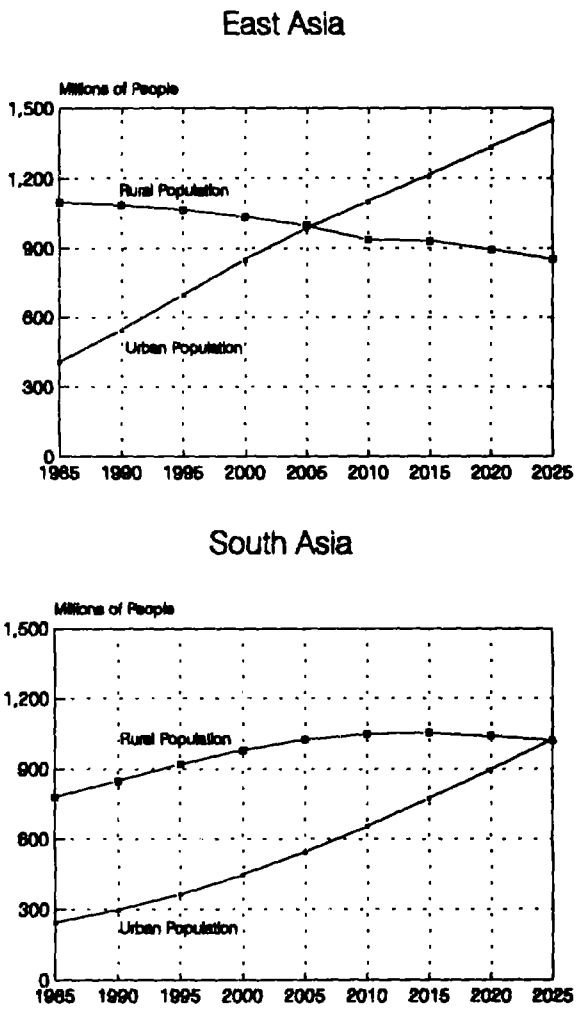
Urbanization is fueled by economic growth. The locational advantages and the economies of scale of large cities enable them to generate goods and services far in excess of their share of the national population. Shanghai, with only 1.2 percent of China's population accounts for about 12.5 percent of the nation's industrial output. Bombay, India's leading financial and business center, has just over 1 percent of the country's population, but generates 10 percent of India's industrial jobs and handles more than a quarter of foreign trade. It is estimated that the Bangkok metropolitan region, with 16 percent of Thailand's population, accounts for 48 percent of GNP, and 75 percent of manufacturing.[10] In Bangladesh, nearly half the manufacturing jobs are in Dhaka, inhabited by just 6 percent of the country's popula-

Figure 1.6: Number of Poor (in millions)



Source: World Development Report 1990.

Figure 1.7: Growth of Urban and Rural Populations in Asia 1965–2025



Source: United Nations 1991.

tion. Given these advantages, economic growth and urbanization are bound to remain linked.

Similarly, industrialization will continue to be the driving force of economic growth in Asia, although this trend is more pronounced in countries in the East Asia Region. While industry accounts for nearly 20 percent of GDP across all of Asia, China, Indonesia, Malaysia and Korea have industrial sector shares of more than 40 percent. The rapid pace of industrialization is expected to continue as countries in the region liberalize markets and relax trade regimes. Also, most of the industries are located in urban areas and add to the concentration of urban pollution problems.

Box 1.2: Megacities in Asia

1990	2000 (Projected)
Shanghai	Dhaka
Calcutta	Karachi
Bombay	Bangkok
Seoul	Bangalore
Beijing	
Tianjin	
Jakarta	
New Delhi	
Metro Manila	

Population growth combined with economic development and industrialization is generating an extremely rapid growth in demand for energy. At current growth rates, energy demand in Asia is doubling every twelve years (compared to a global rate of every twenty-eight years). In addition, energy intensity (the amount of energy per unit output) in Asia is the highest in the world.

The challenge before Asia, therefore, is to find ways to make fundamental trends in economic and population growth more sustainable, and to reverse the pollution and resource degradation trends that are already apparent. What the resulting form of sustainability will ultimately "look like" is the subject of strong debate, and must be addressed on an economy-wide basis for each Asian country. The next chapter describes a framework for focusing on the great number of economic, political and social decisions required in each country attempting to achieve greater sustainability, compatible with continued growth.

Notes

1. According to data from the Global Environmental Monitoring System (GEMS) of the United Nations.
2. GEMS data.
3. The total emissions data for Bombay includes sulfur dioxide, nitrogen dioxide, carbon monoxide, particulates, and hydrocarbons. Admittedly,

a summation across all of these pollutants is less meaningful than the disaggregated amounts, but the disaggregated amounts are not readily available.

4. Anthropogenic carbon emissions are the result of human activities, such as fuel consumption and various industrial processes (such as cement production). An important non-anthropogenic source of carbon is the rotting of biomass.
5. World Bank 1990, pp. 60–62.
6. World Bank 1992b, pg. 7.
7. Hilborn, Ludwig, and Walters 1993.
8. According to the International Labor Organization, while the proportion of the total workforce in Asia that are unemployed or underemployed has fallen from 58 percent in 1970 to 47 percent in 1985, the absolute number has increased from 289 to 410 million.
9. The term "sink" refers to the local ecosystem's absorption of pollution. "Source" refers to environmental problems created when resources are extracted for human use. Water pollution caused by industrial waste is a sink problem. Loss of biodiversity attributable to low river flows caused by high water extractions for urban use is a source problem.
10. Mingsarn 1992.

2

A FRAMEWORK FOR IMPROVING ENVIRONMENTAL MANAGEMENT

At a broad level, the debate about environmental management has shifted from concerns over *physical limits* to growth, to concerns over achieving *sustainable* growth, using appropriate policies and incentives. Evidence suggests that where environmental policies are publicly supported and firmly enforced, dramatic improvements in sustainability consistent with the physical resource base can be achieved.

The range of required activities is extremely wide—in terms of the policy instruments, the affected economic sectors, and the affected populations. Agenda 21, presented by the world's developing countries at the 1992 United Nations Conference on Environment and Development (UNCED), is an ambitious document in every sense. As in any situation where public opinion and public behavior are important, changes will take time to be absorbed and realized. Equally important, long-term political commitment is required to support and enforce the required policy reforms.

This chapter proposes a framework for improving environmental management. The first of its five components is the need to set priorities—an obvious but difficult step imposed by shortages of financial and administrative resources. It then addresses four key areas of national environmental strategies: designing cost-effective policy instruments; improving institutional capacity; increasing public and private sector investments; and improving technology, even in areas not fully supported by the market. Two final sections address the need to combine national level (top-down) and local-level (bottom-up) approaches, and the economic and social impact of improved environmental policies.

Actions Required

Setting Priorities

The complexity of actions required, combined with real financial and institutional constraints, means that the first element of any framework be to set priorities. Priorities for action are ideally based on collection and analysis of available data, careful valuation of the costs and benefits of various types of interventions, assessment of the administrative burden of alternatives, and participatory decisionmaking. This is clearly a daunting and politically difficult task, which is why government priority-setting processes are rarely made explicit.

Unfortunately, it is much easier to analyze the symptoms of non-sustainable development than to make difficult choices concerning priorities for intervention. How should countries set priorities between local and global pollutants, and between policy reform and capital investments? A full cost-benefit comparison of alternative scenarios is often unrealistic, since it requires too much data and covers too many hypotheticals. In practice, priorities are best set as the result of a process involving both technical and public inputs, and taking into account scientific, economic, and medical evidence (box 2.1).

Ultimately, based on these inputs, governments and communities set priorities among different environmental problems. But this is only the beginning, as other choices must also be made.[1] First, governments must decide what level of environmental quality is politically and economically feasible. Second, governments must decide what instruments should be employed in achieving its environmental objectives. If all social costs and benefits of each incidence of environmental deg-

Box 2.1: An Analytical Approach to Setting Priorities

Setting priorities is basically a process of ranking future actions, such that the things to be done first will achieve the greatest gain relative to the available resources. Priorities, therefore, determine the path by which improvements in environmental management are to be achieved. *How far* one travels down the path—*and how fast*—are determined by many factors that change over time, such as the level of resources available, the administrative capacity of the government, and the role played by the public through participatory or political processes.

Setting priorities involves ranking alternative policies and expenditures such that those with the highest ratio of benefits to costs are implemented first. The benefits to society of mitigating environmental damage due to a specific cause needs to be compared with the economic and social costs of achieving that mitigation. There may exist inexpensive (partial and upgradable) measures that achieve significant improvements and therefore have a high benefit-cost ratio. This is especially the case where future harm can be prevented.

There are a variety of measures that can be used to address environmental problems, including economic policy reforms (such as energy pricing), specific environmental policies (such as new regulations, adequately enforced), and targeted environmental expenditures. Because these measures must be applied simultaneously and in a complementary manner, it is necessary to have a good understanding of the likely future effects of economic and environmental policies to ensure that investment and expenditures undertaken *today* will not be made redundant *in the future* by policy measures. Similarly, it is important to identify and address institutional and other implementation constraints first before making policy and/or expenditure commitments.

Experience has taught us the lesson that prevention is much better than cure, so that it is ever important to ensure, for example, that appropriate standards for the disposal of toxic wastes are introduced and enforced. A second lesson is that partial solutions at a modest cost may be preferred to "permanent" but expensive measures that may have relatively low benefit-cost ratios. *In setting priorities for environmental management, it is the incremental benefit-cost ratios that matter.*

Source: Adapted from World Bank 1992b, pp. 1–15.

radation were available, then optimal levels of intervention could be determined. However, neither available data nor current methodologies allow this. Environmental objectives and instruments must be determined by linking available data and valuation of costs and benefits with such factors as the feasibility of enforcement and the intensity of public concern over risk. These issues, as well as the important role of public participation in the setting of environmental objectives, are discussed throughout the sector-specific chapters.

Policy Reform

The second element in the framework is to design cost-effective policy instruments that minimize costs, economize on scarce administrative skills, and are broadly acceptable to society. Environmentally appropriate policies are not inconsistent with policies that foster growth and trade, but they do attempt to correct the bias of market and policy failures that lead to over-exploitation of non-priced and under-priced environmental resources.

Although the exact descriptions and intensities of environmental problems vary by country, the underlying causes of the degradation vary little. The causes can be traced to both market failures (such as lack of information, price externalities, public goods and free riders, and inadequate property rights) and policy failures (concerning pricing or trade policies).

Policy reforms used to improve sustainability can be clustered into three distinct but complementary groups:

- market-based policies, which use pricing, taxes, or marketable permits to modify behavior;
- regulatory or administrative policies that impose quantitative restrictions, enforce property rights, and screen investments (both public and private); and
- extra-regulatory approaches to pollution control, such as the introduction of public disclosure requirements and increased use of the court system in environmental liability suits.

Most Asian countries have developed environmental policies that draw heavily upon the sec-

ond group—which is consistent with the traditional path taken by the OECD countries as well—but less so on the more innovative approaches of the first and last groups. The emphasis on regulatory policies has had relatively high administrative costs as well as relatively low economic efficiency. For both reasons, efforts to encourage reform in the other two groups promise both greater cost-effectiveness and better use of scarce administrative skills.

Market-based Policies. The most important type of market-based policy reform is pricing reform. "Full-cost" pricing (that is, removing subsidies *and* internalizing the externalities imposed by the resource use or pollution emitted) is fundamental to reducing the consumption of resources in virtually all sectors. Taxes and/or tradable permits levied on pollution and congestion are equivalent to raising the price on air, water, and land resources. Depending on the relevant elasticities, market-based policies will lead to some increase in financial flows to the "owner" of the resource—which is often the government.[2] These revenues can be reinvested in the resource itself, particularly in the case of public infrastructure investments (for example, in water supply and energy) and public goods (such as air and forests). In addition, both price increases and fiscal instruments can help stimulate technological adaptation that favors greater efficiency and reduced pollution.

Pricing policy is appropriately applied to both goods (such as electricity, water, road use, parking, land, and trees) and to incidences of resource degradation (such as pollution and vehicle emissions). Specific areas in which pricing reforms are particularly important in Asia are summarized below (see also chapters 3–7 for details).

- **The urban sector**. Asian municipalities, struggling to keep up with rapid urbanization and industrialization, face continual infrastructure expansion and maintenance problems. Increased user fees to attempt to make water supply, drainage, sewage, and solid waste more financially self-sustaining are important. In practicality, user willingness to pay for water exceeds willingness to pay for sanitation and solid waste disposal. Pricing policies that help water utilities recover costs and that discourage wasteful use are an essential first step to solving water crises. In the transport sector, pricing measures (fuel, emissions and/or parking taxes) are a partial step to reduce emissions and congestion, but must be combined with other sticks (such as traffic management) and carrots (public transport) to be effective.
- **The industrial sector**. Market-based approaches to industrial pollution should—based on experience more than theory—combine strong disincentives (pollution charges, permits, or presumptive charges) with mild fiscal incentives (temporary financial subsidies, accelerated depreciation, or lower customs duties) (see box 4.9). The incentives should be more time-bound than the disincentives, and designed to accelerate abatement during the transition from the period of little industrial pollution control (the 1970s–1980s) to the period of broad compliance (1995 and beyond). Sound sector policies combined with proper pollution-related policies will also stimulate technological adaptation and clean technology investments (box 2.2).
- **The energy sector**. Full cost pricing of energy inputs and electricity will stimulate higher supply-side efficiencies, modernization of equipment, demand-side conservation, and capital flows from the private sector. All are important. In addition, such reforms could stimulate investment in clean and renewable energy sources, particularly for rural areas that remain off the national grid. Where coal remains the overwhelming choice for energy and power generation, pollution abatement will only result from direct pollution controls, whether market-based or regulatory. Price reforms are essential to help utility companies finance coal beneficiation and clean coal technologies.

Box 2.2: Policy and Entrepreneurial Responses to the Montreal Protocol: Evidence from the Dynamic Asian Economies

A recent OECD study examined how the governments and firms of Hong Kong, Korea, Malaysia, Singapore, Taiwan and Thailand responded to the challenge posed by the Montreal Protocol to reduce their consumption of ozone-depleting substances (primarily chlorofluorocarbons [CFCs]). Although the strategies and costs incurred varied by country, some lessons emerged.

First, it is clear that countries that put in place quantitative restrictions on CFCs sent a clear signal to firms to begin conserving, and this was important. Initial reductions were often quite dramatic as firms that had few prior incentives to conserve introduced better housekeeping and engineering controls. These reductions came at a small marginal cost and with high benefits (i.e. CFC reduction by half). This implied a strong case for early implementation of control measures, even if, technically, the countries had a ten-year grace period.

Second, costs tended to rise rapidly after the initial 50 percent reduction. However, faced with the right set of incentives, firms exhibited considerable ingenuity for least-cost solutions. Harnessing this ingenuity is an important consideration in the design of policies.

Third, the firms were helped by governments, which played a positive role in diffusing technical and market information to CFC users. In some cases, governments provided centralized recycling services and helped firms evaluate alternative technologies. These services were particularly helpful to smaller firms.

Finally, once CFC quotas were in place, governments did well to devise an allocation system (permits) that enabled them to capture the bulk of the quota rents. These rents were then used to finance measures designed to facilitate the CFC phase-out effort. Clearly, a similar approach could be taken for other industrial pollutants, with the primary difference being that the political commitment to pollution reduction would have to be generated domestically, and not through a binding international agreement. An example of this is the recent tradable sulphur dioxide permit system introduced in the United States.

Source: O'Connor 1991.

- **The agricultural sector**. The two most overexploited agricultural resources are marginal lands (which lack clear tenure arrangements) and water, both of which are often treated as free goods by farmers. Water conservation can be directly affected through the higher pricing of irrigation water. (In comparison with energy, demand elasticities for water are lower—at least in the range of politically realistic increases—and therefore the percentage conserved would be less.) The use of marginal lands for agriculture, however, is typically less of a pricing issue than one of property rights (see below).
- **Forestry**. Forest concessions and stumpage fees have been priced traditionally very low in Asia, leading to massive deforestation with excessive social costs. Setting higher rates requires careful valuation of forest resources and their externalities (box 2.3). The use of public lands for grazing and social forestry can also be made more sustainable through pricing, enforcement of access, and more clearly defined property rights.

Command and Control and Other Regulatory Policies. Non-market-based policy reforms—including regulatory, legal and administrative reforms—are required to complement market-based ones. No country in the world has relied solely on market-based environmental policies to reduce pollution. The command and control approach to pollution control, in which governments specify allowable factory emissions and often even specify the technologies to be used, is very common. Examples of other types of non-market-based reforms are non-tax methods to reduce transport emissions and congestion, such as emissions standards, aggressive vehicle inspection programs, traffic management, tighter zoning, and investments in public transit alternatives to private cars. (These steps have all been taken in Singapore). Further examples for both the transport and energy sectors are programs to upgrade technologies and fuels, such as the introduction of unleaded gasoline in Malaysia and Thailand, switching from coal to natural gas

Box 2.3: Potential Gains from Forestry Policy Reform in Indonesia

Indonesia would gain significant financial and environmental benefits from policy reform in the forestry sector. The two main reform areas required are in pricing policy and in trade liberalization. The required adjustments would place considerable pressure on the wood industry, but could be phased in over three to five years.

Currently, Indonesia captures only about 30 percent of the surplus or rent accruing from logging, compared to about 85 percent in Indonesia's other major natural resource based sector, petroleum. Moreover, trade restrictions on the export of logs and wood products have reduced domestic log prices to about half the world level, and the Government captures only 12 percent of the rents that could accrue if log prices were double. Raising forestry fees (which include royalties and license and reforestation fees) and removing export restrictions could generate up to $2.6 billion in additional revenue. Also, higher fees would reduce incentives for unsustainable forest exploitation, and therefore help internalize the environmental cost of excess deforestation. In addition, fees should be levied on the value of standing timber, not only on processed wood, which encourages waste in logging and processing.

Forestry-based trade controls are by far the most important category of export regulations in Indonesia today. These encompass prohibitions on exports of unprocessed logs, rattan and veneer, the regulation of exports of sawn and processed timbers and plywood, and prohibitive export taxes on sawn timber. These controls have a major impact on resource allocation, revenues and the environment. They were introduced to encourage greater domestic value-added, but were subsequently (and wrongly) justified as policies to ensure sustainable forest management. The resulting low prices have induced rapid growth in wood processing industries, and plywood has grown to be a leading export (total exports were about US$3 billion in 1991).

However, the log export ban is an ineffective conservation measure because it does not slow the rate of logging for domestic consumption or for processing for re-export. On the contrary, artificially low domestic log prices have led to over-cutting and over-investment in processing capacity. The "sustainable" level of log production in Indonesia has been estimated at about 25 million cubic meters per year. However, logging of natural forests increased from about this level in 1980 to an estimated 37 million cubic meters per year in the late 1980s. Moreover, due to over-investment, the wood industry now has the annual capacity to process well over 50 million cubic meters of logs. Low prices have also reduced the profitability of timber plantations in Indonesia, meaning that a greater proportion of wood must come from natural forests.

Source: World Bank data (Indonesia Country Department).

in Seoul, and upgrading to higher grade coal in China. Cost recovery programs, recycling, and local involvement (often with the informal sector) can improve the prospects for solid waste disposal.

In the natural resource sectors, examples of non-market-based policies include public efforts to promote better adapted technologies through the dissemination of technical information, applied research, and improved extension services. Improved land titling and resource tenure also show positive correlation with environmental management.

Extra-regulatory Policies. Although interest is rising, Asian countries have turned only recently, when at all, to innovations in the area of extra-regulatory approaches to pollution control. For example, requirements of public disclosure of point-source pollution data can lead to direct negotiations between polluters and communities, consumer boycotts, and/or liability court cases. Disclosure is relatively low-cost, requires relatively little direct government involvement, and invokes the power of the market into the environmental arena. (Increased local participation, however, is not a substitute for more comprehensive environmental policies.) Although specific examples of direct community participation in industrial pollution control have arisen across Asia, no country has formalized the right of communities to know.

The introduction of public disclosure requirements in both Japan and the United States motivated dramatic public response with corresponding impacts on corporate behavior. The use of court systems in environmental liability suits has increased in Eastern Europe. South Asian countries appear to be more active in these extra-regulatory approaches than East Asian countries (with some exceptions in Thailand and Indonesia), perhaps because the public has more forcefully demanded

involvement through such channels.

Institutional Strengthening

The third element in the framework is to build sufficient institutional capacity to accomplish the important steps of priority setting and policy reform. Institutions constrain the choice of policies. The policy mix must be weighed not only against an analysis of the efficiency of the approach but against a country's ability to implement. Weak institutions typically lack both the technical skills and political authority to change the behaviors of firms, households, and farmers. Weak enforcement agencies often lack both the information (such as emissions data) and means (such as consistent and fair enforcement capabilities) to implement policy. Weak legal and administrative procedures undermine the government's ability to enforce environmental compliance in almost all sectors—whether compliance by polluters to pollution standards, or access by migrant farmers to state-owned forests.

Political commitment to protecting the environment is increasing throughout Asia. Almost all Asian countries have promulgated legislation to protect their air, water and land. Many of them have created Ministries of Environment and/or specialized agencies at the Federal and Provincial levels. While some of them have produced guidelines and standards in order to enforce the legislation, others are currently involved in this process. It is at the level of *implementation*—monitoring environmental impacts and enforcing regulations—that government institutions are weakest.

Although the donor organizations have relatively little experience with strengthening environmental institutions, current ideas on "best practices" are summarized in box 2.4. Included in this box are six technical areas in which environmental institutions need strengthening. These range from the ability to set standards and analyze policy at the national level, to the ability to perform actual monitoring and enforcement at the local level. Most environmental institutions would benefit from inviting broader participation—by the private sector, parastatals, NGOs, and communities groups—in environment assessments and other activities.

Beyond these technical areas is a set of broader questions relating to decentralization, a well-established trend in Asia. The decentralization of monitoring and enforcement authority for urban environments and industrial pollution can be positive for the environment, but only if local agencies have adequate resources, central support, and local accountability for achieving their mandates. Similarly, the decentralization of fiscal and planning authority for local infrastructure investments can bring public expenditures more in line with local environmental concerns. However, decentralization is a particularly multifaceted issue, and there are few successful case studies from which to draw convincing lessons.

Institutional strengthening will not progress significantly in any of these areas without a long-term political commitment to environmental goals. Similarly, donors, must accept a long-term horizon, often of five to fifteen years. Unfortunately, those countries most in need of environmental assistance are often those with the least absorptive capacity. The last chapter discusses some innovative donor approaches to institutional strengthening (see box 8.2).

Increasing Public and Private Sector Investment

The fourth element in the framework is to mobilize private sector investment, in line with more sustainable pricing policies, and public sector investment, in line with environmental priorities. The overall costs of sustainable policies have been shown to be large in absolute numbers, but small in relative terms: the World Bank estimates that developing countries need to expend 2 percent to 3 percent of GDP per year to achieve greater sustainability.[3] In Asia, this translates to about $38 billion per year by 2000, two-thirds of which is in East Asia (table 2.1).

The highest projected costs are for water supply and sanitation ($12.4 billion per year by the year 2000), followed by natural resource management ($11 billion), energy sector and transport-re-

Box 2.4: "Best Practices" for Strengthening Environmental Institutions

"Best Practices" for strengthening environmental institutions—a concept for guiding both government and donor interventions with environmental institutions—can be approached via two sets of questions. The first is the set of technical areas to be covered by technical assistance (TA). The second question concerns the steps required to lead to increased project or TA effectiveness. In terms of the first concern, there are six broad areas in which technical know-how, methodologies, and processes are often needed:

- Strengthening the ability of national-level environmental agencies to create environmental policies and set standards;
- Reinforcing the need of government finance and planning ministries to align pricing and trade policies with sustainable development objectives;
- Strengthening the ability of national, provincial, and municipal agencies to monitor and enforce environmental regulations;
- Assisting government agencies and parastatals (such as power utilities and water/irrigation authorities) in conducting EAs of planned capital projects;
- Assisting governments to complete their NEAPs and to do follow-up; and
- Encouraging broader public participation in the EA and NEAP process, including the participation of local NGOs.

In terms of the second question, the steps for strengthening environmental institutions is similar to those for other government agencies. First and foremost must be an institutional and political agreement on overall goals and objectives. Maintaining an institutional focus on goals is also the most promising way to get the political process in line. Also, the agreement on goals should not be limited to the environmental institutions alone, or they will likely be marginalized in the broader policy formulation and budgeting process. Even in the context of decentralizing authority and responsibility, local institutions can be marginalized in the absence of central support.

Second, emphasis must be given early on to the quality of personnel recruited to the environmental agencies. Unlike in many developing Asian countries, Japan was able to fill the initial positions in its nascent environment institutions with technically qualified personnel. If not done early on, such institutions are likely to become civil service back-waters that no amount of TA can fix.

Third, the issue of corruption cannot be avoided, especially in the context of monitoring and enforcement. Adequate institutional incentives to support honest inspectors are fundamental to achieving broad-based compliance to environmental standards.

Fourth, donors must expect and accept that results will only come in the long-term, perhaps after a 5–15 year commitment. A hurried attitude to get results may not only not work, it may also make corruption and other inefficiencies worse.

lated investments ($6.5 billion), industrial pollution ($4.8 billion), and population and educational services ($3.3 billion). These levels of financial and technical resources are beyond the capacities of individual country government and donor agencies, and require the involvement of the private sector to the extent possible.

Several issues arise concerning the financing of these investments. First, to what degree can they be made *financially viable*? The most financially viable environment-related investments are those that are good for both economic development and the environment, including energy conservation, waste minimization in industry (as opposed to end-of-pipe investments), recycling in the urban and industry sectors, fuel efficiency in the transport sector, soil conservation, and sustainable forestry. Increased private sector investment should be promoted through pricing and policy reform, and through improved access of the private sector to information, commercial loans, supplier credits, and, under special circumstances, to government incentives (box 2.5).

Second, to what degree can public-sector investments—which are presumed to be economically viable using shadow prices, be made more *self-financing*? Viability issues arise in such public services as water and sanitation infrastructure, agricultural extension and research, and education and family planning programs. Donor support for infrastructure projects should be made contingent on financial plans that encourage project cost-recovery to the extent possible. Even if capital costs cannot be recovered, user fees and taxes should try

Table 2.1: Estimates of Additional Investment Required for the Environment in Asia by 2000

	East Asia	South Asia	Total
	(US$ billions per year)		
Water supply and sanitation	7.0	5.4	12.4
Reducing emissions from energy generation	2.0	0.7	2.7
Changing to unleaded fuel; controls on vehicle pollution	2.9	0.9	3.8
Reducing industrial pollution	3.6	1.2	4.8
Soil conservation and afforestation	5.0	3.6	8.6
Additional resources for agriculture and forestry research	1.4	1.0	2.4
Family planning	1.4	1.0	2.4
Primary and Secondary education for girls	0.7	0.2	0.9
Total	24.0	14.0	38.0

Source: World Bank and Asian Development Bank estimates.

to cover operating and maintenance costs. More analytical work is required, both conceptually and practically, on ways to make environmental interventions more self-financing (box 2.6, and chapter 8).

Third, to what degree do investments under consideration address environmental problems with cross-border or *global impacts*, such as global warming, ozone depletion, biodiversity, and pollution of the seas? In these cases, strong arguments exist for international cost-sharing to help finance the investment costs. Such payments should not be thought of as development assistance, but as economically efficient allocations of costs and sharing of benefits. These concepts are recognized in the GEF and the Montreal Protocol (see box 2.7).

Box 2.5: Examples of Commercial Credit for Pollution Control

Two World Bank projects that provide credits for pollution control are the industrial pollution projects in India and China. In both cases, subsidized lines of credit are justified for pollution control investments that include prototype technologies, have a demonstration effect, have inherently high risk, or treat hazardous wastes with high social benefits.

The GEF portfolio also includes examples of donor-assisted credits for pollution control, such as the China Ship Waste Disposal project and the Pakistan Community Integrated Waste to Energy project.

Finally, to what degree do market-based policy reforms assist, through efficiency gains, to financially strengthen agencies investing in environmental sustainability? For example, price reform for stumpage fees in Indonesia would transfer significant rents now accruing to the private sector to the public sector, providing needed revenues to invest in environmental protection. Electricity and water tariff increases would not only reduce inefficient use, but help restore profitability to utility companies currently unable to adequately their distribution and billing systems. Such efficiency gains help offset the up-front costs of policy reforms and environmental investments.

Improved Technologies and Technology Transfer

The last element of the basic environmental management framework is the need to foster technological improvements and efficiency gains, even when research, development and demonstration costs are not fully borne by the market. Improvements in productivity and efficiency are essential to making continued economic growth possible at a time of growing populations, urbanization, industrialization, and an increasingly degraded resource base (box 2.8).

Economic and trade openness is fundamental to technology transfer. In the polluting sectors (urban, transport, industry, and energy), "clean"

Box 2.6: Approaches to Making Environmental Interventions More Self-Financing

The most fundamental approach is to expand the use of user charges and "polluter pays" principles, although the "ability to set the price," the "ability to pay," and the "ability to collect" are not often all in place. Another promising idea is to use revenues generated from "green" revenue-producing policies, such as increased stumpage fees or land rents to cross-subsidize technical research and extension in more sustainable agricultural and forestry practices. This idea has direct appeal in Indonesia, Malaysia, and the Philippines, where the need for technologies for marginal and degraded lands is increasingly urgent. A third approach is to build on the Environmental Fund concept used in Europe, based on earmarked revenue sources, to help finance pollution control projects.

A fourth and perhaps most promising approach is the use of "improvement levies" to help finance large infrastructure investments with positive environmental impacts (such as mass transit, sewage and sanitation, and water treatment plants). Improvement levies have been widely used in the U.S. and Latin America. The idea of improvement levies is to broaden the tax base from those who directly use the investment (i.e. metro system riders or water consumers based on usage), to those who enjoy the externalities (i.e. real estate owners whose property values rise as a result of improved access, and the wealthier communities whose marginal utility from improved urban sanitation exceeds what they would have to pay based solely on water bills). There are many variations of improvement levies, but in all cases, their use can make or break the financial viability of urban infrastructure investments.

technologies will be most available in those Asian countries with open trade regimes and business climates that foster foreign investment. Combinations of supplier credits, export-import financing, technology sharing agreements, royalty agreements, and joint ventures make the importation of such technologies easier and less expensive. In these markets, relatively little public sector intervention is required—except for, perhaps, information dissemination to smaller firms.

In addition, many high-efficiency industrial and transport technologies pay for themselves over a few years (see chapter 4, box 4.10). The biggest exception is the case of emissions reduction technologies for thermal plants, which typically represent add-on costs. Since these investments do not pay for themselves financially, they will only be installed if the regulatory environment is sufficiently tight.

In the green sectors, technological issues have an extremely high priority. Public sector involvement in technological research, development, and demonstration has a much higher priority than in the pollution sectors, due to the less commercialized and more site-specific nature of the technologies. In agriculture, continued intensification will be essential to both expanding food production and reducing pressures on marginal lands and forests. Intensification technologies with negative environmental impacts need attention. On marginal lands, low-cost measures for soil and moisture conservation need to be adapted and demonstrated locally to farmers. On rainfed uplands, more diversified cropping models incorporating more perennials and fewer annual foodcrops need to be researched and tested. In forestry, local research on sustainable management techniques is needed, differentiating between sustainable commercial forestry, natural forest management, and sustainable social forestry. The Consultative Group for International Agricultural Research (CGIAR), including the recently established Center for Forestry Research in Indonesia, are the lead international bodies working with developing country government on these issues.

"Top-Down" Versus "Bottom-Up"

The framework outlined above calls for increased willingness to cut across the traditional sectors of public investment and donor-funded projects. Certain aspects of the framework are "top-down" policy approaches that affect the economic environment in which market decisions and investments are made. Other aspects are more "bottom-up," consisting of either local policies, monitoring and

Box 2.7: Global Environmental Operations

Global Environmental Facility

The Global Environmental Facility was established in 1990 with $1.3 billion to provide grants and concessional funds over a three year pilot phase. The Facility assists developing countries address four global environmental problem areas: global warming, loss of biological diversity, pollution of international waters, and depletion of stratospheric ozone (addressed almost entirely through the Montreal Protocol for which the Bank manages the investment operations). The GEF draws collaboratively on the experience and expertise of the UNEP, UNDP, and the World Bank. The participating governments are currently working out the details of the restructured GEF to go beyond the pilot phase. Since 1990, $241 million (33 percent of the total) have been directed towards Asia through investment projects, technical assistance, and research. Four of the investment projects have been approved and are under implementation (shown with an *). The others are in various stages of preparation.

Country	Project Name	Project Cost (US$ millions)	GEF Funding (US$ millions)	Bank Funding (US$ millions)
Bhutan	Trust Fund for Conservation*	20.0	10.0	
China	Ship Waste Disposal*	64.0	30.0	15.0
Laos	Integrated Protected Areas	25.5	5.5	10.0
Philippines	Integrated Protected Areas	301.0	20.0	224.0
Philippines	Leyte Geothermal	1300.0	30.0	365.0
India	Non Conventional Energy Project*		30.0	120.0
Thailand	Promotion of Electric Energy Efficiency*		15.5	30.0
Indonesia	Biodiversity Conservation		12.0	22.0
China	Sichuan Gas Transmission		10.0	300.0
India	Cost Effective Options for Limiting Greenhouse Gas Emissions (TA)		1.5	

Montreal Protocol Operations

Under the Montreal Protocol for protection of the ozone layer, five projects have been prepared in Asia, of which four have been approved (shown by an *).

Country	Project	Cost (US$ millions)
Philippines	ODS Phase-out Engineering*	0.18
Thailand	ODS Phase-out Engineering*	0.40
China	ODS Phase-out Engineering*	1.50
Indonesia	ODS Phase-out Engineering*	0.25
Malaysia	Halons and MAC Recycling	1.63

Other Global Conventions

Two other international agreements were negotiated at the UNCED conference in 1992—the Biodiversity Convention and the Climate Change Convention. These are not yet operational.

enforcement, or specific investment projects (box 2.9).

The distinction between "top-down" and "bottom-up" approaches is useful in laying out the full geographic and administrative scope of an environmental strategy. The framework reinforces the notion that a "sustainable" economy does not consider the environment a separate add-on, but mainstreams environmental concerns across sectors, at all levels. In pursuing improved environmental management, each country should include both top-down and bottom-up components in its strategy, and any country that fails to do so will have an incomplete approach.

Box 2.8: Technological Requirements for Improving the Environment

Industry	The conventional approach to "end-of-pipe" technologies, although important, is less optimal than investments in new processes that combine higher efficiencies with less waste. The introduction of "clean" technologies often require foreign suppliers or partners—and a business environment that can foster such relationships.
Energy	A wide range of both supply and demand side technologies can improve efficiency, and are cost-effective in many sectors. The choice of fuel is equally fundamental. Asia is heavily committed to coal, but some peripheral movement towards natural gas and renewable technologies should be promoted through both pricing and technology transfer.
Urban and Transport	Further refinement of cost-effective sewage systems is required, as traditional sewage collection is too costly for much new investment in many Asian cities. In transport, more aggressive emissions control on cars, diesel vehicles, and two-stoke engines is required—with a particular emphasis on the rapidly growing fleet of two-stroke engines.
Agriculture	New farming practices and technologies are essential to maintaining the momentum of "intensification", which must contribute at least 95% of increased food output at a time of increasing soil degradation throughout Asia. On marginal lands, diversified cropping models and techniques to upgrade degraded lands need to be researched and applied.
Forestry	Sustainable forestry management techniques are not yet common (whether commercial or community-based), and need to be more widely researched, adapted, disseminated and implemented.

Economic and Social Impacts of Improved Environmental Management

The Impact of Structural Adjustment on the Environment

Structural adjustment processes have mixed impacts on the environment, although any resulting adverse impacts are better addressed through more targeted environmental policies than through manipulation of macroeconomic policies. The four areas of adjustment with potential environmental impacts are: (a) restoring macroeconomic stability; (b) adjusting relative prices, through tariff liberalization and removal of subsidies; (c) short-term recessions and government cutbacks; and (d) institutional changes. Of these, the first and the last (a and d) have primarily positive impacts, and most Asian countries have already worked through many of the effects of (c).

Therefore, the potential for adverse impacts lies primarily in the adjustment of relative prices. The removal of subsidies (such as energy, agricultural inputs, and stumpage fees) almost always unambiguously favors the environment. However, the expansionary impacts of currency devaluations, tariff liberalization, and reduction of real interest rates may be most directly and adversely felt in natural resource use, especially in the forestry and fishery sectors. The clearest example of this is the forestry sector, where, in the absence of efficient pricing of forestry resources, the liberalization of either high tariffs or log export bans would lead to expanded production. The expansionary effects of structural adjustment would lead to excess extraction unless appropriate sector-specific pricing policies are in place.

The Impact of Improved Environmental Management on the Poor

Strategies to achieve sustainability that use pricing and other regulatory measures to reduce access to and over-exploitation of natural resources have direct and often inequitable impacts on the poor. Concern about the impact on the poor of improved environmental management is particularly great in South Asia, which has over half the world's poor.

There are parallels between analyzing the social impact of environmental policies and analyzing the social impact of structural adjustment on the poor. In the case of structural adjustment, efficiency considerations are paramount in order to set the macroeconomic and sector preconditions for growth. Nevertheless, adverse impacts for certain population subgroups have been identified and addressed separately—in a manner complementary

Box 2.9: A Framework for Improving the Environment

Key elements	National-level (Top-down approach)	Local-level (Bottom-up approach)
Setting priorities	National priorities, as analyzed and expressed in national environmental action plans, capital budgets and sectoral planning documents. Openness in decision-making.	Local determination of local priorities. Decentralized capacity to address local issues. Local participation.
Policy reform	Sound economic policies. Market-based environmental policies (pricing and taxation). Regulatory and legal reforms. Public disclosure.	Policies for local environmental management, i.e., incentives and regulations based on the local ambient pollution and resource base. Adequate data collection and monitoring.
Institutional strengthening	Capacity-building for national-level policy analysis and implementation (e.g. tax, pricing, and legal reforms). Choice of policy instruments in light of institutional capacities.	Capacity-building for local-level policy implementation, monitoring and consistent and fair enforcement. Community organizations and NGOs.
Financing for public and private sector investment	Favorable business environment. Donor lending for sector adjustment and policy reform.	Pricing and institutional reform to increase the viability of investments favoring the environment. Increased "commercialization" of public infrastructure.
Technology	Open trade policies. Favorable business environment for technology transfer.	Public and donor involvement in selected research, development, and demonstration, particularly in the areas of agriculture and forestry. Public information services for small and medium-sized firms.

to, and not substituting, the underlying adjustment measures.

A similar approach should be taken in the case of mitigating unacceptable social impacts of environmental policies. Where price reforms are introduced, for example, adverse social impacts for certain population subgroups should be addressed in a targeted and time-bound manner that does not offset the intent of the underlying adjustment process. For example, in cities the most important adverse impacts on the poor from full-cost resource pricing are likely to be in the areas of water, electricity, and fuel (including biofuels). Through the combination of market differentiation (a lower level of service for the poorest communities) and financially strengthened utilities (achieved, in part, through pricing reform), the option of cross-subsidizing the poorest communities becomes available.

The measures required to offset inequitable impacts of environmental policies will be very different in urban and rural areas. The urban poor are, disproportionately, victims of urban environmental degradation: they are less buffered than the nonpoor from water pollution, toxic wastes, solid wastes, high traffic, and air and noise pollution. Urban environmental investments will help the poor probably more than middle and upper class

city-dwellers. Therefore, investments in urban environmental cleanup can be considered to be socially progressive.

In the case of water supplies, poor communities already often pay exorbitant prices to private hawkers, and these prices should eventually fall through the provision of adequate and more efficient public supplies. Poor households also may use very dirty water from local supplies, which they either have to boil (imposing a financial cost for fuel and time, estimated at 1 percent of GDP for Jakarta) or consume (with commensurate health and productivity costs). Therefore, the impact of higher water prices in poor communities may be less than first thought. Also, as mentioned above, market differentiation (such as community standpipes) can be very low-cost, and even cross-subsidized from other water users with in-house service.

The situation in rural areas is more complicated. The rural poor are often disproportionately, and usually inadvertently, the perpetrators of environmental degradation. The environmental policies required to bring about increased rural sustainability involve both positive and negative impacts on the poor. Reforms in land tenure, to the extent that the poor gain tenure, would be positive. The truly landless, however, would be increasingly cut off as others gain title. Solutions to the landless poor have to be site and area specific. One trend that may help to relieve some of the pressure in East Asia is that the rural population is actually decreasing as urban populations grow (see chapter 1, figure 1.7). A second trend that should be supported through government and donor programs is the diversification of rural employment into nonfarm activities. Nonfarm employment is usually less resource-intensive than farming, and therefore has less environmental impact. Finally, expanded intensification on irrigated lands and higher value-added through mixed cropping on marginal lands should help to absorb the labor surplus of the rural landless poor.

Notes

1. O'Connor 1992, pg. 35.
2. Marketable permits, which also internalize externalities, do not necessarily transfer revenue to the government. They would only do so if they were auctioned and not allocated along some formula to be distributed free of charge.
3. World Bank 1992a, pp. 170–4.

3

URBAN ENVIRONMENTAL MANAGEMENT

Urbanization in Asia

Growth of Cities

By 2025, as many people will be living in Asian cities as there are in all of Asia today. Of these projected 4.3 billion people, nearly 2.5 billion are expected to live in urban areas. In East Asia, the urban population is projected to exceed the rural population by 2005; and by 2025 about 1.5 billion people (63 percent of the total population) will be living in urban areas. In South Asia, the urban population is also expected to exceed the rural population by 2025, when more than 1 billion people will be living in cities (see figure 1.7, chapter 1). There is, therefore, a dramatic demographic shift taking place in Asia, as the urban population is expected to *triple* between 1990 and 2025.

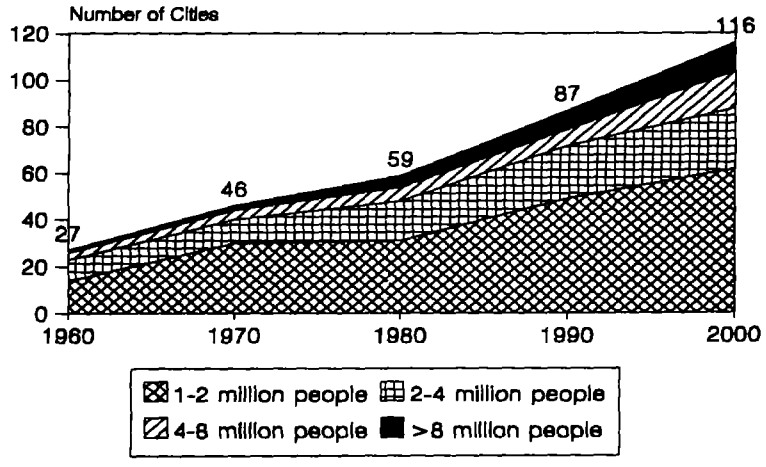
The number of large cities is also growing rapidly in both East and South Asia. Currently, fifty-six cities in East Asia have more than 1 million inhabitants (thirty-eight of them in China), while in South Asia thirty-one cities have more than 1 million people (twenty-three of them in India). Six cities in East Asia and three cities in South Asia are megacities with more than 8 million people. Not only is the number of large cities increasing, the rate at which smaller cities are becoming larger is also increasing (figure 3.1).

To date, cities have had a lower incidence of poverty than rural areas, but with rapid urbanization, increasing numbers of the poor will be found in the cities and towns of Asia. For example, in India there is evidence that the incidence of rural and urban poverty is converging (figure 3.2). The poor form a significant portion of the population in some of the largest cities—60 percent in Calcutta and Jakarta, 45 percent in Karachi and Madras, and 35 percent in Manila.[1] The poor who live in squatter settlements close to waste dumps and industrial sites, and put up with overcrowding, lack of potable water and sanitation facilities, disproportionately bear the impact of environmental degradation.

Key Environmental Problems

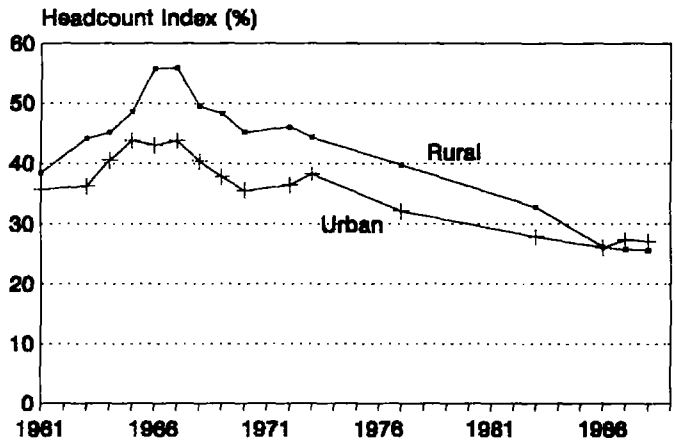
Given high population densities, high incomes, and large industrial concentrations, cities have serious environmental problems. Infrastructure and service needs are unable to keep pace with the rapid growth

Figure 3.1: Number of Cities in Asia by Size, 1960–2000



Source: United Nations 1991.

Figure 3.2: Incidence of Poverty in India 1961-89



Source: World Bank data.

in urban population. The total pollution load from the different sectors in urban areas exceeds the capacity of local governments to collect and dispose of municipal sewage and solid wastes and to control toxic wastes and emissions. This concentration of wastes overwhelms the assimilative capacity of natural ecosystems, leading to environmental degradation. Because discharges of pollutants in urban areas are spatially concentrated, they are potentially more dangerous to human health.

Water Pollution. Probably the most pervasive environmental problem in Asia is water pollution, and cities cause most of it. Water pollution is responsible for substantial mortality, particularly among children. United Nations GEMS data show that levels of fecal coliform (500 per 100 milliliters) in Asian rivers far exceed the maximum recommended for potable supplies (10 per 100 milliliters) and even the maximum that defines surface water as polluted (100 per 100 milliliters).[2] Given the lack of adequate water supply alternatives, surface water pollution is a major health threat to those who use surface water for consumption. The median level of dissolved mercury at the sampling sites (0.2 micrograms per liter) also far exceeds the recommended standard of 0.001 micrograms per liter. Fish and shellfish absorb substantial amounts of waterborne mercury, which humans then consume.

Water pollution in Asian cities is largely caused by untreated domestic sewage. For example, in Metro Manila, about 65 percent of water pollution is from domestic waste; and in Bangkok, about 75 percent of pollution in the lower part of the Chao Phraya River comes from domestic waste. Industrial effluents, which present difficult and expensive regulatory problems (chapter 4) compound domestic sewage pollution, but are, by volume, significantly less.

Governments have intentionally focused more on water supply than on sanitation or sewage treatment. Official data in Asia indicate that average urban access to safe drinking water is 82 percent of the population, and that 77 percent has access to some form of sanitation facilities, generally onsite disposal of human and solid waste. These sanitation facilities, however, are often poorly constructed and badly maintained. Liquid wastes overflow into open drains, spreading polluted water. Flooding during the rainy season spreads sewage into residential neighborhoods. Finally, where sanitation and sewerage has received high priority (usually the more affluent neighborhoods), sewage treatment is very limited or nonexistent and the wastewater is dumped untreated into rivers and streams (box 3.1).

Many Asian cities are located in coastal areas, and excessive withdrawal of groundwater has, in some cases, resulted in salt water intrusion, making the groundwater unfit for consumption. This problem is acute in Bangkok, Jakarta, Madras and Manila (see chapter 7). In Bangkok and elsewhere, surface water pollution has forced public

Box 3.1: Sewage Treatment in India

Of India's 3,119 towns and cities, only eight have full sewage collection and treatment facilities; 209 have partial facilities. The Ganges River alone carries the untreated sewage of 114 cities, each with 50,000 or more inhabitants. India's secondary and tertiary towns suffer even more from lack of adequate infrastructure than primary cities.

utilities to extend water lines to more distant sources, or treat water from increasingly polluted sources. In Shanghai, pollution forced water intakes to be moved upstream more than 40 kilometers at a cost of about $300 million; in Jakarta, investments exceeding $1 billion are required to bring in water from more distant watersheds.

The impacts of water pollution are especially telling on the poor. Where access to safe drinking water is limited, polluted water is consumed by the urban poor, who have little alternative other than to pay exorbitant prices to purchase water from private vendors. In Manila, diarrhea in shanty towns is twice as common as in the rest of the city. Studies in Calcutta and Delhi show higher rates of disease in many slum areas and longer duration per illness.

Air Pollution. WHO data show that twelve of the fifteen cities with the highest levels of particulate matter, and six of the fifteen cities with the highest levels of sulfur dioxide are in Asia (see chapter 1, table 1.1). Overall, of the seven cities worldwide that received the worst ranking for air pollution in 1988, five are in Asia: Beijing, Calcutta, Jakarta, New Delhi, and Shenyang.

Air quality is worsening in virtually all Asian cities, except perhaps in Korea. (Elsewhere in the world, middle-income cities are showing broader improvements.) Data from GEMS air pollution monitoring provides evidence that ambient concentration of suspended particulate matter (SPM) is worsening in every city monitored, and generally exceed WHO guidelines. However, the cases of lead, SO_2 and NO_x emissions are not as uniform. Lead emissions are improving in Kuala Lumpur, following the introduction of unleaded fuel. The trends for SO_2 differ by city, but are getting worse in most Chinese and Indian cities and staying steady or improving slightly in some of East Asian middle-income cities. NO_x concentrations are still generally below WHO guidelines, but levels of CO exceed WHO guidelines in urban areas with heavy traffic.

With few exceptions, motor vehicles are the major cause of air pollution in Asian cities (table 3.1).[3] Vehicle populations have been growing exponentially throughout Asia, doubling every seven years (figure 3.3). Beyond the number of motor vehicles, however, vehicle characteristics also aggravate pollution. Domestically manufactured motor vehicles, especially in India and China, have performance and emission characteristics of 1950–60 vintage vehicles and lack pollution controls. Owing to the high cost of vehicle ownership, scrappage rates are low, resulting in a vehicle fleet that is of old and often poorly maintained. The concentration of motorcycles is not only higher than in other areas of the world, it is generally much greater than the rest of the four-wheel vehicle population. Many motorcycles are powered by old design two-stroke engines that emit up to ten times more hydrocarbons and smoke per kilometer than do the four-stroke engines of cars and trucks. In addition, diesel vehicles in Asia account for a greater proportion of the vehicle population and total kilometers driven than in other regions of the world. Further, some of the fuels used are among the dirtiest in the world, especially with regard to sulphur in diesel and lead in gasoline.

Insufficient urban road space and ineffective traffic management cause traffic congestion. Cities such as Bangkok and Jakarta have massive traffic jams that delay commuters by hours: peak-hour speed in Asian cities averages around 16 kilometers per hour. Few cities have made serious efforts to reduce congestion and have accepted it as a way of life. Besides being costly in terms of time lost and the drag on commerce, stationary vehicles sitting in traffic contribute significant incremental air pollution.

Table 3.1: Contribution of Motor Vehicles to Air Pollution in Selected Asian Cities

City	Year	Total emissions all sources ('000 tons/year)	Percentage attributable to motor vehicles					
			CO	HC	NOx	SOx	SPM	Total
Beijing	1989	n.a.	39	75	46	n.a.	n.a.	n.a.
Bombay	1981	546	86	20	44	n.a.	3	31
Calcutta	1978	537	87	15	25	n.a.	n.a.	n.a.
Delhi	1987	428	90	85	59	13	37	57
Kuala Lumpur	1987	435	97	95	46	1	46	79
Manila	1987	496	93	82	73	12	60	71
Seoul	1983	n.a.	15	40	60	7	35	35

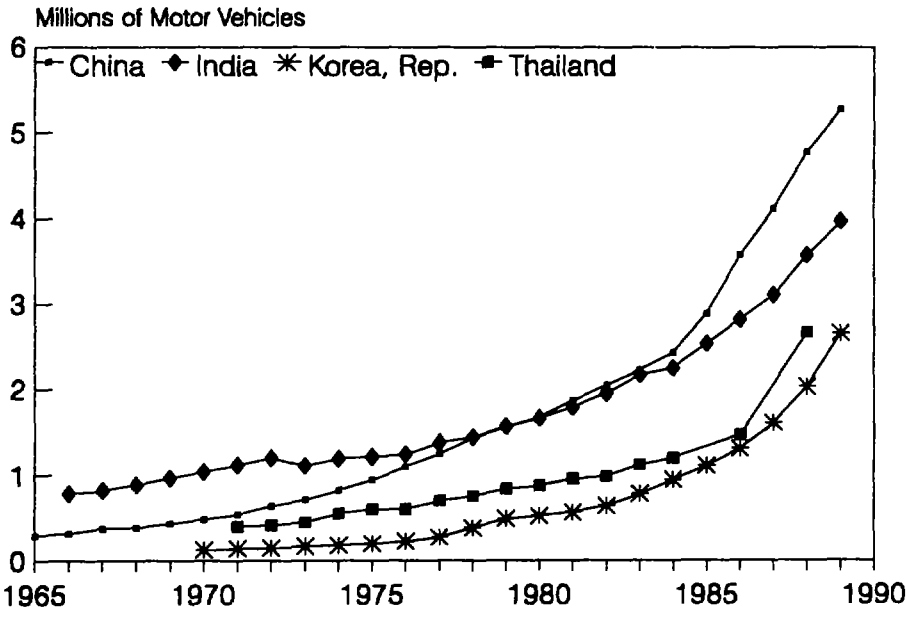
n.a. Data not available.
Source: World Bank 1992a.

Industry is the next major source of gaseous emissions (see chapter 4). Although large industrial plants discharge many times the emissions of individual small plants, clusters of small-scale plants operating obsolete equipment, and under little regulation, can also be significant polluters.

Finally, in some cities domestic heating/cooking is a major contributor to air pollution. For example, coal smoke from home and commercial heating is the main air quality problem in Beijing and other Chinese cities. In New Delhi, the residential sector is the largest source of SO_2 (46 percent) and NO_x (37 percent) and contributes a significant share of CO (33 percent) and SPM (18 percent). Dust, especially from eroded areas, quarries, cement plants, and unprotected building sites, adds to the urban air pollution problem.

Air pollution causes considerable suffering, and, unlike water pollution, affects all residents. Lung cancer mortality is four to seven times higher in Chinese cities than in the nation as a whole. Sixty percent of Calcutta residents

Figure 3.3: Total Motor Vehicles in Use in Selected Asian Countries



Sources: MVMA, "World Motor Vehicle Data", 1991; International Road Federation, "World Road Statistics", various years.

suffer from respiratory diseases, compared to the national average of 2.5 percent. A 1990 US Agency for International Development (USAID) study in Bangkok estimated that SPM causes up to 1,400 deaths per year, and that lead pollution causes 200,000–500,000 cases of hypertension, 300–900 cases of heart attack and stroke, and 200–400 deaths per year. The long-term effects of lead poisoning on Bangkok children include 400,000–700,000 total IQ points lost per year—3.5 IQ points per child through age seven.

Solid Waste. In the low-income Asian countries, large cities such as Calcutta and Karachi generate around 0.4–0.7 kilograms of solid wastes per capita per day; in middle-income countries, cities like Bangkok, Kuala Lumpur and Manila generate around 0.5–1.0 kilograms of wastes per capita per day. The amount of solid waste generated in large Asian cities typically exceeds 1 million tons per year (table 3.2).

Most Asian cities dispose of their solid waste in landfills. Recycling is limited to "ragpickers" in the informal sector. The difficulty of finding and managing landfills combined with the strain of keeping up with growing demands have led to inadequate solid waste collection, recycling, and disposal systems. When cities fail to collect garbage, households and industries dump solid waste on the roadside or in waterways and drains, causing waterways to block and flood. Even when dumped in landfills, solid waste creates problems, including odors, smoke from fires, leaching of chemicals into surface- and groundwater, and breeding of rats, flies, and other disease vectors. In addition, many cities dump toxic and hazardous waste together with domestic waste, increasing the hazards to human health.

Solid waste generation is expected to increase substantially with economic growth. For example, while Bombay produces 1.2 million tons of solid waste per year, Tokyo—with about the same population—produces 4.5 million tons. The increasing amount of industrial toxic waste adds to the problem, both because of its impact on health and the high cost of cleanup.

Table 3.2: Solid Waste Generated in Asian Cities

City	Waste generated: '000 tons per year	Waste generated: Kilograms per capita per day
Seoul	10512	2.80
Beijing	3580	1.59
Jakarta	1800	0.75
Bangkok	1800	0.88
Manila	1380	0.50
Bombay	1150	0.55
Kuala Lumpur	730	1.29
Colombo	160	0.75

Source: UNCRD 1989

Inappropriate Land Use. Urban encroachment into ecologically sensitive areas in Asia has been responsible for watershed degradation, floods, landslides, biodiversity loss, fish catch loss, and coastal degradation. In many Asian cities, the availability of good land for expansion on the urban fringe lags behind population growth. Urban sprawl has reclaimed wetlands, converted prime agricultural land and forests, and settled on fragile slopes and along waterbodies and coastal zones. Also, with better areas cut off from use, the poor have typically moved to marginal lands such as waste dumps, hillsides, and sites adjacent to industries near the city center, with environmental and health consequences.

Since the poor use wood and other biomass for household fuels, urbanization has indirect impacts on surrounding forests. In India, wood provides 50 percent of the urban cooking energy, and it is estimated that forest cover around many Indian cities declined by 15 to 60 percent during 1972–82. Though fuelwood prices have increased, the urban poor cannot afford other alternatives such as kerosene stoves (chapter 5).

Costs. The total cost to the Asian economies of urban environmental degradation has not been cal-

culated. However, some estimates have been made for selected environmental problems. For example, in India, waterborne diseases cause loss of 73 million work days per year, valued at $428 million per year.[4] Rough calculations show that the environmental costs due to air pollution in Bangkok could be $1 billion to $3 billion per year (table 3.3). Environmental costs in Asia's other megacities are equally significant.

It should be noted that these and other estimates of the cost of urban environmental degradation are controversial, because in order to reflect costs in monetary terms it is necessary to place economic values on human sickness and death. These estimates are most appropriate when used to compare benefits and costs of alternatives *within* cities and countries. They are much less appropriate for comparing costs and benefits across countries.

Table 3.3: Annual Cost of Congestion and Air Pollution in Some Asian Cities (US$ Millions)

Region	Congestion	Air Pollution
Bangkok Metropolitan *Area*, 1989	272	380-580
Bangkok Metropolitan *Region*, 1993	400	1,300-3,100
Seoul	154	n.a.
Manila	51	n.a.
Jakarta	68	400-800

n.a. Data not available.
Sources: Shin and others 1992; Ostro 1992a; and World Bank analysis.

Tackling Key Environmental Problems

Managing urban development in an environmentally sound way is extremely complex because of the cross-sectoral and cross-jurisdictional nature of the urban economy. Urban infrastructure and service provision encompasses transport, communications, industry, energy, shelter, zoning, water supply and sanitation, flood control and drainage, solid waste, education, health, and recreation. The spatial planning, pricing, service levels, and management of all of these aspects of urban management may impact on the environment. As a result, environmental concerns should be integrated into may urban planning and management decisions. As always, the choice of action will depend on the economic, social, and geographic characteristics of the specific metropolitan area.

In general, there are four environmental problems that need to be addressed in Asian cities: water pollution, air pollution, solid waste management, and inappropriate land use. This section addresses these problems with particular emphasis on the municipal, domestic, and transport sectors. Approaches to reducing pollution in the industrial and energy sectors are addressed in chapters 4 and 5 respectively.

Water Pollution

The health and welfare impacts of water pollution have to be tackled on two fronts: provision of safe water to urban populations and reduction of water resource pollution.

Provision of Safe Water. Assuring the provision of potable water to the growing populations of Asian cities has been an urban sector goal for decades, and environmental concerns enhance rather than diminish this goal. The basic technologies for water supply systems are well known in the region and reasonably efficient. However, action is required in service mix and cost recovery, water conservation, demand management, and regulatory and delivery institutions. In most Asian countries, consumers pay a fraction of recurrent and capital costs of urban water supply. This prevents water authorities from recovering financial resources necessary for maintenance and capacity expansion.

Pricing water to reflect the cost of providing it would serve both development and environmental objectives. Cleaning up water supplies, as well as expanding services to rapidly growing urban and industrial consumers, requires high levels of both investment and operating capital. Financially strong water agencies/utilities would be better equipped to provide better services to an expand-

ing population with increasing needs. Affordability studies indicate that the vast majority of the urban population (including the poor) would be willing to pay more if service were provided to meet their needs. If complete cost recovery were possible from most consumers, then it would also become possible to subsidize services to the poorest communities through cross-subsidies. (For a more detailed discussion of water resource management, see chapter 7).

One approach to minimizing future capital expenditures is through conservation, which is less expensive and more environmentally sound than new investment. To the extent water can be conserved—and little work has been done in this area—a corresponding amount of new investment can be postponed. More effective maintenance can help overcome the problems of leaks and pilferage. Recycling water in the industrial sector can provide water to firms at a fraction of the investments needed to supply clean water. Demand management can be achieved through both financial incentives (such as higher prices for both water supply and fees to firms for discharging industrial wastewater) and technological intervention (through, for example, installing new toilet fixtures). It is also important to look at the demand for water in other sectors. For example, irrigation is the largest use of water in Asia. Increasing the efficiency of irrigation can release water for growing industrial and domestic demand.

Reduction of Water Pollution. As stated above, even though domestic sewage is the main cause of water pollution in Asian cities, treatment and disposal of sewage is given lower priority than the provision of clean water. Most governments refrain from providing waterborne sewage collection and treatment systems due to the prohibitive investment costs to overcome the enormous initial deficit of infrastructure. However, piped sewer systems (costs ranging from $300 to $1000 per household, not including the cost of sewage treatment facilities) appear to be the only viable option for the high-density cores of cities. Elsewhere, there is room for application of alternative technologies that could make a significant difference. These include alternative low-cost sanitation options such as condominial sewer systems, pour-flush latrines, or small-bore sewers.

Sewerage tariff reform—whether combined with water supply tariffs or applied separately—are needed to expand investment. Assuming adequate revenues through tariff reform, investment can be both public and private. Malaysia, for example, is encouraging the privatization of 43 municipal sewage systems. Community groups can also play an effective role in the distribution of water and the organization of sanitation systems in poor settlements. Such efforts are already beginning in Asia.

Transportation and Air Pollution

There are two basic approaches to reducing vehicle pollution: reducing emissions per vehicle mile traveled and reducing the total number of vehicle miles traveled. In theory, an emission tax is the most efficient means to reduce pollution, as it would provide consumers with incentives to choose the least-cost options across these two approaches. However, such a tax would be weighed down by need for effective emission monitoring, which is difficult. More common are strategies to reduce both emissions and congestion, using a mixed set of instruments, including taxes on fuels, vehicles, and parking; incentives and regulations affecting vehicles; and traffic management and the provision of public transport alternatives (table 3.4).

Specifically, there are a number of ways to meet the first objective of reducing emissions per vehicle mile traveled: (a) enforcing higher maintenance standards on existing vehicles, in order to keep emissions closer to the design standards of the vehicles; (b) introducing vehicles designed to meet new emission standards; (c) introducing unleaded fuels (with or without catalytic converters) for the rapid reduction of atmospheric lead;[5] and (d) retrofitting motor vehicles to use other kinds of fuel modifications or fuels, such as liquefied petroleum gas (LPG). Thailand successfully shifted the fuel

of three-wheel taxis from a mixture of gas and fuel oil to LPG. Some of these measures to reduce emissions per vehicle are more cost-effective than others depending on the characteristics of the city under consideration. A strategy for reducing emissions would begin with the least-cost measure, and slowly move up the marginal-cost curve to more costly measures.

The second objective is to reduce total vehicle miles traveled. This can be accomplished by either reducing the total demand for travel or altering the mix of vehicles used to carry travellers. The first option may be achieved in part by increasing the cost of travel, but urban travel demand is relatively inelastic. More important is improved spatial planning to reduce the total demand for travel.

Altering the mix of vehicles used to carry travellers requires policies to move people away from the use of private automobiles towards other forms of transportation. Here, experience has shown that a two-prong approach is required. The first prong is to raise the cost of private vehicle use. Options include traffic management (for example, one-way systems, closing streets, downtown pedestrian zones, provision of exclusive bus lanes) and demand management (such as increased parking fees, road tolls, fuel taxes, and carpooling programs). The second prong is to provide alternatives to private automobiles, which can be in favor of either larger vehicles (vans, buses, or mass transit), or nonmotorized options, primarily bicycles. Without viable transit alternatives, the higher road user fees would lead to higher financial costs of travel with relatively little decrease in actual travel.

When planning investment in public transport systems, the modal choice requires careful attention. Many cities are attracted toward mass transit systems, but few are financially viable (Hong Kong's is the striking exception). Mass transit systems cost $50–150 million per kilometer to build, and light rail transit systems between $8–60 million per kilometer; for both, operating costs are about 10–25 cents per kilometer per rider. Busways, on the other hand, cost about $1 million per kilometer (at ground level), and $10 million per kilometer (for elevated stretches), or about 2–8 cents per person to operate, and could move the same number of passengers with dedicated busways.

However, the mere provision of public transport is not enough to lure commuters away from their cars onto public transport. Simultaneous disincentives for private vehicle use are required to achieve ridership. Similarly, the provision of public transport alternatives is not sufficient to achieve reduced congestion or emissions. As some motor-

Table 3.4: A Taxonomy of Instruments to Control Automotive Air Pollution

Target area	Command and control	Market-based incentives
Fuels	Fuel quality standards	Fuel pricing/taxes
Vehicles	Emission standards Fuel efficiency standards Inspection and maintenance Vehicle scrappage programs	Vehicle taxation
Transport Management	Traffic management (bans, high occupancy vehicle lanes, etc.) Parking restraints Public transport policy Land-use regulations	Congestion charges Parking charges/taxes

Source: World Bank 1992a.

ists switch to public transit, others will start driving upon seeing the congestion slightly relieved. Thus, it is always essential to attack urban congestion through comprehensive measures—both traffic management and pricing—that restrict automobile use.

In many Asian cities, given rapid urbanization, growing income levels, and constraints imposed by current transport infrastructure on economic growth, large-scale investments in public transit are increasingly required and viable. Currently there are ten mass transit systems in nine cities in Asia (table 3.5). Manila is extending its light-rail system, and ongoing studies in Jakarta are examining the feasibility for guided bus transit and light rail. Karachi is considering the development of a 90 kilometer partially-elevated bus/light-rail transitway. Bangkok is seriously considering several mass transit investments. These investments are the first step in urban programs to alleviate congestion and transport-related pollution, which are mutually reinforcing objectives. Additional work related to achieving financial viability is addressed later in this report (chapter 8) as a high priority for Asia.

Table 3.5: Urban Mass Transit Systems in Asia

City	Mass rapid transit (Metros)	Light-rail transit	Total
Anshan	0	1	1
Beijing	1	0	1
Bombay	0	1	1
Calcutta	1	1	2
Dalian	0	1	1
Manila	0	1	1
Pusan	1	0	1
Seoul	1	0	1
Tianjin	1	0	1

Solid Waste Management

Disposal of domestic and industrial solid waste, like sewage, is given relatively low priority in many Asian cities. Municipal waste collection and disposal agencies are often stretched for collection vehicles, transfer stations, and disposal facilities. Cost recovery is not emphasized, and the financially starved agencies are unable to meet operating and maintenance costs and capacity expansion needs.

Institutional strengthening and sound management practices are required to ensure efficient service provision. Collection should be decentralized to the local municipal level or lower, while disposal responsibilities should be at the level of the metropolitan region to ensure that the process is environmentally sound. More attention needs to be paid to financing capital requirements as well as meeting recurring costs. Municipalities should strive to recover the costs of collection through user charges, while disposal costs could be met through local taxes and/or intergovernmental transfers given the environmental benefits of sound disposal.

The potential role of the private sector (both informal and formal) in solid waste management needs to be explored. Recycling of solid wastes could reduce the pressure on the collection, disposal and handling systems. Informal scavengers already operate marginal recycling operations in many Asian cities. In Jakarta, it is estimated that about 200,000 people earn a livelihood in this manner. Twenty thousand people live around a dump called "Smokey Mountain" in Manila—and resist relocation, as they derive their livelihood out of scavenging for recyclable material.

There are ample opportunities for participation by the private sector and community groups in dealing with household wastes. Contracting out the management of transfer stations, processing facilities, landfills and special industrial waste facilities is a feasible option.

Land Management

From the 1950s through the 1970s, public agencies were the primary actors in land development. Their record was dismal as they were overwhelmed by the speed and pressure of rapid urbanization that resulted in high costs, high subsidies, and tortuously involved development processes. In India,

undue faith in the public sector (and great suspicion of the private sector) combined with such restrictions as the Urban Land Ceiling Act (which limited the private assembly of land for development), constrained urban land development.

Now, governments are increasingly recognizing the need for private markets to play an important role in urban land development. This arrangement has been successful in the United States, where public partners do the planning and provide incentives for private developers to include design features that are in the public interest. Two types of reforms are needed to facilitate private land development: (a) reforming land development regulations by revising or eliminating standards requiring high-cost materials and processes, simplifying other regulations, and streamlining review processes; and (b) reforming land titling by revising laws to permit unambiguous transfers of ownership, clarifying tenurial rights, improving land ownership records, and streamlining the process of title transfers.

However, more efficient titling and regulatory environments cannot by themselves guarantee environmentally sound land development strategies. Rigid controls have to be replaced by flexible graded systems with (a) critical (environmentally sensitive) zones where tight controls would be applied; (b) zones with simpler and more flexible standards, and (c) zones totally free of controls. In addition, governments have to play a leadership role by siting public infrastructure (roads, public transit, electricity connections, water supply, and sewerage) to induce development away from environmentally sensitive lands. Developers and communities have to be monitored to ensure that they do not develop on ecologically sensitive land. High-density development should be encouraged given the scarcity of land in most Asian cities. Finally, government (or environmental NGOs) could buy the most sensitive land and put it to conservation use.

Institutional Framework

To support the technical and policy approaches described in the earlier section, stronger institutional frameworks and actions on the part of public and private actors are necessary for environmentally sound urban management. Political and social complexity in urban areas often results in weak governance at the local level, which becomes a hurdle in developing an environmentally sound urban development program.

The management of urban development involves numerous agencies, typically at municipal, provincial and central government levels. The multiplicity of actors with overlapping, uncoordinated, or poorly defined responsibilities aggravates the institutional weakness and hampers the development and implementation of a broader urban management strategy that also includes the environment (box 3.2). Separate agencies often provide individual services with little coordination in their activities.

In most Asian countries, governance is dominated by the central government. Local governments in cities have little power to raise revenue and implement programs. While cities are relatively wealthy, city governments are often unable to tax this wealth base to generate revenues. In turn, allocation of revenue to city governments is more often dictated by political considerations than by needs of cities.

Also, most local governments in Asian cities lack the capacity to carry out effective urban planning and management that integrates environmen-

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Box 3.2: Institutional Arrangements in Jakarta

Six central ministries, two semi-autonomous centrally administered agencies, and nine provincial public agencies have a direct effect on urban environmental quality management in Jakarta. In general, central ministries and central agencies play an important role in formulating policy and compiling ambient standards, whereas the provincial agencies formulate regulations and carry out monitoring and enforcement. In certain functions such as reviewing environmental impact assessments, both central and provincial level agencies participate. Given the bureaucratic culture in Indonesia, agencies respond only to vertical lines of command, and there is resistance to interagency cooperation.

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tal concerns. While lack of capacity is widespread in all local government agencies, it is particularly so in fledgling environmental agencies responsible for monitoring and enforcing environmental regulations. These agencies usually have low status in the bureaucracy, have inadequate powers, and lack adequate staff, skills and equipment. Consequently, neither the regulatory agencies nor the private sector take environmental regulation seriously.

Environmental planning is also hampered by the lack of environmental information for urban areas. Much information is not collected, and even when collected it is often stored in different agencies and not easily accessible for planning purposes. This is compounded by the lack of analytical frameworks for understanding the problems. Most local government authorities are not fully aware of the magnitude of the problems or the impacts on the population. Also, there are limited professionals who have the capacity to conduct environment-related analysis.

Although they are shackled by their lack of capacity, most public institutions rarely involve the private sector, local community, or other interested actors in environmental activities. This lack of user participation in urban service provision usually results in less support for long term operations and maintenance than would otherwise exist.

However, there are encouraging signs towards decentralization in Asia that address both the functional and fiscal needs of metropolitan governments. For example, cities in China are more or less autonomous entities; in the Philippines, there is a move towards decentralization; and in India, though the provincial governments dominate, metropolitan-wide agencies have been established for many large cities. Although not all decentralization efforts to date have had full success, the trend is important and positive for urban environmental management.

Developing an Institutional Strategy

To address the multidimensional nature of urban development issues, efficient institutional mechanisms are needed. This report makes five recommendations to help strengthen urban institutions.

- Focus on the entire metropolitan area, not just on political areas (that may no longer be relevant anyway), and give importance to providing and operating basic urban services.
- Involve all actors who influence environmental quality in urban areas, particularly the private sector, NGOs and community groups.
- Set up a process for strategic planning that balances and prioritizes environmental management activities across sectors and build them into capital planning and budgeting processes.
- Establish capacity for financial management, revenue generation, and program implementation at the local level.
- Build local capacity to monitor environmental trends and to apply the analytical framework necessary for environmental management.

This strategy takes on obvious importance in light of the rapid rate of urbanization presented earlier: there will be at least 112 cities with over one million people by the year 2000, and the rate at which smaller cities are graduating to this status is increasing. This strategy is also being applied by the UNDP/World Bank Metropolitan Environment Improvement Program (MEIP, see box 3.3). Each of the five elements is elaborated below.

Metropolitan Region Focus and the Role of the Public Sector. Urban program development and implementation should be targeted on cities and their immediate hinterland. The public sector should have a basic role in setting standards, monitoring, enforcement, and certification. With the past failure of the public sector to deliver its services, there are positive initiatives to shift functions to the private sector. However, environmental quality management is not something that can be left solely to the private sector to resolve. While the private sector can participate in the process of planning, standard setting, and provision of urban services, the public agencies must retain responsibility for implementing legislation, defining

Box 3.3: The Metropolitan Environmental Improvement Program (MEIP)

MEIP is a Bank-executed, UNDP-funded pilot program currently active in Beijing, Bombay, Colombo, Jakarta, Kathmandu and Manila. In each city, MEIP assists in the preparation of an environmental management strategy (EMS) under the guidance of a steering committee, with a series of workshops and discussion sessions to ensure transparency and participation. The EMS is expected to be integrated into the planning and budgeting process for the city. MEIP assists the cities in preparing high-priority investment projects to tackle the critical environmental problems, some of which will be funded by the World Bank or by other donors.

MEIP also assists NGOs and other community groups with small demonstration projects in waste recycling, environmental education, and slum upgrading, with a view to upscaling the project. MEIP brings its participants from the different cities together once every year to learn from one another and to debate on the future course of the program. Finally, in some cities such as Colombo, MEIP has been successful in taking the leadership in defining a framework for urban environmental management, with the cooperation of other donors.

The MEIP approach has been quite successful (though unevenly so across the different cities) in highlighting environmental issues, and bringing a wide variety of interested groups together to develop a program of action. The process of consensus building has been time consuming, but the high degree of support and ownership of MEIP in the participating cities, and the low cost of demonstration projects are showing new ways to work in the urban sector. It is important to ensure that the MEIP strategies and feasibility studies are followed up with investment.

guidelines, regulating both private and public bodies, providing incentives for the private sector to meet environmental goals, and providing services where the private sector cannot play a role.

Environmental Network. While urban environmental problems are cross-sectoral in nature, most of the planning and investment work in urban areas is still done in sectors—industry, water supply and sanitation, housing, transportation, energy, and so forth. In addition, policies formulated at different levels—national, provincial, municipal—have an impact on urban activities and environmental quality. To combat these problems, experience has shown that a network, that is, an agreed arrangement for action between the different agencies and groups who influence urban environmental quality, can help.

At the metropolitan level, there are a variety of actors whose activities influence the urban environment—government agencies, the public sector, the private sector, community groups, and the media. A network can be developed by holding frequent in-country meetings and workshops attended by all the identified groups. The workshops could be the forum for advising on the scope of urban environmental programs and/or for measuring progress achieved on such programs. This can go a long way toward building public awareness, applying public pressure for environmental management, gaining agreement on an analytical framework for environmental management, and motivating public and private participants.

Establishing this process of dialogue and consensus building is beginning to make progress in some Asian cities. For example, under MEIP, some cities have formed steering committees composed of government agencies, private sector, NGOs and community groups, to develop environmental programs for their respective metropolitan areas. An early lesson from this process is that informed consultation, based on an agreed-upon analytical framework, is a requisite for this network approach.

Strategic Planning and Budgeting Process. Following the demise of urban master planning,[6] the emphasis of urban managers shifted to identifying feasible projects and expediting their implementation. However, problems associated with uncoordinated project-by-project activities are mounting, especially since most urban infrastructure is provided by sectoral agencies of the central or provincial governments, rather than the local government.

One appropriate response to this situation is the increased use of capital budgeting (multisectoral public infrastructure investment plan for a city for a year or several years) to encourage some coordination. Capital budgeting must still be tied to good strategic and physical planning. Unlike a master plan, however, capital budgeting requires

a direct plan of action which agencies are to implement.

The capital budgeting process is as important as the final budget itself. First, it should build on a planning process that has set priorities based on an analysis of alternatives. Second, a capital budget can help spotlight environmental objectives by specifically looking at the environmental impacts of each budgeted investment. Third, provincial and national authorities should remain within the process, as they have complementary and residual responsibilities. Fourth, the strategic planning and budgeting process has important implications for the private sector and the public, and needs its participation, through the above-mentioned network or other formats appropriate to the municipality.

Financial and Program Management. The process outlined above requires that local governments improve their capacity for financial management, revenue generation, and program implementation. In the context of tariff reform for local services, decentralization (with possible expanded fiscal authority) and increased investment on infrastructure, the credit-worthiness of cities and local utilities is extremely important.

Local Capacity for Environmental Analysis. Within the context of a priority-setting and budgeting process, it is necessary to have a good understanding of the environmental quality trends in the metropolis, and the cost and benefits of alternate strategies for achieving different environmental quality goals. Monitoring environmental quality is essential. Capacity for data collection and analysis has to be built up at the local and regional levels. Government institutions need not be the sole repositories of such capacity. Private industry can develop the capability to monitor and analyze the implications of industrial pollution and recommend mitigation strategies; community groups can focus on the impacts of environmental degradation on human welfare and recommend actions for mitigation; and the media can play a useful role in disseminating this information and raising the awareness of environmental issues in the community.

The World Bank's Role in Urban Development

Past Activity

For more than two decades, World Bank involvement in the urban sector in Asia has addressed some urban environmental problems through water supply and sanitation projects. The Bank's urban strategy during the 1970s focussed on low-cost infrastructure improvements, often on behalf of the urban poor. The strategy was implemented through three basic types of programs: (a) slum upgrading, where basic water supply, sanitation, drainage and other infrastructure were installed in existing slums without altering the buildings; (b) sites and services schemes, where new land was subdivided and provided to poor families with infrastructure but without completed new housing; and (c) improvements to citywide water, sewerage, and drainage systems. These programs increasingly emphasized cost recovery, as it become evident that it was necessary to reduce government budget constraints to achieve the high coverage required for the growing urban populations.

In addition to these more traditional types of urban projects, in recent years there has been increased recognition of broader urban environmental issues. For example, the Ganga component of the Bank's Uttar Pradesh Urban Development Project (fiscal 1988) supported the establishment of sewage treatment facilities and river pollution monitoring equipment to reduce the pollution in the Ganges River. There is growing realization that institutional strengthening is often the key to improved environmental management. Since 1990, Bank assistance for institutional strengthening and support to land use planning agencies, pollution control boards, and river basin management authorities reflect this trend. For example, the Jabotabek Urban Development Project III (fiscal 1990) carries an environmental protection and pollution control component which deals with institutional strengthening and training in monitoring

and enforcement at the provincial level. The Tianjin Urban Development and Environmental Project (fiscal 1993) assists in the strengthening of the Tianjin Environmental Protection Bureau.

The most innovative approaches to urban infrastructure and service provision in an environmentally sound manner have been in projects focussing on individual metropolitan areas. In Beijing, environmental impacts from all urban activities (including industry) are being analyzed, and a comprehensive environmental management and investment strategy is being developed, taking into account the long-term economic development strategy for the metropolitan region (box 3.4). The Bank has also supported innovative methods of financing for environmental management. The Tianjin Urban Development and Environmental Project supports the establishment of a revolving fund to finance pollution mitigation investments by industries.

In addition, Bank assistance has helped strengthen the capacity of local governments to prepare infrastructure projects which are environmentally sound. The East Java and Bali Urban Development Project (fiscal 1991) is an innovative approach in this direction (box 3.5).

In the transport sector, much of the environmental focus has been on components to mitigate the environmental impacts of projects. The steps required by the environmental assessment process have formed the building blocks for improved urban environmental management. For example, the Shanghai Metropolitan Transport Project (fiscal 1991) established a pollution monitoring unit in the Municipal Environmental Protection and Sanitation Bureau. The Ship Waste Disposal Project (fiscal 1992) in China will help reduce pollution of international waters caused by oily wastes and bilge slops from ships.

Box 3.4 The Beijing Environment Project

The project will assist Beijing Municipality in planning cost-effective strategies for a comprehensive environmental protection program, strengthening the policy and institutional framework, and supporting priority investments needed to start the process. It will address pollution problems associated with air and water quality and the disposal of domestic and industrial solid wastes. The physical works will include: (a) the construction of sewer networks to prevent pollution of groundwater and the city's waterways; (b) the construction of a pressurized hot water piping system for district heating to alleviate air pollution from the burning of coal at domestic residences; (c) renovation of a number of highly polluting industries, and in some cases, relocation of these industries from the inner city area; and (d) construction of a sanitary landfill and procurement of equipment for municipal solid waste disposal.

A study component, called the "Beijing Environmental Master Plan Study" will produce an integrated plan for air quality, water quality, and urban refuse management in the Beijing region to the year 2015. Among other things, the study will develop least-cost strategies to achieve the targeted environmental quality goals within the context of development objectives and to assess the economic, financial, and institutional feasibility of achieving those goals.

Economic and Sector Work

The environmental impacts of urbanization have received significant attention. Detailed studies on costs, benefits, and strategies for reducing pollution in Bangkok, Manila, Jakarta and several cities in Malaysia are nearing completion. A Bank paper, "Urban Transport and the Environment in the Asia-Pacific Region," highlighted the issues of inefficient fuels and motor vehicle emission standards, described above. The strategy also recommended that the Bank revisit the question of urban mass transit in Asian cities (box 3.6). Studies have been completed that examine the feasibility of mass transit systems in Jakarta and Karachi. The Environmental Strategy Paper for China (fiscal 1992) underscored the implications of rapid urbanization and industrialization. Also, the Bank has begun work with the Government of India on an environmental action plan for the Singrauli region (box 3.7).

A regional overview of the urban sector is planned for fiscal 1994, with a significant focus on environmental issues. Urban sector or related work is planned for: India (Bombay Urban Review fiscal 1994), Pakistan (Urban Sector Strategy, fiscal 1994), Nepal (fiscal 1994), Bangladesh (fiscal

Box 3.5: The East Java/Bali Urban Development Project

In this project, the Bank lends funds through the Government of Indonesia to forty-five local governments in East Java and Bali for investment in small urban infrastructure subprojects such as equipment for water supply, urban roads, kampung improvement, public markets, solid waste management, drainage, and sanitation. The project applies two Indonesian planning vehicles—the Integrated Urban Infrastructure Development Program (IUIDP), and the Environmental Assessment Process (AMDAL)—to urban infrastructure. IUIDP, designed in 1984, is a framework for improving government programs in urban infrastructure, with the responsibilities on the local government. Established in 1986, AMDAL defines the environmental assessment process, and is being applied for the first time for small urban infrastructure. The East Java/Bali project is the Bank's first serious attempt to integrate environmental concerns into decentralized urban planning and implementation.

Box 3.6: Mass Transit and the Asia Urban Transport Agenda

The Urban Transport Agenda Paper for Asia (1991) identifies four important steps toward the sound development of mass transit systems:

(a) Take an incremental approach to the development of mass transit systems built on present needs and constraints, but allowing for physical, operational and technical evolution;
(b) Find ways to reduce the capital and operating costs of mass transit systems and to expand their benefits to users, developers, and society at large;
(c) Define the role of mass transit within the urban transport system in terms of demand management and relative to other modes of public transport (including nonmotorized transport);
(d) Assess the potential interrelationships between mass transit and urban development in managing urban growth and productivity more effectively.

1995), and Sri Lanka (Infrastructure Development Strategy, fiscal 1994). These reviews are expected to identify strategies to deal with urban environmental issues. In addition, MEIP-assisted Environmental Management Strategies are expected to be completed in Bombay, Colombo, Jakarta, and Manila; and detailed understanding of the urban environment and intersectoral linkages should emerge. MEIP has also begun the Asia Urban Air Quality Strategy and Action Plan that will establish baseline information for air quality in the program's six cities, identify emission sources, and assist cities to develop least cost air pollution abatement strategies.

Lending Program

During the fiscal 1990–92 period, the Bank lent nearly $5.1 billion in the urban sector in East and South Asia (about 20 percent of the total Bank lending to these two regions). Environmental components accounted for nearly $372 million, or about 7 percent of the urban lending. The size and share of urban environmental lending was much higher

Box 3.7: The Singrauli Development and Environmental Strategy Study

The Singrauli region in India contains the largest coal deposits in India. The availability of water from nearby Lake Rihand and the abundance of coal have stimulated the development of super-thermal power stations and industries in the region. The population in the area more than tripled from 200,000 in 1971 to 700,000 in 1991. Rapid urbanization has led to a variety of environmental problems—deforestation of rural areas, pollution of Lake Rihand, air pollution from emissions of the thermal power stations and industries, and dust from mining. Weak governance in the region exacerbates the problem of providing basic services to the region.

The Singrauli Development and Environmental Strategy Study is an attempt to remedy the above situation. Previously, the Bank has been involved in eight studies on the region (with a total cost of $4.9 million). These studies have identified the nature and magnitude of problems in the region, linkages and causes. This new Strategy study, financed by the Overseas Development Administration (ODA), will make recommendations on infrastructure and services provision, help prepare high priority infrastructure and service projects, and assess ways to strengthen local institutions and governance.

in East Asia ($339 million, or 10 percent of urban lending) than in South Asia ($33 million, and 2 percent of urban lending).

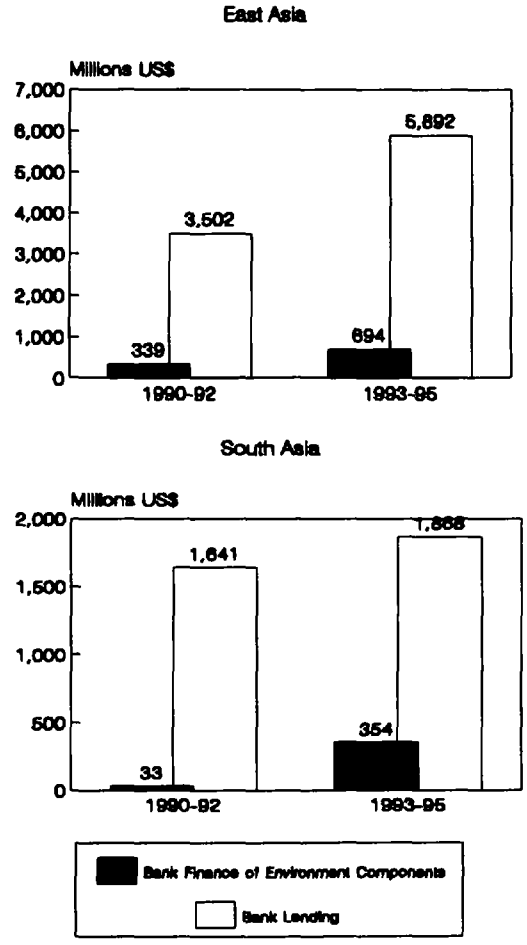
During fiscal 1993–95, the Bank expects to lend nearly $8 billion to the urban sector in Asia (about 26 percent of total lending). Preliminary analysis indicates that urban environmental lending is expected to more than triple to about $1 billion and will account for about 14 percent of total urban lending. East and South Asia lending for the urban environment are expected to increase to about $696 and $354 million, respectively (figure 3.4). The increase in environmental lending reflects the increased attention being paid to urban environmental issues.

Future Directions

Urbanization in Asia represents one of the most important demographic and social phenomenon of this century and facilitates economic growth. However, there is need to manage urban growth in an environmentally sound manner if the benefits of economic growth are not to be overwhelmed by the costs of environmental degradation. The problems of pollution and environmental degradation demand concerted action and huge investments in improving water quality, sewerage and sanitation, solid waste management, and air quality. One estimate for water quality and sanitation improvements in Asia alone is $12.4 billion per year by 2000 (see chapter 2, table 2.3).

Governments in Asia are making serious beginnings to address these problems. By more than doubling its urban environmental lending Asia, the Bank is supportive of these initiatives. While Bank support for investments is important, Bank policy guidance may make a more widespread impact. The Bank's approach is to focus on metropolitan regions and help metropolitan authorities develop environmental sound infrastructure programs with local accountability. At best, the process involves all the actors in cities—government agencies, private sector, NGOs, and community groups—as a means to arrive at a broadly agreed strategy for managing the urban environment. Besides generating enthusiasm and support, a strategy which lends a special urgency to policy, pricing, efficiency and integrated management, will engender innovation and help cities mobilize financial resources from domestic and external sources.

Figure 3.4: Total Bank Lending and Bank Finance of Environmental Components for Urban/Infrastructure Projects in the Asia Region, Fiscal 1990–92 and Fiscal 1993–95



The megacities in Asia also face enormous transportation problems. The problem will be especially acute in the cities of East Asia, where vehicle populations are doubling in less than seven years. The Bank has not supported mass transit in the past. However, given the current conditions in Asia there is a broad need to assess the economics of mass transit as a possible component of a

Box 3.8: Urban Environmental Projects in Asia

East Asia. Urban environmental projects are being prepared in Liaoning, Shanghai, Zhejiang, and Southern Jiangsu Province with similarities to the Beijing Environmental Project. In Indonesia, urban environmental efforts will be addressed through an Urban Environment Project (FY94). The Industrial Efficiency and Pollution Control Project in the Philippines is attempting to develop an environmental management strategy for Metro-Manila. A Petroleum Product Reformulation and Air Quality Control Project is being prepared for Thailand.

South Asia. Sri Lanka is currently preparing (with MEIP assistance) an environmental management strategy for Colombo. Work is just beginning in Bombay, with MEIP guidance and Bank assistance, to prepare an environmental management strategy for Bombay. However, in both these cities, follow-up investment arrangements are yet to be made. In Pakistan, the Punjab Urban Environment Project (FY94) is expected to introduce environmental focus into the urban sector, including the industrial sector. The Bank is also preparing a project to assist Karachi build bus-ways. Kathmandu became a participant in MEIP in early 1993.

multimodal transport strategy, at least in the megacities. While the crisis in secondary cities may not yet be at hand, it is also useful to look at options for large investments in public transit as a proactive action than a reactive one. This assessment should take into account the environmental, urban planning, and financial implications of such systems.

The environmental problems associated with urbanization are more widespread in East Asia, and Bank urban projects reflect this concern. The integrated city/regional approach to urban infrastructure and service provision is well established in China and making progress in Indonesia and the Philippines (box 3.8). The Bank could assist in developing similar programs in other major urban areas in the region, such as Bangkok and Kuala Lumpur, and in secondary cities in China, Indonesia, and the Philippines.

Public health issues related to safe water and sanitation are the most serious in the South Asia region, and the lending program reflects this concern. The expanded environmental focus is relatively weaker in the South Asia program, and the water supply and sanitation projects are being prepared with little consideration of other polluting sectors, and without the guidance of any environmental management strategy. However, there are some emerging initiatives that could provide the foundation for an enhanced urban program that integrates environmental concerns (box 3.8). Urbanization is reaching crisis proportions in India with accompanying environmental problems, and the Bank could play a useful role by assisting not only the megacities, but also the rapidly expanding secondary cities.

Notes

1. UNDP 1991.
2. GEMS, the Global Environmental Monitoring System, has been operated by WHO and UNEP since 1974.
3. The exceptions are northern cities with unusually high seasonal concentrations of SO_2 due to winter coal burning.
4. CSE 1989.
5. Unleaded fuels are not available in many Asian countries, including Bhutan, Cambodia, Myanmar, Nepal, Pakistan, the Philippines, and Viet Nam. Malaysia and Thailand are introducing unleaded fuels. Where unleaded fuels are introduced, taxing leaded fuel is needed to shift demand over to the unleaded fuel.
6. Master plans were common in the 1960s and 1970s, but urban master plans have been criticized for being too dominated by physical planners without regard to the economics of infrastructure provision and urban growth.

4

APPROACHES TO INDUSTRIAL POLLUTION

Overview of the Problem

The industrial sector in East Asia grew at the extremely high rate of 9.1 percent per year between 1965 and 1990, and is now nine times its size in 1965 (table 4.1). Manufacturing growth has been even higher. Industrial growth in South Asia has also been high (5.6 percent between 1965 and 1990), and the sector has quadrupled in size. There has also been a region-wide structural shift towards increased industrialization—industry has increased its share of total output from 32 percent to 45 percent in East Asia, and from 21 percent to 26 percent in South Asia—and this structural shift is expected to continue into the future.

An expanding industrial sector affects the pollution load in two basic ways. The first is to increase the total volume of pollutants in the short and medium terms. (In the long term, total pollutants may decline if dramatic shifts into cleaner industries take place, or if the share of the industrial sector itself falls. Neither shift is imminent in Asia.) The second is to change the pollution *intensity* of industrial output (the amount of pollution generated per unit of output). In Asia, both the growth and the intensity effects are leading toward heavier pollution loads in the short and medium term.

Table 4.1: Industrial Production Growth Factors in Asian Economies, 1965–90 (constant 1990 US dollars)

	Industrial production (US$ million)		Growth factor
	1965	1990	
EAST ASIA			
Taiwan (China)	485	66,774	137.6
Indonesia	2,722	42,743	15.7
Korea, Rep. of	6,984	109,819	15.7
Thailand	2,985	31,810	10.7
Malaysia	2,084	16,536	7.9
China	20,937	155,331	7.4
Philippines	4,567	15,466	3.4
TOTAL	40,279	355,930	8.8
SOUTH ASIA			
Pakistan	1,964	10,010	5.1
India	22,212	85,772	3.9
Bangladesh	1,130	3,359	3.0
TOTAL	26,010	101,769	3.9
DEVELOPED COUNTRIES			
Japan	320,914	1,234,938	3.9
Australia	46,893	91,571	2.0
Germany	402,585	583,608	1.5

Source: World Development Indicators 1992.

No comprehensive data exists on either total pollution loads or pollution intensities in Asia—a constraint to full understanding of the extent and cost of the industrial pollution problem. Partially in response to this constraint, the World Bank's Industrial Pollution Projection System (IPPS) has been developed to provide an approximate means to estimate trends in industrial pollution. The IPPS uses pollution coefficients from United States manufacturing concerns for 1988, and applies them to industrial output in Asia.[1] The system captures shifts in subsectoral output but

not shifts in technology over time.

Since IPPS estimates are not directly based on Asian pollution data, it is not known if they are biased low or high. Their accuracy depends on how closely Asian technologies mirror United States technologies in 1988. Also, since it is arguable that industries are less regulated in Asia than in the United States, pollution loads may be higher in Asia. A possible bias in the opposite direction is that Asian technology is, on average, younger than in the United States, and therefore inherently cleaner. It is not possible to reconcile these and other factors at the present, so the estimates presented here are meant to be indicative only.

The resulting indicative trends for industrial pollution in Indonesia, the Philippines and Thailand are shown in figure 4.1.[2] The six pollutants shown are two indicators each for water pollution (BOD and suspended solids), air pollution (SO_x and particulates), and toxic wastes (a composite index of various toxics emitted into the air or water, or in solid wastes and heavy metals). Between 1975 and 1988, these three countries had broad-based increases in pollution intensity across all forms of pollution, including ten-fold increases in Thailand, eight-fold increases in the Philippines, and four-fold increases in Indonesia. In comparison, the toxic indicator in Japan *fell* by two-thirds between the late 1960s and 1987.

The severity of these pollution problems varies widely in different locations. Industry is highly concentrated in East Asia, leading to high concentrations of pollutants. Provincial industrial output data (figure 4.2) shows that industrial activities are heavily concentrated in Indonesia and China but less concentrated in India.[3] There are extremely heavy pollution loads in the ambient environment of Indonesian and Chinese cities. For example, box 4.1 presents a profile for Beijing, which is not considered to be a heavily industrialized city. Other industries, such as tanneries, may be found in rural areas but are often clustered, with severe localized impacts on the environment (box 4.2).

The environmental costs of rapid industrial growth in Asia can be broken down into (a) contamination of water resources, including pollution of groundwater, (b) unacceptable levels of air pollution, and (c) unsafe handling and disposal of toxic substances. These costs are increasingly measured in terms of contaminated water, air, and land; adverse health impacts; and damage to local fisheries and wildlife. Public health impacts (such as cancers and respiratory ailments), are now being found in and around industrial areas, particularly in the vicinity of heavy metallurgical, chemical, and coal-fired industrial processing plants. These impacts are the direct result of using both dirty fuels (coal) in highly inefficient thermal processes (boilers, heating, coking, and so forth) and of the manufacture and application of chemicals with inadequate treatment facilities.

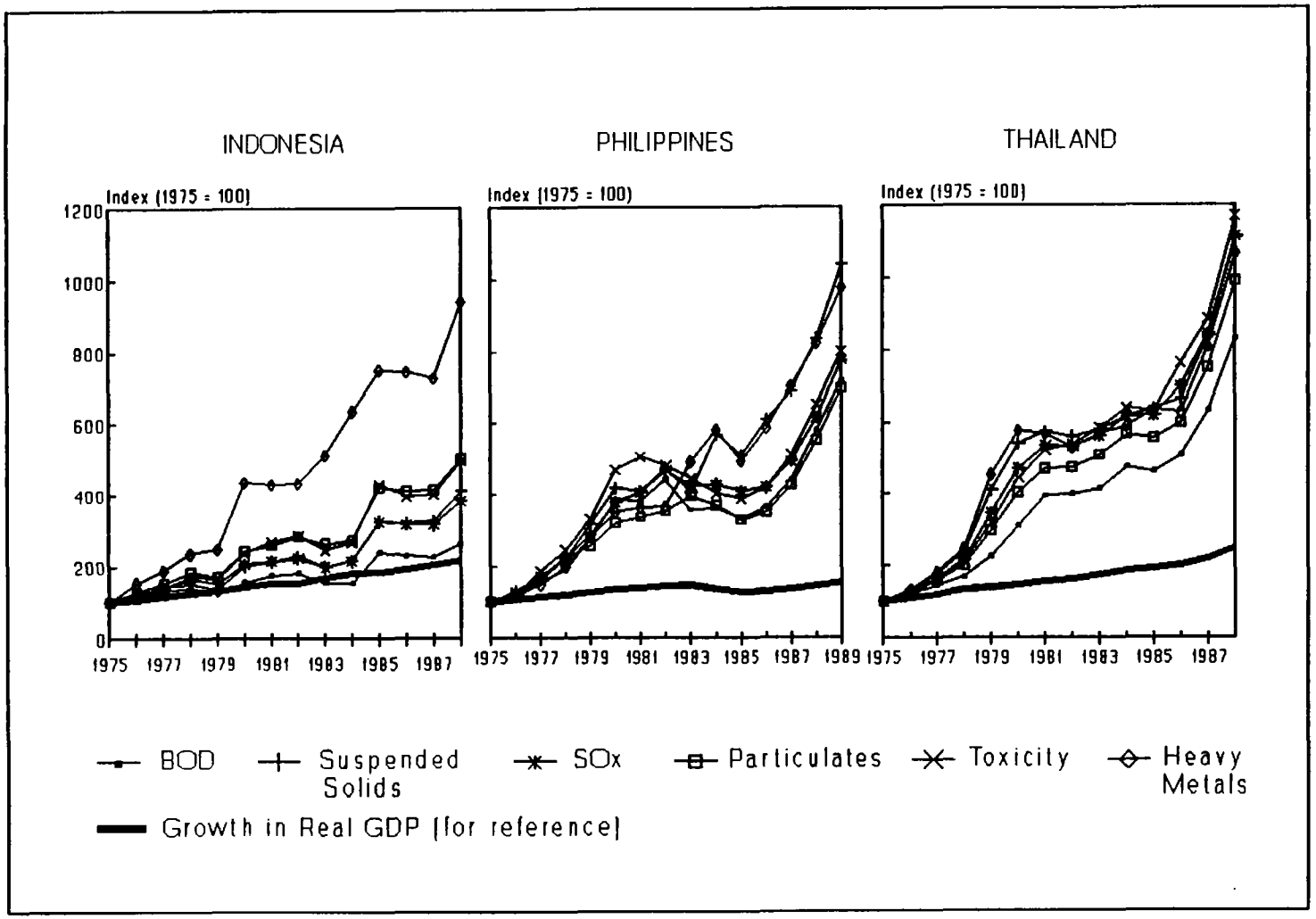
As mentioned, the existing data on industrial emissions and effluents is extremely sparse and provides little basis for making local and regional comparisons. The availability of data in the urban, transport, and energy sectors is generally much

Box 4.1: Industrial Pollution in Beijing

There are some 5,700 industrial enterprises (excluding township and village enterprises) in Beijing, employing 1.7 million people. They produce about 1 million cubic meters per day of wastewater, contributing approximately 45 percent of the volume and 60 percent of the total water pollution load in the municipality. In addition, they produce 24 percent of the soot and dust emissions of the city, and 4 million tons of industrial solid wastes each year, of which 267,000 tons are toxic and hazardous. Half of these enterprises, producing 70 percent of the output, are in the most densely populated 5 percent of land in the municipality. Many polluting industries are being moved out of these densely populated areas, and occasionally the moving costs are financed by the "sale" of the land. Others are simply being shut down.

The most common industrial approach to pollution control in Beijing has been through end-of-pipe (EOP) technologies. By 1988 a total of 692 wastewater treatment plants had been installed in factories in Beijing. However, a survey showed that many of the EOP treatment systems were not being operated because of the high electricity demand and high operating costs. As a result, the municipality now favors a cost-effectiveness approach to the solution of individual industrial pollution problems. In many cases, this leads to pollution prevention at source through technical transformation, rather than EOP treatment.

Figure 4.1: Estimated Total Industrial Pollution in Selected Asian Countries

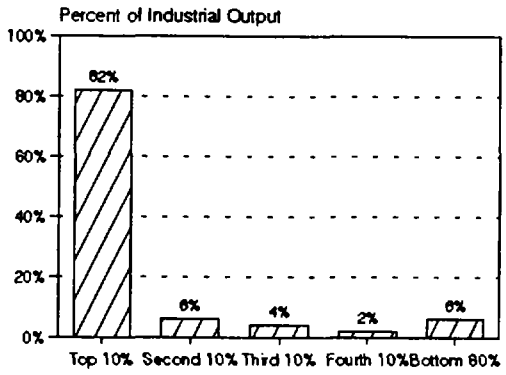


Source: Calculated from IPPS, World Bank 1992 (see caveats in text).

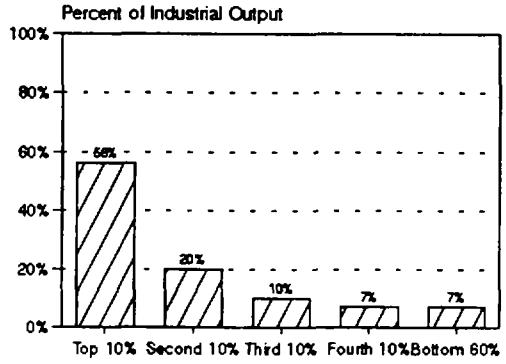
Figure 4.2: Geographic Distribution of Industrial Output (using provincial or state data)

Land Area Ranked by Degree of Industrialization

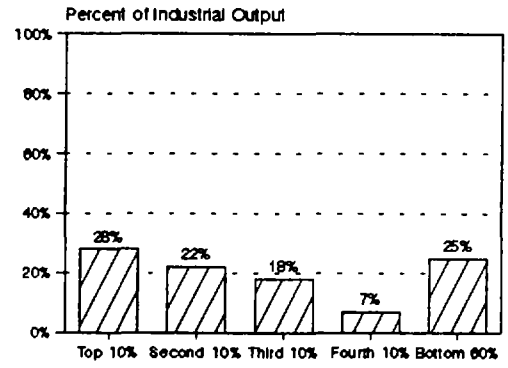
Indonesia, 1989



China, 1990



India, 1983-84



Sources: Data for Indonesia compiled from World Bank data; "The Statesmen's Year-book 1992-1993". Data for China compiled from China Statistical Yearbook 1991; "The Statesman's Year-book 1992-1993". Data for India compiled from World Statistical Yearbook 1987; "The Statesman's Year-Book, 1992-1993"

better than for the industrial sector. As a result, recommended approaches to the industrial pollution problem both recognize the need for additional data and include strategies that can function relatively efficiently even in the absence of good data.

Water Pollutants. Large quantities of waterborne pollutants result from industrial production—especially inefficient production—and from natural resource use and conversion (box 4.3). The major categories of waterborne pollutants include: oxygen demand substances, measured by biochemical oxygen demand (BOD) and chemical oxygen demand (COD); other standard industrial pollutants (such as total suspended solids, ammonia, phosphorous, sulfide, nitrate, sulphate, chloride, and oil and grease); and polluting characteristics (such as pH).

There is very little systematically collected data from the region on industrial water pollutants. Among the exceptions are some urban data on BOD pollutants released by industry: the industrial contribution of BOD pollutants is estimated at approximately 25 percent in Bangkok and 35 percent in Manila.[4] However, it is generally known that rivers in Asia are becoming saturated with BOD and COD compounds and that there are declining levels of oxygen in over half of the rivers monitored in Asia. Most riverine industrial pollution is confined to river systems within countries, with the important exceptions of the Ganges and the Mekong. Other major transboundary rivers such as the Brahmaputra, Salween, and tributaries of the Indus are not (yet) heavily polluted with industrial waste.

Box 4.2: Leather Tanning in Asia

The leather tanning industry in *China* and *India* is made up of a few large export-oriented units and a large number of manual, small scale units producing mainly for the domestic market. Most of these facilities are rather primitive and do not meet minimum discharge standards. Release of wastewater seriously compromises groundwater quality, and problems are compounded by the discharge of heavy metals. Most of the small tanneries are concentrated in clusters that would facilitate common treatment facilities after heavy metals and sulfides have been removed by pretreatment. Toxic solid residues and sludge are now disposed without treatment, producing noxious gases causing air pollution.

In *Indonesia*, leather tanning includes about 540 enterprises processing 123 million tons of hides to manufacture 50 million tons of finished leather. Small-scale enterprises (fewer than twenty workers) process in 470 plants about 12 percent of the total; the remaining production comes from medium- and large-scale plants. The tanneries cause water pollution problems with high BOD and COD values in their discharges together with chromium, phenols, sulfides, ammonia, dyestuff, heavy metals in dyestuff, detergents, and antiseptic agents. Average compliance with national discharge standards is estimated at 2 percent. Even the largest tanneries remove less than 20 percent of the required pollutants, and 435 tons (at least thirty-six times the standard) of highly toxic chromium compounds are discharged annually into the rivers of Java. In addition, substantial amounts of solid waste, approximately 73 million tons a year, are disposed of in an unknown way.

Source: Kent 1991; Mulckhuyse 1991.

Box 4.3: Water Pollution from the Iron and Steel Industry in India

In 1986, India's iron and steel subsector produced 10 million tons of steel, with a capacity of about 15 million tons per year. About 65 percent of the production capacity is in the public sector. These public sector plants run at low efficiencies. No direct data on the environmental impact of the public sector industries are available. Using the Bank's best estimate of wastewater production figures as a guide, the public sector plants with a production of 6.5 million tons of pig iron (with a capacity of about 9 million tons) generate:

	Million cubic meters
Gas water	19.5
Quench water	9.1
Pickling solution	7.8
Condensate	0.9
Ammonia water	0.3

Wastewater streams also contain suspended solids, oils, waste acids, chromium salts, phosphates, ammonia, cyanides, phenols, chlorides, fluorides, sulfides, and heavy metals. Contaminated gas water, quench water, and condensate are in many cases being discharged without treatment. The cooling water needs of 585 million cubic meters are partly recycled through cooling towers. This mitigates some of the thermal pollution caused when warm condensate is otherwise dumped into nearby rivers.

Based on experience elsewhere, major industrial sources of these pollutants include fertilizer plants, refineries, pulp and paper mills, metal plating factories, and the chemical and metallurgical industries. In terms of the more specific organic waste load (BOD), the major polluting industry subsectors are food industries, alcohol distilleries, tanneries, pulp and paper mills, oils and fats, and pharmaceutical plants. While some plants in Asia have pretreatment facilities, in many cases these facilities are not operated and the wastes are simply dumped into the sewer system or available water bodies. Almost always, a few large industries contribute a large proportion of total pollutants (box 4.4).

Increasingly during the dry season, industrial wastewater is an important constituent of total water flow. As total urban, industrial, and agricultural demand on water resources increases, dry season shortages can cause sharply higher concen-

Box 4.4: Industrial Pollution in Surabaya, Indonesia

Surabaya, the second largest city in Indonesia (population 3 million), illustrates the environmental effects of concentrated urban and industrial growth on water quantity and quality. By 1977 shortages of raw water (particularly in the dry season) were so obvious that the Governor of East Java issued a decree imposing a moratorium on the further development of industries using water from or disposing wastes into the Surabaya River. While this pushed development upstream and into certain outlying areas, it did not address the roots of the problem. By the early 1980s, pollution of the Surabaya River had reached such a magnitude that the river had become virtually anoxic and was untreatable by conventional methods.

A detailed study at that time found that 80 percent of the river's pollution was caused by industry, despite the heavy use of the Surabaya River for domestic waste. The major polluters were pulp and paper, monosodium glutamate, dyeing, sugar, tile, coconut oil and metal fabrication plants. Of twenty-eight firms surveyed in detail, only four (14 percent) complied with applicable BOD standards and eleven (30 percent) with COD standards. Also, four major polluters contributed 94 percent of the total BOD load from industrial sources. If these four problem polluters were to comply with regulations, the total industrial pollution load would be reduced by 75 percent. Through direct intervention by the Governor's office, compliance by the four firms was achieved in late 1987.

Pollution levels in the Surabaya River have improved, but not enough. In the downstream portions of the Surabaya River in 1991/92, average BOD concentrations were 6–8 milligrams per liter, and COD concentrations were 26 milligrams per liter. These levels are still at or above the acceptable levels for water to be treatable for domestic use. During one recent dry season, pollution became so concentrated that both Surabaya's water treatment plants and water-demanding industries had to be shut down because they could not function. Heavy agricultural withdrawals further constrain the ability of the river to flush the steadily increasing amounts of upstream human wastes.

PROKASIH, a nationwide clean river campaign program, has been active in Surabaya to bring greater public and political pressure onto industrial polluters. As a result, more industries have installed treatment facilities. Some evidence indicates that among those firms who signed voluntary PROKASIH agreements in 1991, BOD and COD pollution loading fell by over 50 percent. However, anecdotal evidence also indicates that some firms only rarely operate these treatment facilities (in order to save on operating costs), due to lack of effective enforcement.

The lesson from Surabaya is that targeted pressure on major polluters can lead to short-term improvements, and that a partial degree of compliance may be achieved without strong enforcement institutions. However, such targeted pressure does not reduce the long-term importance of developing more inclusive and systematic enforcement systems. The regulatory regime in Surabaya is still inadequate, and pollution charges (and/or incentives) need to be implemented in order to force (or convince) companies to reduce pollution levels. In addition, enforcement is demonstrably haphazard, and needs to be strengthened. The Indonesian Government, together with PJT (Perum Jasa Tirta, a state corporation charged with water resource management for the entire river basin), must address these major outstanding issues before the Surabaya River will become cleaner.

trations of pollutants. The combination of increased industrial output and increased withdrawals of river water means that whatever dilution effects were previously observed are no longer achieved. This is particularly true in the urban areas and densely populated river basins of China, India, and Indonesia.

Air Pollution. The list of conventional air pollutants from industry includes: SO_x, NO_x, total suspended particulates (TSP), CO_2, CO, and hydrocarbons (such as methane). Industrial air pollution primarily comes from energy use. Industry consumes more than 40 percent of all commercial energy[5] in Bangladesh, China, India, Korea, Malaysia, Myanmar, and Viet Nam. As a result, energy efficiency is one of the most important and least-cost investments that industrial firms can make to reduce air pollution. Energy efficient technologies are implicit in most investments in clean technologies (see below), which reduce pollution through reduced inputs and lower pollution intensities.

As shown in the previous chapter, the air in Beijing, Calcutta, Jakarta, and New Delhi exceeds WHO air quality guidelines most of the time. In Beijing, it is estimated that industry emits 59 percent of particulates and 39 percent of SO_2 (more than power plants, which emit 24 percent of SO_2). In Bangkok, industry emits about 21 percent of TSP

(slightly less than power plants, which emit 33 percent). In addition to these megacities, there are a much larger number of smaller cities with even more severe air pollution problems, often because these cities were developed specifically as industrial centers close to raw materials and fuel sources. Shenyang and Taiyuan in China, Illigan City in the Philippines, and the Singrauli region of India are prominent examples.

Toxic Pollutants. Toxic pollutants released from industry include heavy metals, cyanides, and pesticides and can be emitted into the air and water, or in solid wastes. Little is known about the quantities or precise sources of chemical and toxic residuals, since almost no governments or industries do any sampling of toxic pollutants anywhere in Asia (with some exceptions in India). However, their impacts are found in polluted groundwater, surface water, and urban and periurban refuse dumps.

High concentrations of industry in urban areas compound the risks. These wastes tend to accumulate in the poorer sections of the city, and direct contact with local populations (mostly children) occurs daily. These risks were realized in tragic extreme with the deaths in Bhopal in 1984 (box 4.5). In addition to toxic releases and residues in the ambient environment, occupational hazards increase with both increasing pollution intensity and industrial output (box 4.6).

In the absence of Asia-specific data, a second-best approach to estimating Asia toxic releases is to use coefficients of toxic pollution intensity derived elsewhere (see the previous caveats). The World Bank IPPS project combines United States coefficients of some 320 toxic pollutants and creates a toxic-intensity index that combines the quantity and toxicity releases across air, water and solid discharges. It should be remembered, however, that these are indices of total releases, not of estimated ambient pollution levels.

The results of this analysis show extreme sectoral variation in toxic pollutant intensity, ranging from fertilizers and pesticides with an index of 105 per $1,000 of product, to soft drinks and carbonated waters with only 0.22 per $1,000 (figure 4.3). The subsectoral composition, the level of technology and the status of environmental controls will vary from nation to nation. However, these toxic intensity indicators can be used as a first approximation of how shifts in national industrial output have affected the relative level of toxic releases. As shown in figure 4.1, the estimates of toxic releases for Indonesia, the Philippines, and Thailand show fourfold to tenfold increases in the total volume of toxic wastes emitted. However, perhaps an even more important conclusion of the IPPS analysis is that the intensity, or *unit* volume of toxic releases per unit of output, is also increas-

Box 4.5: Industrial Accident at Bhopal

In December 1984, a pesticide factory belonging to Union Carbide at Bhopal, India, accidently released over 30 tons of methyl isocyanate. The toxic release resulted in the death of more than 2,800 people living in the vicinity and caused severe respiratory damage to over 20,000 others. Victims continue to suffer from the debilitating effects of the disaster.

The Bhopal incident illustrates how a rapidly growing city witnessed industrial growth without commensurate investments and regulations concerning industrial safety, pollution control, and zoning. Union Carbide assumed full responsibility for the accident. However, for its part, the city government was historically reluctant to adopt stricter safety and pollution control measures for the fear of adversely affecting employment.

Another aspect of the Bhopal tragedy was the lesson it provides concerning land use. In Bhopal, a rapidly increasing population and high land and construction costs caused a severe housing shortage. Many migrants were forced to occupy shanty settlements in and around industrial plants. They served as a cheap pool of labor for industry, construction, and domestic help in the city. By 1984, Bhopal had 156 such communities containing one-fifth of the city's population. Two of these colonies, Jaya Prakash Nagar and Kenchi Chola, were located close to Union Carbide, even though the area was not zoned for residential use. The proximity of high-density, unzoned housing near one of the city's largest toxic industries was the result of prolonged inaction on the part of the city government.

Box 4.6: Industrial Pollution and Health in Thailand

Industrial activity in Thailand has resulted in increasing occupational exposure of workers to toxic chemicals. As a result, Thai workers have experienced significant occupationally linked health problems. A survey of five regional hospitals in 1983 found that over 7 percent of total poisoning cases were occupationally related. In 1984, an investigation into occupational disease showed that the average lead levels in the blood of workers in various tasks at a Thai battery plant was in the range of 12 to 48 milligrams per 100 milliliters of blood. Allowable levels in non-occupationally exposed people are set at between 0.025 and 0.10 per 100 milliliters—implying that lead exposures in workers were 480 times greater than health standards. Since the study included less-exposed workers, such as administrative staff, in its sample group, the health risk may be even more extreme than indicated in the study.

Another study performed by the Ministry of Public Health showed that the incidence of environmentally related health cases increased from 2.00 cases per 100,000 people in 1978 to 8.88 per 100,000 in 1987. These results are summarized below.

Incidence of Occupational Disease per 100,000 workers, 1978–87

	1978	1983	1987	Annual increase (%)
Insecticide poisoning	1.97	4.76	8.64	17.9
Lead poisoning	0.01	0.02	0.10	29.2
Manganese, Mercury and arsenic poisoning	0.01	0.01	0.04	16.7
Petroleum products poisoning	n.a.	n.a.	0.02	n.a.

n.a.: Data not available.
Source: Ministry of Public Health, Thailand

Two caveats are in order. First, the studies do not indicate that adequate control groups were used to properly attribute all the impacts to the work place. Lead ingestion, for example, is widespread, due to water pipes, paint, and particulates from leaded gasoline. Second, improved diagnosis and reporting will appear as higher incidence. Therefore, these data are perhaps better used to illustrate the seriousness of the problems than to show detailed trends.

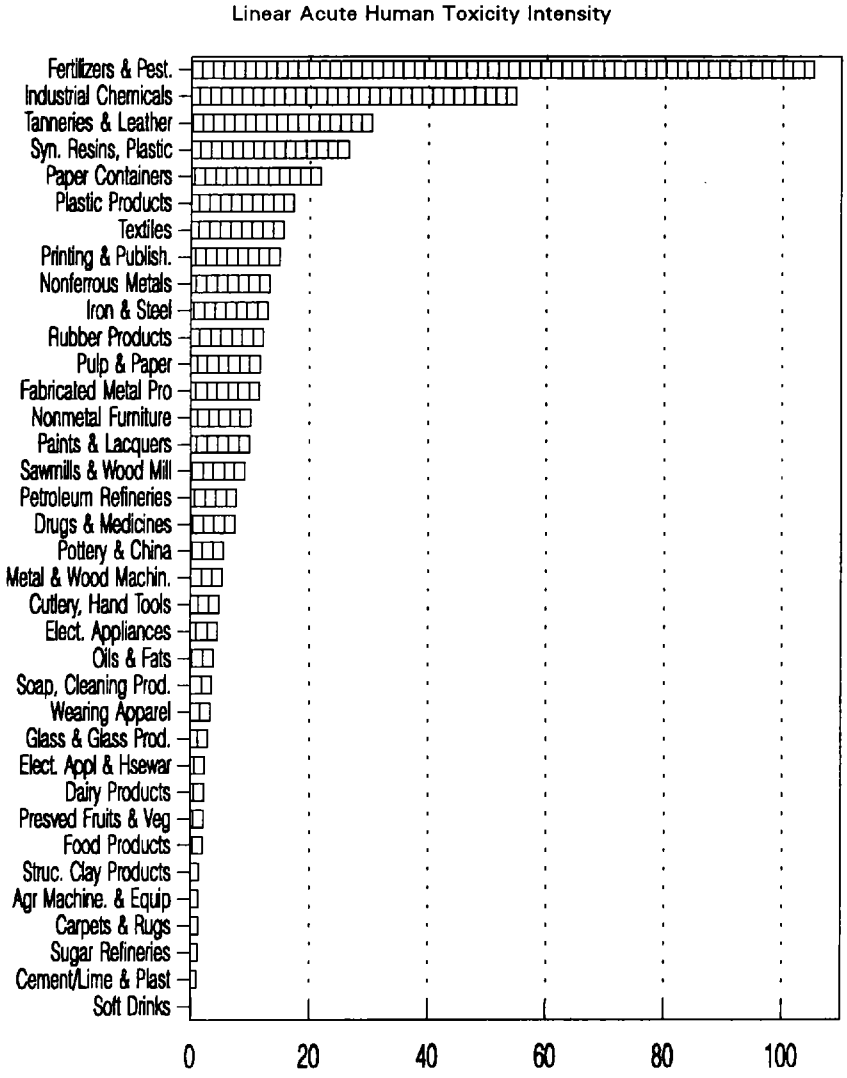
ing dramatically in Asia—particularly in East Asia.

Small- and Medium-Scale Industries. The importance and dynamism of small- and medium-scale industries (SMIs) is one of the distinguishing features of the industrial sector in Asia (box 4.7). SMIs are an important source of employment for low-income earners, and therefore, politically as well as economically, provide an important function in alleviating the effects of poverty. Also, in India and parts of China that are undergoing fundamental industrial sector reforms, SMIs are the most dynamic industrial subsector.

SMIs pose difficult pollution abatement problems. Although they are not be the major polluters in most subsectors, they often pollute more per unit of output than large firms operating in the same sector, for several reasons.[6] First, managerial and employee skills, as well as the technology used, are of a low level, leading to wasted resources, high pollution levels, and high health and safety risks to employees. Second, the economies of scale of higher technology pollution abatement equipment do not work in favor of SMIs. Third, their poor access to financial resources make it difficult for SMIs to upgrade their technology or install EOP treatment systems. Finally, limited access to information constrains their awareness of both the problems and solutions.

China is particularly aware of the pollution potential of township and village industrial enterprises (TVIEs). In southern Jiangsu Province, TVIEs are growing 15–20 percent per year and account for 45 percent of industrial output. Their serious contribution to environmental problems has prompted the municipal and provincial govern-

Figure 4.3: Industry Toxicity Indicators



Note: Linear acute human toxicity intensity is a composite index of over 300 toxic releases, weighted according to human toxicity.
Source: World Bank, IPPS 1992.

ments to pursue detailed specialized strategies for TVIEs involving relocations, closing, changes in the production line, changes in raw materials, pretreatment and common treatment facilities, and financial incentives. These policies can be best discussed in light of a broader strategy for addressing industrial pollution, as presented below.

Addressing Pollution Problems

In the past decade, most Asian developing countries have enacted laws and regulations concerning industrial pollution and created or strengthened agencies to enforce these regulations (table 4.3). Legislation for toxic and hazardous wastes is the most recent component of this effort. Some countries have gone further and set up a system of incentives and penalties for pollution control (box 4.8), drafted safety codes for factory workers, and crafted public awareness campaigns. All of these are steps in the right direction. However, it is at the level of implementation (that is, monitoring of environmental impacts and enforcement of regulations) that industrial pollution management is weakest.

To reduce industrial pollution in Asia, a multipronged approach is required. This must start with government commitment and a demonstrated will to clean up the most polluting industries. Effective pollution control systems require the removal of economic distortions (subsidies) and the definition of clear standards, followed by a combination of incentives, regulations, and monitoring activities to enforce the standards. This is already an enormous challenge, and some targeting will be required—for example, toward the most polluting subsectors or the most polluted regions. If there is sufficient institutional capacity to implement indus-

Table 4.2: Growth Factors of Toxicity Intensity of Production

Country	Years covered	Growth Factor
Indonesia	1976-86	5.40
Pakistan	1974-84	3.17
Malaysia	1977-87	3.05
Korea	1977-87	2.50
Thailand	1976-86	2.48
China	1977-87	2.12
India	1976-86	1.97
Bangladesh	1976-86	1.75
Sri Lanka	1977-87	1.59
Philippines	1977-87	1.12
Japan	1977-87	1.11

Note: Toxicity intensity is a measure of toxicity per unit of output. The growth factors are the ratio of toxic intensities for the beginning and end of the 10-year period shown, when the toxic releases are linearly weighted for degree of human toxicity.

Source: IPPS, World Bank, 1992.

try-specific programs, some governments may also provide information and other incentives to encourage the adoption of clean technologies.

Policy and Institutional Approaches

Enforceable and Appropriate Standards. Governments set both ambient pollution standards and industry standards. Ambient standards are often based on WHO guidelines, which indicate at what point public health is adversely impacted. Industry standards set allowable pollution levels for firms, and are the basis for regulating them. With few exceptions (such as tradable permits), industrial pollution control policies must be premised on clearly defined industry standards. It is the responsibility of policymakers to ensure that aggregate pollution levels do not exceed the ambient standards.

There are different types of industry standards, such as standards that define acceptable levels of pollutants per unit of output (load-based standards) or acceptable levels of concentration in the effluent streams (concentration-based standards). It is generally conceded that although widely used, concentration-based standards are less effective, as industries can simply dilute their waste

Box 4.7: Industrial Output Share of Small- and Medium-Scale Industries

The table below summarizes available statistics on the importance of SMIs in the industrial sector in Asia. They account for more than 50 percent of the total industrial sector output in China and India, and for 10–25 percent in most other Asian countries. Unfortunately, sufficient data to more carefully analyze the relative concentration of SMIs in polluting industries (vs. cleaner industries) in Asia does not readily exist.

Country	Medium (%)	Small, Cottage, or Household (%)
China (1989)	19.0%[a]	49.4%[a]
Korea (1988)	17.2% (20–99 empl.)	4.6% (5–19 empl.)
Indonesia (1986)	6.9% (20–150 empl.)	11.1% (< 19 empl.)
Philippines (1983)	10.4% (10–99 empl.)	2.4% (< 10 empl.)
Thailand (1986)		1.7% (10–19 empl.)
India (1988/89)	57.8% (< 2 million Rs. investment)	
Pakistan (1985/86)	12.3%(10–99 empl.)	0.9% (< 10 empl.)

a. Chinese definitions are based on production capacity.

Sources: *Statistical Year Book of Indonesia*, 1990; *Korea Statistical Yearbook*, 1990; Government of Pakistan, *Census of Manufacturing Industries*, 1985-86; World Bank, Philippines SAR: *Fourth Small and Medium Industries Development Project*, March 15, 1989; State Statistical Bureau of the People's Republic of China, *Statistical Yearbook*, 1991; India: Economic Information Year Book, 1990-91.

Table 4.3: Agencies and Legislation for Industrial Pollution

Country	Agency	Year Legislation Enacted Air	Water	Toxic/Land
China	National Environmental Protection Agency	1985	1985	1989
India	Ministry of Environment andForests/Pollution Control Board	1974	1981	1986
Malaysia	Department of Environment	1977	1977	1979
Philippines	Department of Environment and Natural Resources	1974	1974	1990
Thailand	Environmental Quality Board/Department of Industrial Works	1975	1975	1989

Source: Vergara 1992.

Box 4.8: The Pollution Discharge Permit System in Beijing

In recent years, Beijing has introduced a range of environmental management systems for reducing industrial pollution, including the pollution discharge permit and fee system. Other systems address environmental impact assessment and quantitative reporting; the design, construction and operation of pollution abatement facilities in coordination with production units; deadline control; and annual "pragmatic" performance systems. Beijing has shown success in its development of strong regulatory (command and control) framework and environmental institutions, but has not widely incorporated market-based instruments in its efforts to reduce industrial pollution.

The pollutant discharge permit system is an approach that addresses phased pollution-loading reduction based on the results of environmental audits and pollution prevention—that is, clean technologies, reduced consumption of raw materials, energy efficiency, waste minimization, and EOP treatment only as needed. The Beijing Environmental Protection Bureau began by making an analysis of current pollution levels, goals, and required reductions. It then initiated detailed discussions with industrial enterprises to agree on reduction plans, involving a wide range of technical and managerial changes. Since Beijing focused on the control of heavy metals and major poisonous substances during the 1980s (and shows a 90 percent reduction in ambient levels of mercury, phenol, cyanogen, chromium, and arsenic), the pollutant discharge permit system was targeted on COD discharges (including organic BOD substances).

Investments are ranked using a ratio of COD reduction (measured in terms of COD discharge per unit of output) to 10,000 yuan investment, and the most cost effective approaches have consistently been new "clean" or "whole process control" technologies, as opposed to EOP treatment. On average, for every 10,000 yuan investment, whole-process control technologies (which are often imported) eliminated as much as 5.9 tons per year of COD discharge, as opposed to 1.8 tons for EOP investments—a three-fold difference. Projected production increases are also part of the analysis, with the condition that pollution increases due to increased output must be offset by further pollution reductions either by the same enterprise, by other enterprises discharging pollutants into the same water area, or by other enterprises in the same subsector in the Beijing area.

The results between 1988 and 1990 for three of Beijing's largest chemical polluters were a 5 percent increase in output and a 6 percent (1,000 tons per year) decrease in COD discharges. It is projected that by 1995, total output will have risen by 50 percent, and COD discharges reduced by 16 percent. Comparable results are expected in other subsectors.

streams to meet the standard. For example, it has been shown that pulp and paper plants in water-scarce India were using four times the amount of water as used in water-rich Canada, partly for this reason. Load-based standards, on the other hand, allow for flexibility and innovation by the regulated firms.[7]

Industrial Growth. Given the magnitude of investment in pollution abatement required, it is easier to clean up industrial pollution in a growing economy than a stagnant one. Higher growth allows for more rapid turnover of aging technology, more rapid restructuring of industry and its product mix, greater opportunities for attracting foreign partners and technology, and higher public revenues. In Indonesia it is projected that by 2010 new investment will account for 85 percent of total industrial capacity. Therefore, policies pursued to control pollution should be consistent with economy-wide policies adopted for sustainable national economic growth.

Table 4.4: Market-Based Policy Instruments to Reduce Pollution

Direct instruments	Indirect instruments
Effluent charges	Input/output taxes and subsidies
Tradable permits	Subsidies for substitutes and
Deposit refund systems	abatement inputs

Source: Eskeland and Jimenez 1992.

Development of Market-Based Instruments. A host of incentives and creative financial arrangements have been used in the developed countries to encourage environmental compliance, including higher pollution taxes, tax incentives, emissions and discharge permit trading, and possible lines of credit for facilities (table 4.4). These are being increasingly considered for use in Asia, to supplement more traditional command and control approaches.

Almost all Asian countries have adopted the "polluter pays principle" as the foundation of their environmental laws and regulations to control pollution. However, this principle has not yet been effectively implemented, primarily because the levels of pollution taxes or charges, combined with their level of enforcement, are too low to have much effect. These are fundamental issues in dealing with industrial pollution.

The most common forms of financial disincentives in Asia are pollution (effluent or emissions) charges. Such charges can be highly efficient but only if rates are set high enough to alter behavior. In many Asian countries, these charges are far too low. In China for example, these charges tend to be lower than the operating costs associated with industrial pretreatment. In addition, the experience in China has illustrated that state-owned enterprises are particularly insensitive to policies that use economic incentives because they are generally not held accountable for high costs. In India, the lack of competition in the refinery sector means that using charges alone to reduce pollution or to phase out leaded gasoline would have little effect.

Pollution charges or taxes are best levied when monitoring, enforcement, and competition are all in evidence. If competition is lacking, then firms can pass on higher costs without having an incentive to reduce pollution levels. If monitoring and enforcement of specific pollutants is costly or difficult, then the more blunt indirect market measures are easier. Indirect taxes are not common in Asia, however. Diesel fuels and energy prices, for example, are not taxed commensurate with their environmental costs. A carbon tax has been widely discussed but not implemented. One new indirect tax policy newly introduced in Thailand is an innovative approach requiring industrial firms to post performance bonds based on projected levels of hazardous wastes. These payments are then subject to environmental audits, and rebates are paid if firms attain lower wastes per unit of output.

Even though "optimal" taxes may be difficult to calculate or introduce in many countries, the use of pollution taxes has a number of benefits. First, with limited administrative capacity of government, they induce the private sector to find ways to control pollution. Second, if the response to the tax is elastic, then pollution abatement will be achieved. If not, then the revenue generated will still be efficiently collected, the polluter will be paying, and additional measures can be invoked. Third, taxes involve the ministries of finance as well as the ministries of environment, and help convince policymakers that damaging the environment is a real cost.

Tradable Permits. Tradable permits have been advocated for their greater potential efficiency in abating pollution than traditional command and control approaches. Under such a system, a regulator would issue enough tradable permits for the marginal benefits and costs of abatement to be equated overall, thus saving the regulator the need to estimate individual plant costs. Rather, each plant is forced to calculate its own abatement costs. A plant with high abatement costs would tend to purchase pollution permits, whereas one with

cheaper abatement options would prefer to reduce emissions and sell its excess permits. The flexibility of the permit system is designed to allow industry to innovate, invest and adjust its compliance strategy in the least costly manner.

In spite of their theoretical appeal, the application of tradable pollution permits worldwide has been limited, partly because governments are not yet ready to create this new market. Even with tradable permits, there is still a need for government monitoring and market supervision, and this ability has been lacking in most countries. In the United States, tradable permits are limited options used primarily in the case of coal-fired thermal power plants, a sector traditionally used to a more command and control approach.

Subsidies. Subsidies have been commonly used in OECD countries, partly to accelerate abatement during the transition from the period of little industrial pollution control (the 1960s and 1970s) to the present period of broader compliance. There is an argument for a similar time-bound role for subsidies in Asian countries to help ease the adjustment of industry into a tighter regulatory environment. The argument for subsidies, however, is weak: in all cases, the carrots should only be offered in the context of strong sticks, and for a limited period. The general case for why, if ever, governments may choose to offer subsidies is presented in box 4.9.

If a country chooses to offer subsidies, the most common forms are investment tax credits and accelerated depreciation relating to investments in pollution control equipment. Only profitable firms—and typically medium and large industrial

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Box 4.9: Subsidies and Industrial Pollution Abatement: Why and When

The "polluter pays" principle, simply stated, does not allow for public subsidies to polluters to encourage them to undertake investments and modifications that they should be doing anyway. Similarly, the common debate between command and control vs. market-based policies for industrial pollution control does not carry over into the extra dimension of why and when subsidies are theoretically and practically justified. Therefore, the reasons for pollution control subsidies are based more on politics than economics.

The reasons that subsidies are commonly used worldwide in pollution control efforts include:

- Firms that made investment decisions in an earlier, less strict regulatory environment, face one-time adjustment costs. Governments have offered to ease that cost.
- Governments recognize that the cost of information in clean technologies is far from zero, and that a public good is achieved by bearing some of this cost—whether through demonstration projects, public R&D, or technical resource centers. This type of subsidy goes to the pollution control industry, not to the polluters directly. An alternate phrasing of this argument is that there is a need for a domestic pollution control service industry to provide such types of information. This industry is currently lacking in developing countries. As per the "infant industry" argument, public benefits accrue from assisting in the startup phase of such an industry.
- Governments view subsides as a cost tradeoff for monitoring, especially when monitoring is difficult or expensive. The argument is that if firms are encouraged to invest in pollution control, then they are more likely to actually reduce their pollution. This argument, which needs empirical verification, would apply only to the short timeframe when firms are making initial pollution-related investment, during which the government gains time to strengthen its monitoring capacity.
- Subsidies serve a purely political or public relations function by showing that the government does not always rely on sticks but can also provide carrots.

These arguments are theoretically weak. Nevertheless, virtually all OECD countries, and increasing numbers of Asian countries (India, Korea, the Philippines, Singapore, and Taiwan [China]) rely on subsidies to meet their environmental policy objectives. In Brazil, Estache and Zheng (1992) found that subsidies, when combined with a strong stick, actually improved the effectiveness of pollution taxes and lead to an overall net increase in public revenues.

In all cases, subsidies—if used—should focus on a finite period (such as five years) during which time the country's enforcement activities become binding. Many Asian countries are now in such a period. However, none of the above arguments apply after such a period has passed, when industry has learned of the tighter regulatory environment, public monitoring and enforcement has improved, and a domestic environmental service industry has emerged to meet local needs.

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enterprises that file taxes—are eager to take advantage of tax incentives. Other forms of incentives are eliminating or reducing tariffs and import duties on pollution abatement equipment and environmentally related instrumentation and control equipment. This can be especially attractive in countries that charge high duties and have to import most of the equipment. Some countries have eliminated such duties outright, on the basis that pollution-related investment has social benefits. Finally, as mentioned in box 4.9, some governments choose to subsidize an "infant" pollution control equipment and services industry rather than polluters.

Market-Based Energy and Resource Pricing. Full-cost resource pricing has a role in promoting industrial pollution abatement, especially in the case of energy prices and water charges. Price reform would encourage industries to conserve and to invest in cleaner technologies. In the case of energy, the first priority is to raise prices to world levels (see table 5.3 in the next chapter). The second priority is to consider energy taxes, as is increasingly being done in OECD countries, in order to internalize environmental costs. Industrial water prices also tend to be below cost, and should be raised to improve conservation and overall efficiency (chapter 7).

Pricing is also an issue for ores and other material inputs, especially when regulated prices for separated and upgraded raw materials do not reflect their increased economic value. When this happens, there is no incentive for the producer or generator to effect this separation. Examples of raw material quality upgrading that can be done at the source are: the beneficiation of minerals and coal; flotation and separation of ores; magnetic separation of iron ores; and the separation of glass, plastics, aluminum cans, and paper for recycling purposes before disposal of solid wastes. But without proper pricing, the result is that poor-quality raw materials are produced, often increasing transportation costs, and causing greater environmental impacts and reduced efficiency in the processing steps of the end user. This problem is pervasive in developing countries where emphasis has often been placed on production volume at the expense of product quality upgrading.[8]

Monitoring. Adequate monitoring of enterprises for compliance with pollution standards is fundamental to the success of pollution abatement policies, and depends on a mutual understanding between governments and polluters. Experience shows that five conditions, all institutionally demanding, are essential if policies are to have the intended effect: (a) a local framework for negotiation between parties; (b) a clear and publicly available statement of standards and agreements reached; (c) a means of monitoring and spot-checking pollution; (d) a means of penalizing defaulters; and (e) a fair and equal application of the regulations to all parties.

Asian countries have adopted several approaches to lighten the administrative burden of monitoring, but no Asian country (other than perhaps Korea) has developed a workable system. To be most cost effective, pollution monitoring should be delegated as much as possible to industry itself, with unannounced checks by the environmental agency. Pollution permits should stipulate how frequently the industries must monitor and report pollution levels. The government can also play a role in helping to develop a local private sector pollution control industry that can be contracted by both government and industry for monitoring and abatement-related services (as in Thailand). Governments can also enlist community involvement in monitoring and approving agreements, as successfully achieved in Bangladesh.[9]

Zoning and Industrial Location. The use and importance of industrial zoning has been overlooked in many Asian countries. Zoning codes customarily have been ignored.[10] The result has been the irrational dispersal of industry, inefficient access to utilities and transportation, pollution of aquifers that may be supplying water elsewhere, and the lack of adequate water and solid waste infrastructure in many areas. From an environmen-

tal point of view, the lack of effective industrial zoning means that infrastructure improvements are disperse and inefficient. More efficient approaches, such as common treatment facilities, are difficult to implement.

To begin to correct the situation, more careful zoning should be applied to all new industrial investment, and planned in the context of current and future investments in utilities, transportation, and wastewater treatment facilities. Stricter zoning, therefore, should become part of a standard environmental assessment process for new investment. Second, special attention should be given to the location choices and options of small enterprises, which are so important in Asia. Third, active relocation of polluting industrial units to more centralized locations should be pursued. As pollution charges are raised, enforcement is strengthened, and investments in common treatment facilities are increased, relocation can become financially preferable to industries compared with remaining isolated and facing even higher investments to come into environmental compliance.

Least-Cost Effluent Treatment Facilities. The least-cost solution to industrial, power sector and municipal pollution will, in many cases, argue for some coordination of treatment. The most typical combination includes pretreatment of industrial effluents which are subsequently treated in municipal systems. This approach, while optimal, will not happen unless one or more industry leaders works together with local government to press for this type of cost-effective investment. International agencies, with first-hand experience of how this has worked elsewhere, also have an important role to play.

Another approach is collective treatment in industrial estates. In a few cases, industrial estate authorities have achieved—usually with government support—the centralization of previously disperse firms (and even, at times, similar types of industries). Bangladesh has proposed relocating a cluster of highly polluting tanneries onto the Dhaka industrial estate. Industrial estates can then offer low-cost collective treatment that would otherwise cost the firms far more. On the Rungkut Industrial Estate in Surabaya, Indonesia, a central effluent treatment facility achieves full cost recovery for treatment of industrial effluents. Its effluent treatment system is so effective that treated effluent is being offered back to industries at lower cost for use as non-process water (for example, for cooling).

Programs for Small- and Medium-Scale Industries. In order to reduce the pollution intensity of SMIs, special programs are needed. Their large numbers and dispersed locations present logistical problems as well as high monitoring and enforcement costs.

In response, aggressive land use zoning and industrial clustering offers the most viable and cost effective option for treating wastes generated by small and medium scale industries. Common treatment facilities can assist firms that often do not have the technical know-how nor the investment funds to treat their own wastes. To achieve this end, extra project effort is required to encourage small and medium industries to undertake, through industry associations or managers of industrial estates, common treatment facilities. Financial incentives, such as to underwrite moving costs to areas with collective treatment facilities, can be used to help bring small industries into environmental compliance. Virtually all of these approaches, including some $30 million in financing, are being pursued in southern Jiangsu Province, China.

Public Disclosure and Community Participation. Government efforts alone to reduce industrial pollution have been disappointing in Asia, as they have been around the world. A relatively low-cost and potentially important improvement in the regulatory environment in Asia would be to introduce public disclosure requirements. The Toxic Release Inventory (TRI) in the United States has had a dramatic effect in bringing public pressure to bear on polluting corporations. This public pressure—which is often mobilized through a efforts of com-

munity groups, labor unions, NGOs, and the media—is felt in terms of damage to corporate reputations and revenue loss.

Research is needed on the modes and information costs of disclosure, but anecdotal evidence from Asia shows it to be locally effective. The Prokasih program in Indonesia is proving to be fairly successful, at low cost. Part of the success of Prokasih is to encourage community participation in obvious industrial pollution problems, and to involve NGOs in important watch-dog and followup functions. Beyond the scope of individual "hot-spots," however, effective public participation requires training of company managers, workers, civil servants, and the general public, to create higher awareness of and respect for standards.

Liability. The potential of future liability for health and environmental damages provides an incentive for firms to reduce pollution. Liability rules are administered by the court system, in contrast to the administration of pollution taxes and charges by government agencies. Where polluters know with certainty that they will be required to pay compensation for damages resulting from pollution, a liability system can be effective in dealing with environmental problems.

A benefit of liability systems is that they are largely independent of government regulatory activities. A drawback is that they can initiate long and expensive litigation, which may not be worthwhile in smaller cases or where the environmental injury is long-term in its effects (and hence where causation is difficult to establish).[11] Liability systems play almost no role in Asia today, but will become potentially more important as (a) court systems become more sophisticated, (b) environmental damages become worse and/or more apparent to the public, and (c) international conventions on environmental liability, such as are being negotiated in both Western Europe and across all of Europe, become more common.

Institutional Development. Without progress on the institutional level, little progress will be made in any of the above areas. The institutions charged with setting standards, designing and implementing pollution control policies, and managing monitoring and enforcement systems, need more authority, autonomy, facilities and skilled human resources.

Some policies are more demanding of scarce administrative capacities than others: the World Bank has recently recommended a system of presumptive charges for urban industrial pollution in both Thailand and Malaysia, partly on the basis that it is administratively easier than more traditional command and control approaches. Nevertheless, there are a few crucial areas in terms of institutional strengthening that must be addressed.

- Do the basics. The adoption of industrial pollution standards, and the creation of viable monitoring and enforcement systems are required, regardless of the choice of market-based versus regulatory policies—so these need attention.
- Set priorities. The choice of policies for pollution control may be time-consuming—and what works for BODs will be different for emissions and for toxics. Therefore, institutions must begin to think more explicitly in terms of which pollutants need immediate attention.
- Use economy-wide policies wherever possible to achieve pollution reduction. It is easier to clean up industrial pollution in a growing economy than in a stagnant one.
- Use market incentives (pricing and taxes) wherever possible. Beyond efficiency arguments, pollution taxes also involve the ministries of finance as much as the ministries of environment, and help convince policymakers that damaging the environment is a real cost.
- Involve the private sector. Several of the approaches discussed above require private sector participation, such as pollution monitoring, planning for least-cost treatment facilities, improved industrial location, and the reduction of liability.

The issue of institutional strengthening, a cross-cutting one, is of highest priority (chapter 2). As argued throughout this report, institutional constraints to improved environmental management are as binding as financial ones. This observation is as true in the industrial sector as elsewhere.

Industry-Specific (Technical) Approaches

Industrial Modernization. As mentioned, it is easier to clean up industrial pollution in a growing economy than a stagnant one, since higher growth allows for more rapid turnover of aging technology, more rapid restructuring of industry's product mix, and greater opportunities for attracting foreign partners and technology. Investments in plant modernization generally lead to lower pollution intensities, since new processes and plants typically use fewer inputs, are more efficient, and rely on more materials recycling than older technologies (box 4.10). Clean technologies often pay for themselves in terms of both lower input costs and allowing firms to remain competitive with new product specifications. Whereas clean technologies can pay for themselves, investments in EOP pollution control equipment never do (see the case of Beijing, discussed in box 4.1).

Box 4.10: Cost-Effective Clean Technology Investments in the United States

A survey of more than 500 companies in the US that adopted cleaner production processes found that each company reduced industrial wastes by between 85 and 100 percent; even more importantly, the investment payback periods were only one month to three years. These types of benefits accrued to old industries as well as to high-technology industries. Technological changes included the incorporation of advance technologies; process modifications involving the replacement of an old substance by a new, less-polluting material; and the adoption of processes that were less chemical-intensive and more mechanical-intensive. The most dramatic case was that of a photographic firm, shown below. The initial cost of $120,000 for the process modification was paid back in a few months by annual savings in the cost of developing solutions ($1.2 million) and silver recovery ($1.4 million)—a total savings of $2.6 million.

Industry	Method	Reduction of Waste	Payback period
Pharmaceutical production	Water-based solvent replaced organic solvent	100%	< 1 year
Equipment manufacture	Ultrafiltration	100% of solvent and oil; 98% of paint	2 years
Farm equipment manufacture	Proprietary process	80% of sludge	2.5 years
Automotive manufacture	Pneumatic cleaning process replaced caustic process	100% of sludge	2 years
Micro-electronics	Vibratory cleaning replaced caustic process	100% of sludge	3 years
Organic chemicals production	Absorption, scrap condenser, conservation vent, floating roof	95% of cumene	1 month
Photographic film processing	Electrolytic recovery ion exchange	85% of developer; 95% of fixer, silver and solvent	< 1 year

Source: Huisingh 1989.

Short of installing new equipment, large efficiency gains can often be made through factory housekeeping, process modifications, smart product design, and consolidation of inefficient units. Raw materials can be conserved and recycled. Waste minimization and upgrading of energy systems should be identified via energy and environmental audits. For conventional EOP systems, a monitoring system should be put in place to ensure that they are properly operated, and not bypassed.

Energy Efficiency. Energy-efficient technologies are implicit in most investments in clean technologies, which reduce air pollution generated at the site through reduced energy inputs. Energy-efficient *process* technologies include upgraded boilers, upgraded controls (which lead to reduced loads through improved real-time efficiency), and high-efficiency motors and variable frequency drives. The most important *power-related* investments for industry are often cogeneration plants, for simultaneous electricity and thermal production. Finally, other investments that lead to reduced industrial power consumption are more efficient heating, cooling, and refrigeration equipment; energy efficient lighting and fixtures; and building improvements, such as windows and insulation.

Lines of Credit for Feasibility Studies and Investments. In 1989, industrial sector investment in East Asia and South Asia were $135 billion and $20 billion respectively. The share of this investment going directly into pollution control, while less than 5 percent, is still measured in billions of dollars per

Box 4.11: Industrial Pollution Project in India

The experience in India illustrates that a blend of enforcement actions and the promotion of limited incentives has yielded results that surpass initial expectations. Since the project became effective, about 50 percent of the financial resources available in the credit line have been committed—mostly for the financing of waste minimization and resource recovery actions (see below). A rough estimate of why firms borrow these resources indicates that one-half borrows because the investments are cost-effective, one-quarter because of a threat of closure unless they do so, and the remaining quarter because of a corporate interest in improving their reputation. Indian industrial associations have also been involved in self-help operations to help firms improve efficiency and learn about newer technologies.

Scope of some industrial pollution projects being financed in India

Problem	Solution	Indirect benefits
Mercury emissions at caustic soda plants	Installation of membrane electrolyzers	Reduced energy consumption
Black liquor discharge at pulp and paper mills	Chemical recovery systems Evaporation	By-product steam
Stillage discharges from sugar/ ethanol plants	Anaerobic digestion	By-product fuel
SO_x emissions from fertilizer plants and scrubbing	Double contact absorption	Sulphur recovery
Dust emissions at plants	Filter bags power	Fly ash recovery for use as building materials
Plastic waste	Collection and reprocessing	Reduced raw materials

Source: World Bank data.

year, perhaps as high as $5 billion to 10 billion per year. (In Europe, Japan, and the United States, capital investment in pollution abatement in the late 1970s and early 1980s averaged 5 percent of total industrial investment.) While this cost must be born primarily by the firms themselves, there are means to provide small incentives that serve the public interest—subject to the overall caveats concerning subsidies as presented in box 4.9.

One increasingly common approach is a line of credit (box 4.11), where funds are put in a dedicated reserve for financing environmentally beneficial projects. Projects must qualify for such funding according to pre-set criteria. Since pollution abatement projects are often perceived as risky by lending institutions, the government may guarantee a portion of the loan, typically 50 to 90 percent.

For pollution control funds, priority projects should be those that: demonstrate new, low-waste technologies; set up centralized waste treatment facilities for groups of industries; and offer technical assistance. If initially underwritten by donors or governments, the line of credit should strive to become self-financing through revenues generated by a pollution charge system, combined with repayments by borrowers. Donor-financed projects should also require that the participating firm be financially viable and not supported by subsidies or other mechanisms (especially public enterprises) which distort the actual cost of operations.

Public-Private Collaboration in Specific Industries. Collaboration and cooperation between government and private industry is important in many of the areas cited above: (a) finding collective solutions, especially for small industries and at industrial estates; (b) planning coordination between industrial and downstream public water treatment facilities; (c) providing technical and market information; (d) cooperating on environmental assessments and permitting requirements associated with new investment; and (e) agreeing on a realistic timetable for industries to adhere to standards. One example of a timetable that allowed technology sufficient time to respond to the demand for pollution abatement (but in the context of a strong stick) is the Malaysia palm oil industry (box 4.12).

Box 4.12: The Chronology of Pollution Control: A Case Study from Malaysia

Malaysia achieved successful results in phasing in pollution charges for palm-oil and rubber factories. Fees were first levied in 1978, which were raised incrementally until 1984—by which time, technological breakthroughs had occurred in palm-oil effluent treatment technology. The key elements accounting for the success of the program were:

- Regular dialogue and consultation with industry;
- Firm government enforcement of regulations;
- Cooperation of industry, government, universities, and research institutions in developing new technologies; and
- Fines that were set high enough by the end to induce real changes in behavior by the polluting factories.

As a result, the palm-oil processors reduced their discharges of BOD by almost 90 percent between 1982 and 1987.

Source: ESCAP 1992; World Bank 1992a, p. 76.

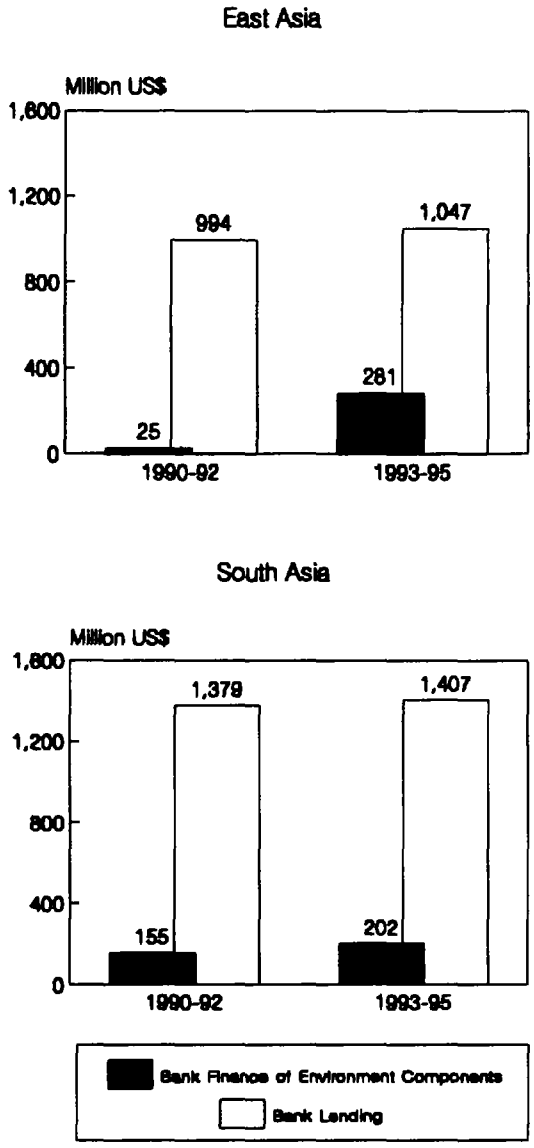
The objective of increased public/private collaboration is to replace the more traditional punitive regulatory approach with ones in which industry actively participates in protecting the environment. Such approaches are also more cost-effective to governments, as the private sector assumes an increased share of the cost of monitoring and enforcement.

The World Bank's Role in Pollution Abatement

Past Experience

The World Bank's experience in lending for industrial pollution control is limited. Pollution has not traditionally been the priority that it is now, and while traditional Bank's loans to specific industrial plants may have included EOP technology, they did not address the broader policy or institutional issues. However, this situation has changed dramatically, and the Bank's current and future pipeline shows a large increase in lending for industrial pollution control in East Asia (figure 4.4).

Figure 4.4: Total Bank Lending and Bank Finance of Environmental Components for Industry Projects in the Asian Regions, Fiscal 1990–92 and Fiscal 1993–95



There are three categories of World Bank loans in the industrial sector (in order of most traditional to the newest): (a) direct investment in industrial establishments, (b) industrial lines of credit, and (c) lending for industrial pollution control. In addition, the World Bank is involved in implementing Montreal Protocol projects for reducing ozone-depleting emissions. These four categories of projects are discussed below.

Direct Investment Projects. Direct investments in the industrial sector are becoming a smaller part of the Bank pipeline, as the Bank has moved from the traditional type of direct investment in public enterprises to industrial subsector restructuring. Nearly all industrial projects financed by the Bank are "A" projects that have significant environmental impacts and hence require detailed environmental assessments.[12]

Direct industrial lending represented about 39 percent of industrial sector lending in the two Asia regions between 1990 and 1992. Most of these investments are in the cement, fertilizer, and petrochemical subsectors, and are typically capacity expansion, renovation, or subsector restructuring projects (table 4.5). The only future projects of this type during fiscal 1994–95 are two projects in China.

Industrial lines of credit. This category included approximately 54 percent of World Bank industrial lending between 1990 and 1992, and poses specific problems for industrial pollution management. These lines of credit are managed by participating financial institutions (PFIs) in the borrowing countries. Although the Bank specifies that environmental criteria be used in project appraisal, the Bank is rarely involved in identifying or appraising individual subprojects. As a result, the scope for interventions to ensure adequate environmental assessment and adoption of cost effective pollution control measures is limited.

The Bank's EA requirements for sector and financial intermediary lending put the responsibility for the EA on the PFIs, even though it is recognized that many PFIs are not qualified to do this. The incentive for the PFI to do so is to reduce its future liability for adverse environmental impacts. Although Asian countries do not currently pursue liability suits against financial institutions, this happens increasingly in the United States—with commensurate interest by United States financial institutions in certifying that proper environmen-

Table 4.5: Direct Industrial Lending in Asia, 1989-95

Year	Country	Project	Loan size (US$ million)	Environmental component (US$ million)
1989	China	Hubei Phosphate	$137	$0
1990	India	Cement Industry Restructuring	300	0
1991	India	2nd Petrochemicals Development	245	0
	Indonesia	Fertilizer Restructuring	222	13
	Pakistan	Cement Supplemental	56	0
1992	China	Regional Cement Industry	83	0
1994	China	Electronics I	250	0
1995	China	Shenyang Engineering Industries	100	8

tal procedures are being followed at the time of investment.

To help PFIs fulfill this Bank-mandated function, the Bank incorporates EA institution-building components into financial intermediary projects. In some cases, the project institutional component is geared towards the PFI itself. In other cases, the project institutional component is geared towards the government pollution control agency, which would have the responsibility of approving the environmental impact assessment associated with the new investment. Although the latter strategy is better for long-term strengthening of government pollution control agencies, the former has been a second-best compromise in countries where the government is not capable of doing adequate environmental screening.

Examples of this type of institutional support are the fiscal 1991 Philippines Industrial Restructuring Project, with a TA component of $2.3 million to assist the government's Environmental Management Bureau in strengthening monitoring and enforcement of environmental standards; and the Sri Lanka Fourth Small and Medium Industries Project, with a $0.3 million program to assist the Central Environmental Agency in developing industrial subsector environmental guidelines.

Direct Industrial Pollution Control. Three projects begun in fiscal 1991 and 1992 in China, India, and Indonesia, are part of a "first generation" effort to design comprehensive industrial pollution control projects. The three projects take different approaches. The Industrial Pollution Control Project in India focuses on the worst chemical sector polluters in four states. the Beijing Environmental Project takes an integrated approach to citywide industrial and urban pollution. The BAPEDAL project in Indonesia focuses on the national environmental protection agency (box 4.13).

Although the projects have different areas of emphasis, they all place strengthening of government pollution control agencies as a top priority. Two projects (India and China) provide financial resources for enterprises investing in equipment—either new waste-minimizing processing equipment or EOP equipment. These two projects are also investing in public infrastructure for pollution control, although with some differences: China is investing in urban infrastructure, while India is investing in common treatment facilities for industries clustered in industrial estates. Clearly, the demand for both of these types of investment will be increasing across Asia.

Box 4.13: Direct Lending for Industrial Pollution Management

Three projects begun in fiscal 1991 and 1992 represent the latest Bank effort to directly lend for industrial pollution control. The projects have different approaches: the India project has a subsectoral focus; China, a geographical focus; and Indonesia, an institutional focus. The three project approaches are not mutually exclusive; in fact, there is much overlapping of project components.

The *India Industrial Pollution Control Project* targets the major polluting manufacturing subsectors: that is, chemicals; fertilizers; leather tanning; dyestuffs; pesticides and insecticides; pharmaceutical; petrochemicals; pulp and paper; sugar; and alcohol distilleries. The project is initially limited to the four major industrial states of Maharastra, Gujarat, Tamil Nadu and Uttar Pradesh, and is designed to achieve better compliance to existing legislation and regulations by working with both government and industry. It has three components: (a) an institutional component to work with the Central and four State Pollution Control Boards; (b) an investment component to finance investments in pollution control equipment, including common facilities and demonstration projects (see also box 4.9); and (c) a technical assistance component to work with government, financial institutions, and firms on problems, technologies, and feasibility studies.

The *Beijing Environmental Project* takes an integrated approach to the industrial and urban pollution problems citywide (see box 3.4).

The *Indonesia BAPEDAL Development Project* chose an institutional development approach because of the lack of national capacity to develop and enforce pollution control programs at any level of government. BAPEDAL is the Pollution Monitoring and Control Agency at the central level. The project has four substantive activities: (a) clarifying and strengthening the mandate for pollution control, including dispute resolution; (b) design and development of pollution control systems, including permit systems, incentives, technical advisory support, and public awareness; (c) support for regional agencies and laboratories; and (d) support of a BAPEDAL recruitment and training program.

Interim Multilateral Fund under the Montreal Protocol. As with the GEF, the World Bank is the primary implementing agency for investments funded under the Montreal Protocol. This fund assists developing countries reduce their emissions of ozone depleting substances. Investment projects are began in 1992 in four Asian countries—China, Malaysia, the Philippines, and Thailand. These projects address options for substitution, recovery and recycling of ozone-depleting substances in the six main contributing sectors of aerosols, mobile air conditioning, refrigeration, foams, solvents, and halons. Estimates of investment funds are: China ($15 million); Malaysia ($13 million); the Philippines ($10.4 million); and Thailand ($15.5 million).

Projects in China include conversion of a CFC aerosol plant to LPG, a pilot project for converting a refrigeration plant from CFC–12 to HCFC–22, two projects to reduce CFC–11 in the foam sector, and three projects to reduce halon emissions used in fire extinguishers. The projects in Thailand, Malaysia and the Philippines target mobile air conditioners. For example, the Malaysia project will demonstrate recovery and recycling of CFCs for mobile air conditioners and is likely to be adopted as the model for intervention in other countries. Engineering design studies for substitution of ODS in the solvents sector have been completed for the Philippines and Thailand. The project in Thailand has been designed in conjunction with similar efforts of assistance provided by Japan (MITI) and the United States Environmental Protection Agency.

Future Directions

Asia-Wide. Previous sections outlined policy, institutional, and industry-specific approaches to reducing pollution rates in Asia. Simultaneous actions on standards, pricing, institutional strengthening, and attention to financial incentives for pollution abatement investments are all needed. Therefore, setting priority actions requires picking specific instruments, subsectors and geographic regions to target, rather than on implementing only part of the basic multipronged approach outlined above.

There are several justifications for a targeted approach. First, relatively few subsectors release

the major proportion of pollutants into the environment, and a cost-effective pollution control enforcement program should give these highest priority. Cost effectiveness would be achieved not only by the regulatory agency in deploying its limited resources but also by industry (since the marginal cost of environmental control is typically inversely related to pollution intensity).

Second, geographic targeting responds to the need to curtail pollution where significant health thresholds and toxic concentrations are being crossed. It is appropriate that the greatest effort be expended in industrial cities and other industrial centers (such as Singrauli and Jiangsu Province) and where clusters of polluting industries (such as cement factories, tanneries, and coal mines) are located.

Third, given limited institutional capacities in Asia, priority should be given to establishing a successful institutional track record in a few critical areas rather than run the risk of diluting resources in pursuit of overly broad objectives. Once an effective but limited program has been achieved, then it can be replicated in other subsectors.

One area in Asia in which the World Bank is not yet engaged is that of toxic and hazardous wastes. As additional data becomes available on both the magnitude of toxic pollutants and the public health costs incurred, the problem of toxic and hazardous waste collection and disposal should be pursued. (However, treatment of contaminated sites is costly and may not be a priority investment.) Whereas biological wastes (BOD) and many COD compounds can be effectively cleaned up within a relatively few years, the heavy metals and other toxins are much more persistent and have far higher cleanup costs. Further avoidance of adopting sound toxic and hazardous waste policies will only imply higher mitigation costs in the future.

Region-Specific. In the near future, more of the Bank's industrial pollution projects will be located in East Asia than in South Asia, because of East Asia's higher level of industrialization, the higher rate of industrial growth, and the higher concentration of industrial activities. The Bank is undertaking industrial pollution studies in Indonesia, Malaysia the Philippines, and Thailand, which should lead to projects in Indonesia, the Philippines and Thailand in fiscal 1994. (In Malaysia, current work is expected to lead to concrete recommendations for implementation, although not necessarily a World Bank loan.) In China, in addition to the Beijing project, Bank-financed work is progressing in Jiangsu Province, Liaoning, Shanghai, Shenyang, Tianjin, and Zhejiang. In spite of the impressive amount of work being done in China, even more could be done.

In South Asia, outside of India, the World Bank has focused less directly on industrial pollution. The biggest gap appears to be in Pakistan, although a small industrial pollution component is planned in the Punjab Urban Environment Project. In India, in spite of the fiscal 1992 Industrial Pollution project and its successor in fiscal 1995, there is much to be learned about the depth of the problems. A major data collection and analysis effort is a priority for India, in order to broaden the knowledge base for future industrial pollution strategies.

Notes

1. Wheeler and others 1991.
2. These are trends for total emissions of pollutants, not *ambient* pollution levels.
3. The Gini coefficients for Indonesia, China, and India (which measure the concentration of industrial output) are 0.16, 0.33, and 0.67, respectively.
4. Preliminary data from World Bank industrial pollution studies in Bangkok and Manila.
5. The term commercial energy includes all sources of energy except for traditional fuels such as wood and dung (see chapter 5).
6. Kent 1991.
7. The World Bank Industrial Environmental Guidelines were drawn up in the early 1980s to the standards of Best Practicable Technology (BPT). Newer technologies can meet the stricter Best Available Technology, Economically Achievable (BATEA) Standards. Enforcement problems arise in the case of older technologies, such as those characteristic of village enterprises in China, which, even after renovation, may not

be able to meet BPT standards. In recognition of this, revised World Bank Environmental Guidelines recognize distinctions between new and older technologies, since these obsolete technologies cannot be simply regulated away without a well-considered period of transition.

8. For example, the Chinese steel industry has had serious problems with the quality of its products and with failing to meet international standards.
9. World Bank 1992a.
10. Vergara 1992.
11. Bernstein 1993, pg. 17.
12. All World Bank Projects are screened according to criteria specified in Operational Directive 4.01. "A" projects have potentially significant environmental impacts.

5

MINIMIZING ENERGY SECTOR IMPACTS

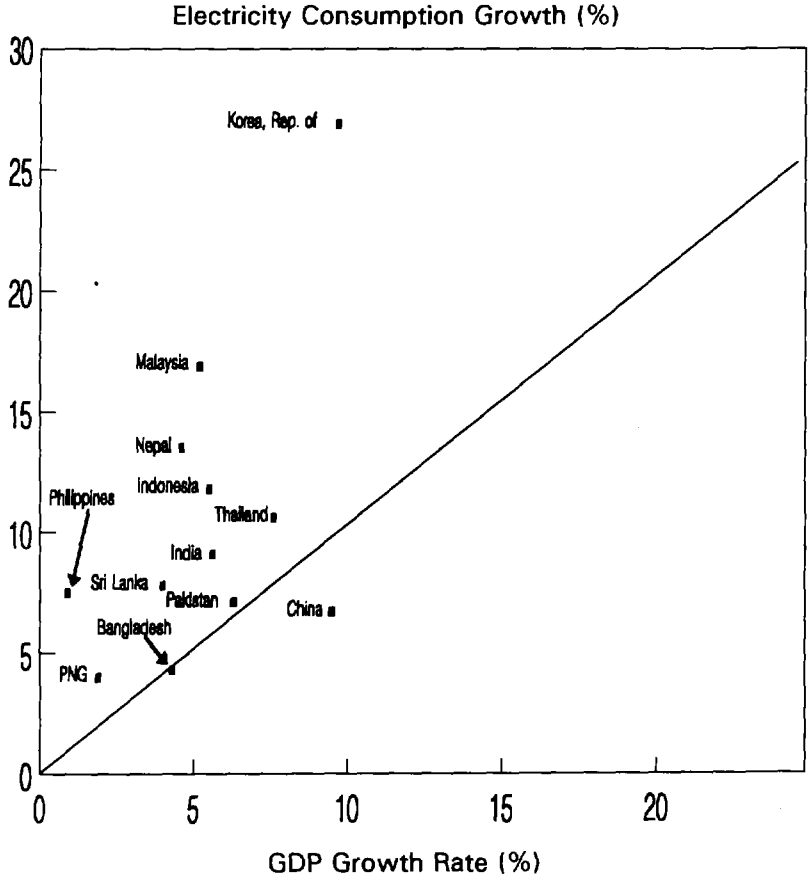
The Energy and Power Sectors

Overview

Along with rapid development and high population growth, energy demand in Asia is growing extremely rapidly. At current growth rates, Asian energy demand is doubling every twelve years—as compared to the world average of every twenty-eight years. The demand for electricity is growing even faster: two to three times faster than GDP for most of the newly industrializing East Asian countries (10–25 percent per year) and up to two times faster for most of South Asia (5-10 percent per year; see figure 5.1). Only China shows demand for electricity growing slower than GDP, which is consistent with its effort to reduce its historically high energy intensity.

The amount of new investment planned in the Asian power sector during the 1990s is two-thirds of all power-related investment being made in the developing world during the period, and would double the sector's capacity by 2000.[1] Asia's fossil fuel-related emissions will increase dramatically and will more than offset any reductions in emissions achieved in OECD countries. In absolute terms, Asia could easily surpass all of Europe in SO_2 emissions by 2000, and surpass Europe and the United States *combined* by 2005. In terms of CO_2 emissions caused by the burning of fossil fuels, Asia will catch up with all OECD countries by 2015 (see chapter 1). By any measure, the growth of the energy and power sectors in Asia is one of the most crucial areas—in terms of both economic growth and potential negative environ-

Figure 5.1: Growth of Electricity Consumption and GDP in Selected Asian Countries 1980–90



Source: World Bank data.

mental impacts—in the region's next phase of development.

The Energy Sector. The potential for large future negative environmental impacts from the Asian energy sector is a direct result of high growth and high dependence on coal. Even though all forms of fossil fuels have adverse environmental impacts, whether local, regional, or global (see below), coal has the most severe. The high use of relatively dirty coal in Asia makes the growth of this component of the energy sector particularly problematic.

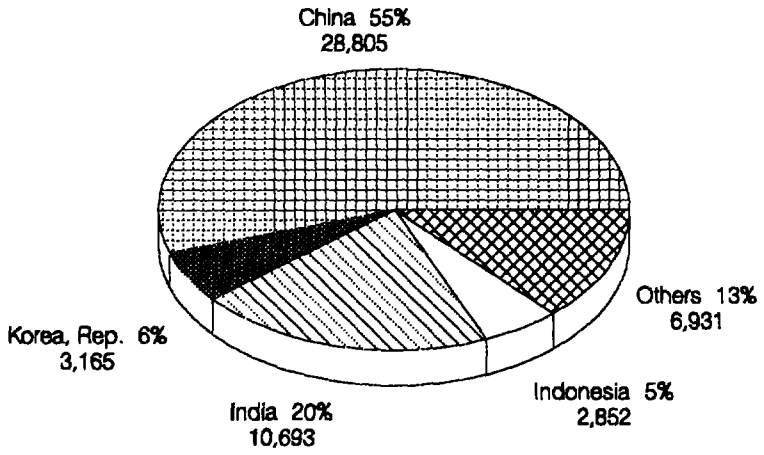
Energy use in Asia is dominated by China and India to a surprising degree (figure 5.2). China alone consumes 61 percent of all commercial energy (not including traditional fuels such as biomass), and 55 percent of all energy in Asia including biomass. India consumes another 20 percent of all energy in Asia. Combined, China and India consume three-fourths of the total: any Asia-wide strategy to address the environmental impacts of the energy sector must target these two countries.

In both East and South Asia, coal is the dominant energy source, followed by liquid fuels, biomass (fuelwood and charcoal), primary sources (hydropower, nuclear, geothermal, and wind), and natural gas (figure 5.3). Over 80 percent of all energy is derived from fossil fuels, and 95 percent from fossil and biomass fuels—both of which are contributors to global warming. China and India consume 94 percent of all coal in Asia. In addition, coal accounts for 96 percent of remaining fossil fuel reserves in these two countries, and 92 percent of the energy reserves for all of Asia.[2]

The breakdown of fuels is not projected to change significantly over the next two decades, in spite of some investment in hydropower. Coal use is expanding at 6.5 percent per year in both East and South Asia, a rate which exceeds regional economic growth. While the use of natural gas is expanding at 9.3–10.1 percent per year in East and South Asia, respectively, gas use is limited to countries with their own reserves (Bangladesh, China, India, Indonesia, Malaysia and Thailand), and Korea, which has invested in the capital infrastructure required to import liquified natural gas. Hydropower is projected to increase fairly rapidly in East Asia (11 percent per year), but at a much slower rate in South Asia (2.9 percent per year). India and Pakistan have ambitious plans to develop hydropower installations, but progress on these plans will be subject to major feasibility, financial, and resettlement-related delays.

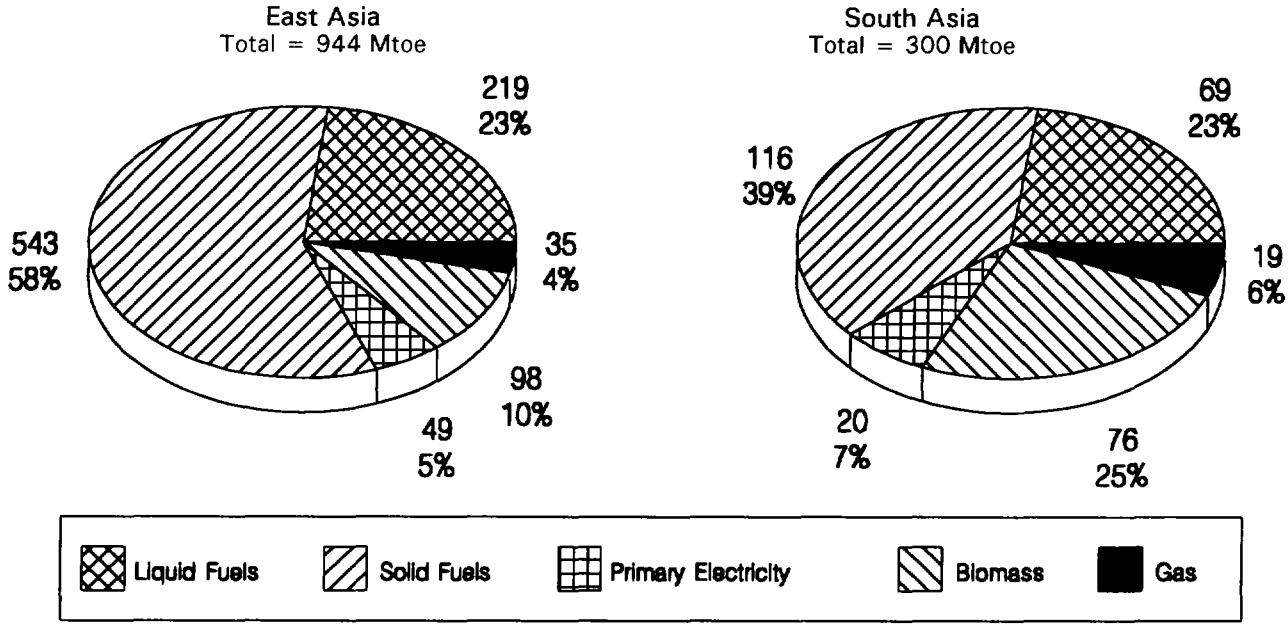
The use of energy and power is distributed differently across the economy in different Asian countries. While industry consumes two-thirds of all commercial energy in China, it consumes only half in India. While the transport sector in China consumes 5 percent of all energy, it consumes 25 percent in India and more than 50 percent in Sri Lanka and Thailand. In Sri Lanka and Thailand, therefore, a focus on transport-related energy efficiency is relatively more important than in China.

Figure 5.2: Total Energy Requirement in Asia, 1989 (Petajoules)



Note: Not including Japan.
Source: U.N. data from WRI, UNEP and UNDP 1992.

Figure 5.3: Energy Consumption in Asia 1989 (millions of tons of oil equivalent)



Source: World Bank 1992a.

The Power Subsector. On average, Asia converts and distributes 30 percent of its energy to electricity, in what is known as the power sector. This sector is far more important than the percentage implies for several reasons:

- The power sector is the fastest growing component of the energy sector.
- The investments required to keep up with demand are huge—nearly $300 billion during the 1990s (see below).
- The scale of many power sector investments can be orders of magnitude larger than most industrial investments (hundreds of millions of dollars, as compared with millions), with environmental impacts to be felt well into the next century. As a result of their large scale, other investment options that might be more environmentally sound are effectively precluded for years to come.
- In the case of coal-fired thermal power, the cost of clean technology is almost entirely add-on. Unlike industry, where some clean technologies and processes lead to significant savings in material inputs and recyclable wastes (see box 4.10 in the previous chapter), this is not the case for coal-fired thermal. This means that the cost of pollution control investments for coal-fired thermal power must be justified in terms of the environment alone.

The developing countries of Asia have 250,000 megawatts of electrical generation capacity (1990), 70 percent of which is thermal-generated, mostly coal-fired. The remaining 30 percent is primarily hydropower, with scattered nuclear and geothermal power installations. To date, few coal-fired thermal pollution abatement technologies have been installed in the developing countries of Asia; they are expensive and have not been a priority of utility companies and large industrial coalburners.

Planners forecast an additional 240,000 megawatts will be needed by 2000 to keep pace

with expected development. This will require approximately $290 billion in capital expenditures, assuming an average cost across all forms of power generation of $1,200 per kilowatt. (This average unit cost is based on estimated costs in the Asia region for 1991/92, and is lower than unit costs estimated elsewhere.[3]) These expenditures will be concentrated in China (approximately $140 billion) and India ($100 billion). Given the high proportion of coal-fired plants, future power plants will require investment in expensive new technologies—over $50 billion in the 1990s alone—to meet international standards for greenhouse gas and acid rain emissions, particulate emissions, and ash disposal problems. A key question for Asian planners will be how to find the most cost-effective ways to reduce energy sector emissions with minimum levels of investment in costly technologies.

Environmental Impacts of the Energy Sector. The highly coal-based energy sector in Asia is, and will continue to be, a significant contributor to global warming, acid rain, and other air pollution problems. However, there are other problems associated with most other sources and forms of energy. This section summarizes the main emissions data for Asia, as well as provides a technical overview of the pollution issues (table 5.1). The environmental impact of hydropower is discussed in chapter 7, in the broader context of water resource man-

Table 5.1: Major Direct and Indirect Environmental Impacts of Fossil Fuels

Plant type	Impact on land	Scale of impact	Impact on air	Scale of impact	Impact on water	Scale of impact
Coal-fired plant	Particulate and gaseous emissions may affect soils	Regional/ national	Gaseous emissions (SO_2, NO_2, CO/CO_2)	Regional/ global	Acidification of surface water by acidic deposition to water and soil	Local/ regional
	Solid waste land requirements (ash disposal)	Local	Particulate emissions	Local/ regional	Thermal and chemical discharges in cooling water	Local/ regional
					Groundwater contamination	Local
Oil-fired plant	Suspended and gaseous emissions may affect soils	Regional	Gaseous emissions (SO_2,NO_x, CO/CO_2,some particulate emissions)	Regional/ global	Acidification of surface waters by acidic deposition to water and soil	Local/ regional
					Thermal and chemical discharges in cooling water	Local/ regional
					Discharges from plant operations and oil spills	Local/ regional
Natural gas-fired plant			Gaseous emissions (NO_x, CO/CO_2)	National/ global (greenhouse effect)	Discharges from plant operations	Local

agement issues.

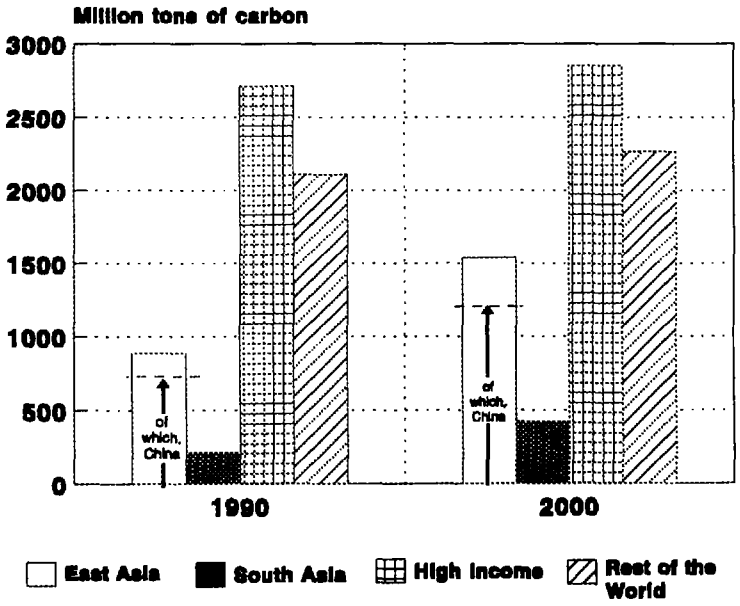
The combustion of fossil fuels creates three material waste streams—gaseous, liquid, and solid—and one thermal waste stream. The most far-reaching of these are the air pollutants, which can be divided into greenhouse gases, precursors to acid rain, and particulates.

Greenhouse Gases (GHGs) consist of a complex mix which includes CO_2, CH_4, N_2O (related to but distinct from NO_x), and other minor gases. GHGs are emitted from both anthropogenic (from human activity) and natural sources. Asia, excluding Japan, accounted for about 20 percent of the worldwide emissions of GHGs in 1985, of which 22 percent was CO_2, 45 percent was CH_4, and 27 percent was N_2O. China is the largest emitter of GHGs in Asia. In China, anthropogenic CO_2 emissions for 1985 (the last year for which complete data sets exist) were approximately 540 million tons, or 60–70 percent of the total (the balance is made up of emissions from rice fields, rural residential cooking and heating, and livestock). India is second to China in GHG emissions, with CO_2 emissions in the range of 150 million tons per year.

Between 2010 and 2015, Asia will catch up with all OECD countries' CO_2 emissions from fossil fuels and cement manufacture, if OECD countries fulfill their UNCED pledges to level off CO_2 emissions at 1990 levels.[4] If OECD emissions continue to grow at a pace closer to "business as usual," Asia's emissions will catch up between 2015 and 2020. The incremental growth of Asian CO_2 emissions, by 2000, more than offsets any savings to be achieved in OECD countries by limiting emissions to 1990 levels (figure 5.4).

Acid Rain is a collective term used to describe the result of sulfur dioxide and nitrogen oxide emissions. At least two-thirds of acid rain emissions in Asia come from coal-fired power plants and industrial sources, and the rest from residential heating and cooking. If cleaned and burned in modern plants with SO_2 and NO_x controls, Asian coals would have a minimal impact on the environment. However, most power plants in Asia have either no pollution control equipment or only rudimentary particulate control.

Figure 5.4: Projected Carbon Dioxide Emissions, 1990 and 2000



Source: World Bank 1992a.

Sulfur and nitrogen oxide emissions have both local and regional impacts. Depending on the height of smoke stacks and the prevailing wind conditions, sulfur and nitrogen oxide emissions can be carried hundreds of miles. Major weather patterns in Asia move from land to sea in the winter and the reverse in summer. Emissions of SO_2 and NO_x are thus carried from China to Korea and Japan, from Southeast China to Vietnam, across southeast Asia, and from India to Bangladesh (table 5.2).

Although data on SO_2 emissions for the Asia region are incomplete, there is a growing body of knowledge from the major source countries. Total sulfur dioxide emissions from China are ap-

Table 5.2: Acid Rain in Asia

Region	High Emissions Current	High Emissions Future	High Depositions Current	High Depositions Future	Ecological Sensitivities
Northeast China	X	X		X	Vegetation
Japan, Korea			X	X	Soil, vegetation
South China		X	X	X	Soil, vegetation
Southeast Asia	X	X	X	X	Soil, vegetation
Southeast Asian Islands	X	X	X	X	Soil
Northern India	X	X		X	Vegetation
Southwestern India			Borderline	X	Soil, vegetation
Northeastern India		X		X	Soil
Sri Lanka, Maldives			Borderline	X	
Siberia, Mongolia				X	Vegetation

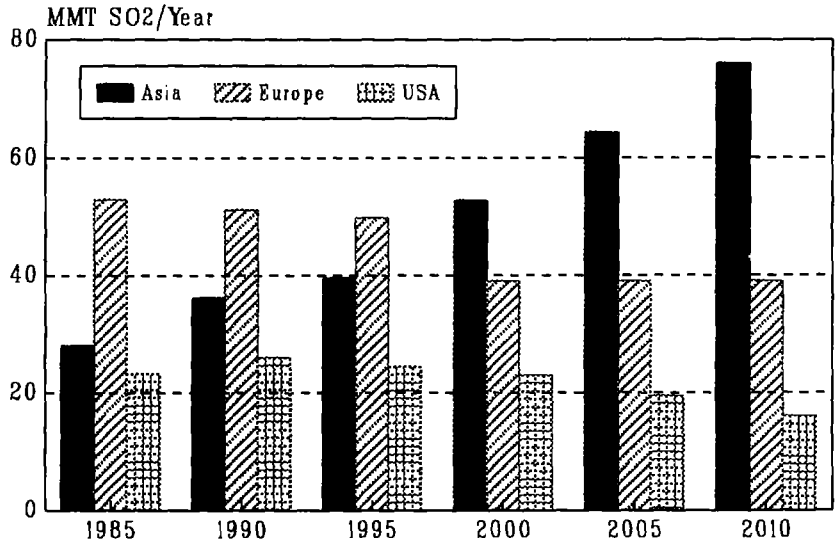
Source: Bhatti, Streets, and Foell 1992.

proximately 18 million tons, with around 7 million tons produced from the power industry. On the whole, China is responsible for about two-thirds of Asia's coal use and a corresponding level of sulphur dioxide emissions. Coal is also the dominant fuel in India, where approximately 200 million tons of coal are consumed per year. Indian coals are generally low in sulfur (around 0.5 percent): based on coal production and sulfur content figures, India emits between 3–4 million tons of SO_2 per year.

Given the projected growth of energy consumption over the next ten to fifteen years, acid rain emissions will also increase. One detailed study predicts that SO_2 emissions will increase from 35 million tons in 1990, to 53 million tons by 2000, and to 76 million tons by 2010 if no substantial efforts to limit emissions are taken.[5] Based on these projections, Asia will surpass both Europe and the United States in SO_2 emissions by 2000 and will emit more than the combined total of SO_2 from all OECD countries by 2010 (figure 5.5). Similar results are obtained for NO_X.

Airborne Particulates may be in solid or liquid form (resulting from condensed gases). They are often carbon particles but may also contain heavy metal and organic compounds (such as in diesel

Figure 5.5: Current and Projected SO_2 Emissions



Source: World Bank and ADB data.

smoke). Suspended particulate matter is an important measure of local air pollution due to their costly impact on health (see chapters 1 and 3). Particulates are emitted largely through fossil fuel consumption by the power, industry, transport, and commercial/residential heating sectors. In all cities, the problem of *re*-suspended particulates, primarily by vehicles, compounds the problem.

The means for controlling particulates from power plants are easy and relatively cheap (as discussed later in this chapter). Since particulate reduction has high health benefits, it is among the highest priority environmental investments for the power sector. Reducing particulates from the transport, commercial, and residential sectors is more costly, and requires a broader review of options concerning choice of fuel, choice of technology, efficiency, and standards.

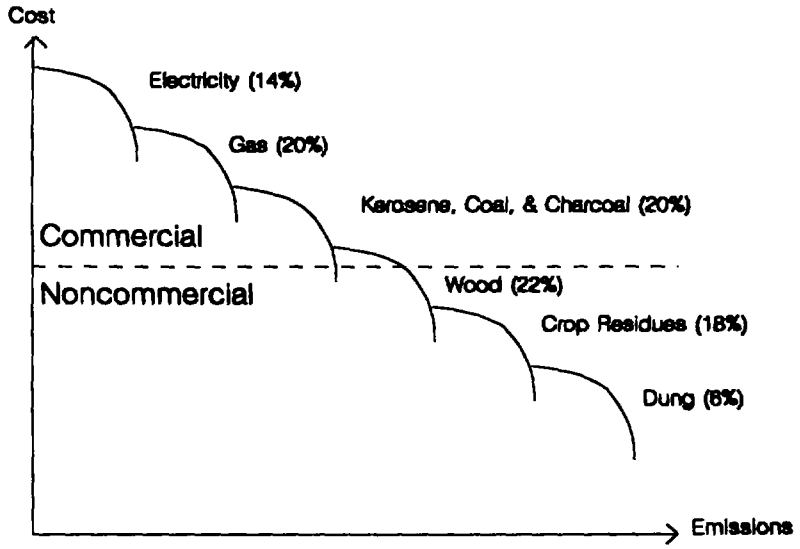
Liquid and Thermal Wastes originate from several sources, including ash-quenching systems, cooling water, coal storage runoff, boiler blowdown water, and water from flue gas desulfurization systems. Thermal power plants are generally located near rivers or other water bodies so that cooling water is readily available. Wastewater streams tend to be warm, acidic, and laden with metals and other inorganic chemicals. Whereas in OECD countries these streams are usually treated and recycled, in most Asian countries they tend to be discharged directly into rivers or municipal waste water systems. Unfortunately, the impact of energy-related water pollution has been virtually ignored across Asia and little data exists.

Power Plant Solid Wastes: bottom ash, fly ash, and scrubber sludge. Coal consumption of 980 million tons in China (1988) required the disposal of approximately 100 million tons of ash, fly ash, and sludge. Not included are other solid wastes such as boiler blowdown and sanitary wastes. In general, these materials are landfilled.

Biomass Fuels and Indoor Air Pollution

While global and regional issues have dominated discussions on the environmental impact of energy, there is growing realization that there are considerable negative impacts from indoor air pollution as well. The vast majority of rural inhabitants in Asia use fuels at the lower end of the "energy ladder" (see figure 5.6), such as twigs and grass, dried animal dung, crop residues, followed by wood, charcoal, coal, and kerosene—in the order of in-

Figure 5.6: Household Energy Ladder for South Asia



Note: This energy ladder is for cooking fuels in South Asia. The percentages shown are rough estimates of the percentage of people presently at each rung. There are regional variations in these estimates. For example, in India, there is relatively less use of wood and more use of grass, twigs, dung and crop residues. In China, the use of coal is relatively greater, but kerosene use is less.

The dotted line marks the approximate point for the transition between noncommercial and commercial fuels. About half of the world's households fall above or below this line.

Source: Adapted from Smith 1988, p. 19.

creasing affordability. Besides having adverse health impacts, these fuels cause other indirect environmental problems. For instance, the demand for fuelwood is a major cause of deforestation in Asia, and the burning of dung instead of using it for fertilizer deprives the soil of needed nutrients (see chapter 6).

Most homes that burn biofuels are smoky and have inadequate ventilation. Biomass smoke is a combination of gases and aerosol (droplets and solid particles). The gases include carbon monoxide, particulates, hydrocarbons, and nitrogen oxides, which are common components of outdoor air pollution. Aerosol components contain many additional organic compounds thought to be toxic—similar to many present in tobacco smoke, another biomass substance. Air pollution levels have often been shown to be higher in rural household microenvironments than in even the most polluted urban environments.[6]

A number of studies were carried out in the 1980s to understand the magnitudes and health impacts of such exposures.[7] The majority of these studies were done in South Asian homes burning biofuels or in Chinese homes burning coal. In Nepal, chronic bronchitis in women was correlated with time spent near stoves, and acute respiratory infections among infants was associated with exposure to household smoke. In India, several studies correlated respiratory distress with smoky fuels. In China, decreased lung function was reported for women using coal stoves when compared to those using gas stoves. While earlier reports of nasopharyngeal cancer seem to be exaggerated, several studies in China found smoke to be a factor for increased cancer risk among nonsmoking women.[8]

For decades, governments and NGOs have made attempts to disseminate more efficient stoves in rural areas, while achieving only mixed success. Unfortunately, most design changes to date have improved energy efficiency and convenience of operation but have led to increased emissions.[9] Although there is no theoretical reason why efficiency improvements cannot be achieved together with emissions reduction, stoves with high efficiency, low emissions, low cost, and social acceptability are yet to become reality. Given the many variables involved in biomass fuels and patterns of use, more research on stove design needs to be conducted.

The economic and logistic barriers to allowing rural households to switch from biofuels to cleaner alternatives are considerable. For this reason, problems associated with biofuels will persist for years among the rural poor. Fuel upgrading (up the energy ladder) is more likely in the medium term in East Asia (for example, Thailand, where it is already happening) than in South Asia where alternatives are less affordable. As a result, efforts to minimize the negative impacts of biofuels should include more sustainable methods of harvesting, research on affordable burning and ventilation technologies, and means to expand the use of upgraded forms of biofuels, such as charcoal, alcohol and biogas. Despite problems in implementation, biogas has had notable success in China.

Minimizing Energy Sector Environmental Impacts

From an environmental point of view, there is no simple answer to the broader question of how to best double and triple Asian energy consumption. In order to address such a wide range of issues, each country must map out its own specific energy sector policy that is consistent with its resource base, geography, and energy users.

Intersectoral linkages between energy and other sectors are quite fundamental to how energy is used and affects the environment. Energy and transport, energy and industry, and energy and construction industry standards are all linked. For example, industrial policies that promote clean technologies (as opposed to end-of-pipe technologies) also foster energy efficiency. Strategies to improve transport sector efficiency (through, for example, emission standards, road user fees, and investments in public transit) also reduce energy-related emissions.

In general, the least-cost, most-balanced approach to minimizing the impending growth in

emissions is to simultaneously increase both supply-side and demand-side efficiency, and to promote clean energy technologies on the supply side. These goals can be achieved through combined policy measures (particularly full-cost pricing), technical and operational improvements, and institutional strengthening in regulatory agencies and utility companies. The remainder of this section elaborates on the policy and institutional measures required to achieve efficiency gains on both the supply and demand sides. Technical advances on the supply side are discussed in the following section.

Policy and institutional barriers are the principal impediment to successful implementation of an ambitious energy sector strategy in Asia. The combined price reforms and management practices required to bring about supply- and demand-side efficiency will lead to the adoption of higher-efficiency technologies.[10]

Not all utility companies in Asia are inefficient: for example, the Korea Electric Power Company and the Thai generating utility, EGAT, have performed well. However, the majority of companies are characterized by a lack of financial autonomy and by poor financial discipline, as well as by a lack of commercial incentives in many markets. Many utilities in the region are plagued with major problems such as high transmission and distribution losses, brownouts or load shedding, and old and inefficient power stations. Often, more attention is given to new plants than to the more difficult tasks of increasing efficiency, reducing losses, and establishing more accurate billing procedures. In order to help change this picture, reforms are required (as detailed in the following discussion.)

Energy Pricing. Low energy pricing is the major barrier to long-term financial stability in the power sector. It also has major environmental implications. Virtually all Asian countries have complex pricing policies that differentiate the energy market by product and end user. Table 5.3 illustrates a pervasive bias toward low energy prices in many markets, including coal in India and China, electricity in South Asia, and kerosene and diesel in significant markets across Asia. (Cross-subsidy issues complicate the picture, but only rarely should energy sources be offered at below cost, which is now common.) Assuming an average energy price demand elasticity of minus 0.5, even a 10 percent price change in the direction of removing subsidies would immediately reduce all emissions by 5 percent—not even allowing for the effects of price reform on supply side efficiency.

Some Asian countries have made significant progress in the last few years in price reform, notably China and Korea. Coal prices in China range from 60 percent of world prices to full parity, and the average is rising as the free market component has expanded recently from one-third to one-half of the total market. Similarly, electricity prices have increased substantially since 1987–88, but the complexity of the tariff system has dampened the incentive for efficiency improvements. China's recent policy of "new-plant new-cost" has resulted in a steady increase that should reach the level of long-run marginal cost (LRMC) by 1996. Most Chinese petroleum product prices are close to international prices, but some heavier petroleum products and natural gas are subsidized. In India, coal prices are 15–40 percent below world prices, and electricity prices are only half of long-run marginal production costs, indicating serious levels of subsidy in both markets. Indian petroleum prices range from far above world prices for gasoline, to below world prices for kerosene, diesel, and naphtha. The average subsidy of petroleum products in India has been calculated to be about 50 percent.[11] The Philippines actually protects its local coal industry, which leads to the domestic use of coal that is dirtier than cheaper international alternatives.

In most Asian countries, there is significant latitude for fostering energy efficiency through price reform in coal, electricity, and petroleum markets. Subsidies for electricity and petroleum products are higher in South Asia than in East Asia.

Table 5.3: Energy Pricing in Selected Asian Countries

COAL	Range of domestic prices (US$ per metric ton)	Average (US$ per metric ton)	Ratio of domestic price to border price
East Asia			
China (1992)	20 - 35	n.a.	0.6 - 1.0
Philippines	n.a.	58	1.2
South Asia			
India (1991)[a]	n.a.	29[a]	0.6 - 0.9

ELECTRIC POWER (1987 prices)	Average electric tariff as proportion of incremental cost of system expansion
East Asia	
China (1992)[b]	0.90 - 0.95
Indonesia	0.88
Korea, Rep.	1.00
Philippines	1.32
South Asia	
Bangladesh	0.73
India	0.54
Sri Lanka	0.67

PETROLEUM PRODUCTS (January 1990 prices)	Ratio of domestic price to international prices[c]			
	Premium gasoline	Kerosene	Diesel fuel	Heavy fuel oil
East Asia				
China (1992)	1.22	n.a.	1.11	1.30
Indonesia	1.37	0.32	0.69	1.16
Philippines	2.02	0.76	1.38	1.59
Thailand	2.10	0.82	1.46	1.17
South Asia				
India (1991)	3.75	0.62	0.80	1.39
Pakistan	2.58	0.48	1.11	0.94
Sri Lanka	3.20	0.56	1.49	1.00

n.a. Data not avalable.
a. Wholesale price in Bombay, referring to coal (2330 kilocalories) from the Majra mine, Chandrapur, delivered to Bombay.
b. Current retail electric price divided by the LRMC of supply in East China.
c. End user domestic prices compared with international spot prices for gasoline, diesel fuel, and heavy fuel oils; and with the average CIF prices in Singapore, Hong Kong, and Japan prices (net of taxes) for kerosene.
Sources: World Bank China and India Departments; World Bank 1992a; Tele-Drop, Inc. 1990; and World Bank data.

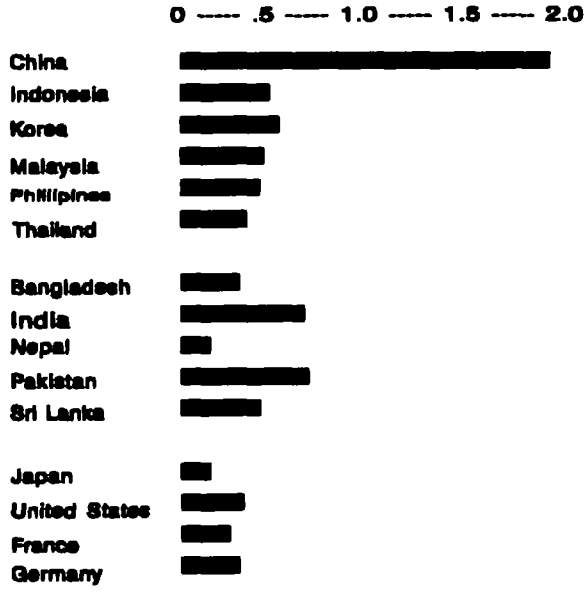
Higher pricing would not only serve the immediate environmental objective of reduced emissions, it would have a major impact on strengthening the power sector and encouraging greater private sector participation—which would help foster, in turn, broader sectoral efficiency.

Inefficient Utility Management and Operation. Both technical and non-technical energy losses are a major problem, particularly in the poorer Asian countries. In 1988, they ranged from 6 percent to 8 percent in Korea, Taiwan and Thailand, to 12 percent in China (which is close to normal), 17

percent in Indonesia, 22 percent in the Philippines, 25 percent in Pakistan, 26 percent in India, and 38 percent in Bangladesh.[12] Reasons for these high losses include theft, badly maintained transmissions and distribution systems, lack of spare parts and poor operating procedures. In addition, low capacity utilization factors (Bangladesh and Indonesia are at 31 percent and 33 percent, respectively, for thermal plants) make the production of electric power very costly from a capital standpoint.

Energy Conservation and Efficiency. Energy intensity, which measures primary energy consumed per unit of GDP, is high in Asia, and is often double many middle income and developed countries (figure 5.7). Energy intensity in China is the highest in the world, although it is dropping steadily as both a function of energy efficiency and of the removal of economic distortions in the measure itself. India and Pakistan are also among the least efficient consumers of energy in the world.

Figure 5.7: Energy Intensity in Asia (1989), kgoe/US$GDP



Note: kgoe = kilograms oil equivalent
Source: Caluclated from World Bank data, 1992.

Investments in energy efficiency, on both the supply side and the demand side, generally have high rates of return and are far more cost-effective than expanding energy use without putting such efficiency investments in place. Since many energy efficiency investments are financially viable without regard to any environmental benefits, they are called "no-regrets" strategies for reducing emissions. A recent World Bank paper cites several studies that illustrate how, at current relatively low energy prices and with the present state of technology, a savings of 20–25 percent of energy consumed in many developing countries could be achieved without sacrificing the economic benefits of energy use.[13] This average does not apply equally to all Asian countries, but would certainly apply to those with transmission and distribution losses above 10 percent, and with energy prices below production or international costs.

An efficiency gain in Asia of only 10 percent by 2000 would reduce the level of new capital investment required by 20 percent, or by $90 billion (50,000 megawatts). Not only are these savings enormous, they are three times what is required to install cleaner technologies on the remaining facilities that would still need to be constructed. Clearly, energy efficiency on both the supply and demand sides is an essential ingredient to any cost-effective and environmentally-sensitive long-term growth plan in the energy sector.

Once suitable pricing and institutional reform has been achieved, efficiency on the *supply side* becomes possible through improved operations at the power plant itself and in the electricity transmission and distribution grid (see the following section). Efficiency on the *demand side* becomes possible through the introduction of new technologies in the industrial, commercial, and residential sectors, such as new boilers, motors, electrical drive systems, motor controls, lighting, process modifications, and heating, cooling, and refrigeration improvements (box 5.1). Minimum energy efficiency standards and energy awareness campaigns, have been effective in Japan, Korea, and China in achieving demand side efficiencies (box 5.2). Di-

rect government involvement with industrial and commercial enterprises, supplemented perhaps by aggressive power company demand side management techniques, can help bring about efficiency changes that go beyond the effects achieved by market-based policies alone.

Energy Taxes. Energy taxes are an indirect mechanism for accomplishing energy-related pollution abatement (see box 4.4 in the previous chapter). As noted, indirect taxes are often easier to administer than direct charges on polluters. One objective of such taxes is to internalize the environmental costs of emissions (based on carbon, sulphur, or particulate consumption) in the operating costs of fossil fuel producers and users. Energy taxes are relatively easy to administer, since the number of transactions at the point at which fuels are first produced or enter the economy is relatively small.[14] Although taxes on transport fuels are very common, more broadly based energy taxes—such as carbon taxes—are increasingly being adopted for environmental reasons in Europe.

Plant Siting. Zoning and site permits can minimize the local environmental impacts of power plants. In most Asian countries thermal power plants are located close to their load centers. Shanghai, Jakarta, and the Singrauli area of India all suffer from air pollution attributable to power plants. In China, nine new plants being built along the southeastern coast will be located in part based on dispersion modelling so as to avoid creating pollution "hot spots". A strong environmental assessment process would provide a structured framework for due public and donor consideration before energy investments are made.

Private Power. Even though the power sector in Asia is mostly state-owned, there is a broad range of ownership and control. Some enterprises are direct government undertakings, some are govern-

Box 5.1: Demand-Side Management

One aspect of demand-side energy efficiency is called demand-side management (DSM). DSM commonly refers to programs, policies, technologies, and rate structures that reduce or shift electricity demand. Power companies promote DSM as a way to reduce high marginal costs of generation. High marginal costs may relate to high peak loads, high fluctuations, or high capital growth requirements.

In order to minimize energy costs (and energy-related emissions), industry and commercial users must be encouraged to examine where and how electrical energy reductions can be made on a least cost basis. Then, by altering management practices and investing in more efficient equipment—often in response to incentives offered by the power company—both the industry and power company benefit. DSM technologies include:

- Cogeneration plants, for simultaneous electricity and thermal production, typically in industry, and for both onsite use and for resale back to the power company;
- Load management systems, which offer substantial load control to the power company at the time of system peak;
- Energy management systems, which lead to reduced loads through increased efficiency;
- High efficiency motors and variable frequency drives;
- More efficient heating, cooling, and refrigeration;
- Energy efficient lighting and fixtures; and
- Building improvements, such as windows and insulation.

DSM programs initiated by utility companies require that they finetune their pricing (based on the time of day and season), initiate a DSM campaign, and possibly share the costs of energy efficient equipment through rebates to end users. Other measures include information centers to industrial and commercial consumers, and guaranteeing the purchase of excess electricity from private power generators.

DSM savings can be very significant. Two California (United States) companies have achieved efficiency gains of 6–14 percent over the past eight years (Nadel 1991). DSM programs in the United States are projected to reduce demand by an average of 3–7 percent over the next decade. The projected U.S. savings are equivalent to 30 percent of new capacity requirements over the same period and will reduce carbon dioxide emissions by about 150 million tons.

Box 5.2: Energy Efficiency in China

China has made notable progress in reducing unit energy consumption levels over the last decade. Progress has been made in widespread promotion of rudimentary energy management practices, energy housekeeping measures, and a variety of retrofitting projects. Government units in all provinces have been established to provide training and technical assistance services, and local testing stations have been established to enforce energy consumption standards.

The institutional system which China has developed has succeeded in prodding a wide array of enterprises to undertake technical and managerial measures to improve energy efficiency. Unlike the U.S. approach, in which utility companies are instrumental, in China (as in Japan and Korea as well), the government works directly with industrial enterprises. China's program is now strong in its broad coverage of enterprises, monitoring of consumption practices, promotion of energy efficiency goals, and information dissemination. Efforts to improve energy efficiency have become a more integral aspect of the energy planning process than in most developing countries. The system seems to work well for disseminating information on consumption norms between provinces, providing incentives for enterprises to adopt efficiency measures, and promoting generic energy conservation investments.

On a technical level, China's energy conservation strategies revolve around two basic themes: (a) linking energy efficiency with the broader process of industrial growth, and (b) upgrading the efficiency of existing equipment. The first theme is based on the opportunity presented by new investment taking place in the industrial sector. Much new industrial capacity installed in the 1980s was below international efficiency standards, and now carries long-term penalties in terms of high recurring costs and high energy consumption rates. More aggressive introduction of energy efficient technologies as part of overall modernization would bring more cost-effective benefits than selective retrofitting. A lasting impact can be achieved through a relatively focussed effort on high efficiency boilers and electric motors, pumps, and fans.

The second theme—upgrading the efficiency of existing equipment—has many components. These include the promotion of industrial cogeneration facilities, reduction of power transmission and distribution losses, improvements in coal quality, and aggressive replacement of inefficient motors and boilers. China has some 400,000 industrial boilers, with average efficiencies of 55–60 percent, as compared with targets of 75–80 percent. The government boiler strategy includes new product design, restructuring of the boiler industry, and training programs to improve operations.

ment corporations under special statutes, and some are government companies governed by normal company laws. It can be assumed that power utilities in Asia will remain largely state owned for a number of years to come. Privatization will consist of partial rather than complete sale, such as divestiture of selected assets, or privatization of management and/or service functions. A main reason Asian countries are taking even these steps is to help mobilize the huge investment resources required for expansion.

There is a modest trend in Asia toward private power investments.[15] Evidence shows that early private investors have succeeded in part because they introduced efficient innovations, such as "slip-form" technology in the construction phase, computer applications, and gas-fired turbines. Private power is, and should be, increasingly encouraged through laws and financial incentives. The incentives required to develop a private power industry are: (a) guaranteed purchase of the energy by the utility, and (b) a fair basis for determining the price paid by the utility.[16]

In some circumstances, privately-owned renewable systems—primarily wind farms and mini-hydropower—are cost-effective investments to feed directly into national grids. In India, for example, a non-subsidized fund designed to encourage investment in wind farms has already solicited 20 applications for installations ranging from 200 kilowatts to 20 megawatts. As part of this effort, the Indian government has offered fair rates for purchased energy, and 100 percent depreciation of investment in the first year. India is estimated to have a maximum potential of 20,000 megawatts of wind resources, and equivalent to one quarter of its 1992 power sector installed capacity.

The benefits of private power from the environmental perspective are due to higher sectoral efficiency, not to any inherent private sector willingness to spend more on the environment. If regulations are not properly enforced, private power

providers are not necessarily cleaner than public sector counterparts. However, experience has shown that in addition to overall efficiency benefits, governments can more easily enforce regulations on private sector companies than on public sector ones.

Technical Approaches to Cleaner Energy

After policy and institutional measures, the second basic approach to a cleaner energy sector is the pursuit of clean technologies on the supply side. As mentioned, pursuit of clean technologies is inadequate without the simultaneous pursuit of full-cost energy pricing. In the energy sector, clean technologies refer to a range of technical options, such as retrofitting existing plants, new conventional energy technologies, and investments in non-conventional energy.

Conventional Thermal Power

Whereas energy efficiency reduces all types of emissions, albeit on the margin, some level of emission-specific investments in thermal power plants will be required to minimize energy emissions in Asia. The first three options listed below are *fuel resource options*, and the next few are *power system options*.

Coal Beneficiation. Asian coals tend to have a higher ash content (20 percent to 30 percent) but lower sulfur content (1 percent to 2 percent) than United States and Korean coals. In India, some coals have such a high ash content (up to 40 percent) that power plant thermal efficiencies have fallen to as low as 25 percent, requiring the use of an additional 33 percent coal to generate the power that would have been generated at more standard thermal efficiencies.[17]

Coal beneficiation (i.e. grinding and washing) reduces the ash content significantly and removes other impurities to produce an optimal particle size for more efficient pulverized coal combustion. Other benefits include a lower moisture content and lower transport costs. In China, studies have shown coal beneficiation to be cost-effective on the grounds of transport cost savings alone, quite apart from any environmental benefits.

Expanded Development of Natural Gas Resources and Networks. The use of natural gas instead of coal or a mix of the two reduces the quantity of CO_2 emitted into the atmosphere. A 1,000-megawatt power plant fired with coal emits about 900 tons per hour of CO_2, as compared with 520 tons per hour (42 percent less) for a gas fired plant. Oil would emit 720 tones per hour (20 percent less than coal). An added benefit of cofiring natural gas and coal is reduced NO_x emissions. It is relatively easy and inexpensive to retrofit a boiler for natural gas—the principal issues are the cost and availability of natural gas.

In Asia there are large amounts of natural gas in China, India, Indonesia, and Malaysia not being utilized for both economic and technical reasons. Strategies to increase the exploitation of these resources could have significant environmental benefits. The constraints to expanded gas utilization are its current lack of price competitiveness with coal, and, partly as a result, the lack of investment in extraction and distribution.

However, as coal prices in Asia are raised to world market levels, and the environmental benefits of burning natural gas are considered, the use of gas for power production can be shown to be one of the least-cost strategies. Korea and Thailand have invested in natural gas infrastructure using imported liquified petroleum gas (LPG), but have primarily done so for economic efficiency and strategic purposes, not environmental purposes. In China, the strategy of full-cost coal pricing has accelerated the production of natural gas. The problems facing gas development in China stem from the declining productivity of its known reserves, the aging gas transmission/ distribution system, and the lack of integrated petroleum sector planning, pricing, and exploration that would lead to expanded supplies. Proven gas reserves are only 3 percent of potential reserves. On the whole, natural gas prices (as well as most petroleum product

prices) are artificially low. More rational petroleum sector pricing would help expand gas supplies, for which there is broad proven demand in China.

Pollution Control Retrofit. To reduce power plant emissions, a wide range of options exist. Specific residuals call for specific technological interventions. For example, reducing acid rain emissions requires limiting the use of coal containing sulfur, and/or equipping power plants with flue gas desulfurization or similar sulfur removal technology. Removing NO_x emissions requires either catalytic reduction, which is 50–80 percent effective, or more expensive atmospheric or pressurized fluidized bed combustion technologies. Reduced particulates is achieved through electrostatic precipitators, fabric (baghouse) filters, and wet scrubbers. Reduced greenhouse gas emissions requires improved thermal combustion efficiencies, and cannot generally be achieved by add-on pollution control equipment.

The required level of investment in pollution control equipment depends on local standards, age of the plant and other plant specific characteristics. For a typical coal-fired thermal power plant, the installation of the standard particulate control, desulfurization, and denitrification technologies commonly used in developed countries adds up to 20 percent to the cost of electricity (see the section on Comparative Costs, below).

Power Plant Upgrades. Power plant upgrades, or retrofits, usually mean the installation of new boilers, turbines and other major components to gain efficiency improvements, although less expensive improvements are also important. Low-cost improvements imply the replacement of valves, gaskets, control sensors, conveyor belts and other items that frequently wear out. Taken together, these items can have a significant impact on overall power plant efficiency. Medium-cost items include pumps, blowers, compressors, major boiler or turbine components, and control system elements. Major cost items include a new boiler, turbine, condenser, pollution control unit, ash conveyor system, fuel handling system and a complete control system. These high-cost upgrades require major commitments of funds, including a major foreign exchange component.

Interregional Transfer and Dispatching. Optimal dispatching and interregional energy transfer are not widely practiced in Asia. Improved dispatching can help reduce pollutants by putting on line plants that pollute less, such as hydropower and gas fired facilities. In each country additional study is needed to determine how much energy could be saved through improved transfer and dispatching, and to determine how this may be done on a practical basis.

Renewable Energy

Renewable energy sources are improving in cost competitiveness with conventional energy. For Asia, the most promising technologies are small and medium-scale hydropower plants (a few megawatts to 100 megawatts, which are less detrimental to the environment than large dams), photovoltaics, solar thermal, wind, and geothermal installations. These technologies are well developed and there is a great deal of technical and economic experience upon which to draw. Renewable energy production is limited by the natural resources available, such as sunlight, rivers, wind, and biomass, and renewable installations are always very site-specific. Philippines, with a relatively large endowment of geothermal resources, plans 1,000 megawatts in geothermal production by 1997, at a projected costs of $1 billion.[18] India has created a $125 million fund for commercial investments in wind-generated power.

Most renewable systems other than biomass have less environmental impact than conventional energy.[19] Each kilowatt-hour of photovoltaic, wind, or hydropower avoids production of 1.3 kilogram of CO_2. On this basis, if 5 percent of China's electric power could be provided in this manner, 26 million tons of CO_2 emissions, or nearly 5 percent of CO_2 emissions from fossil fuel sources, would be avoided. Recommendations concerning the suit-

ability of renewable forms of energy are made below, following cost comparisons with conventional energy.

Nuclear Power

Where the safety and waste management issues are adequately addressed, nuclear power has the environmental advantage of emitting little or no air pollution. In certain situations, nuclear power can be cost competitive with conventional technologies. However, the environmental problems associated with radioactive wastes have not been fully resolved in the OECD countries, and as a result, costs have soared and worldwide construction has slowed dramatically. It is expected that the contribution of nuclear power to total energy supply in Asia will remain insignificant, because of: (a) the ready availability of less expensive alternatives; (b) the shortage of investment capital; (c) nuclear power's stringent requirements of competent, vigilant and effective management of plant operations, and of strict adherence to rules and regulations; and (d) safety concerns and public opposition in the post-Chernobyl era (box 5.3).

Comparative Costs among Conventional Energy Technologies

The comparative costs of various conventional energy technologies in Asia are summarized in figures 5.8 and 5.9.[20] The top chart shows the average capital costs of power generation options. Coal fired power generation costs $1,000–$1,500 per kilowatt depending on the level of pollution control installed, while oil and gas-fired thermal installations are less, because they do not require the same pollution control equipment. Gas turbines are much cheaper ($500–600 per kilowatt), due, in part, to their higher thermal conversion efficiency (45 percent as opposed to 33–35 percent). Cogeneration is a much cheaper alternative to stand-alone powerplants, because of the way energy is more efficiently shared by power (electricity generation) and thermal (steam and heat generation) processes. The low cost of cogeneration investment lends strong support to the argument for enhanced private power investment in developing countries.

The capital costs of hydropower cover a much larger range, but, in general, the largest and the smallest installations have the lowest capital investment costs per kilowatt: the largest because of economies of scale, and the smallest, called run-of-river systems, because they require no reservoirs. Micro-hydropower systems have average investment costs in India of $600–1000 per kilowatt, and the number of installations is expanding rapidly—partly because they have none of the social and environmental impacts of large dams. Figure 5.9 shows the increased cost of electricity generation in coal-fired plants due to the addition of pollution control equipment. Starting from a base generation cost of $.05 per kilowatt-hour, the cost rises by over 20 percent with full treatment of particulates, sulfur, and NO_X, to $.06 per kilowatt-hour.[21] The basic technologies referenced in this table are:

- electrostatic precipitators or fabric filters for particulates, which remove 99 percent of particulates, at a cost increment of 2–5 percent;
- coal beneficiation, or cleaning, which removes both ash and some sulfur, at an additional 2 percent cost;
- wet or dry FGD systems for SO_2 removal, which are 70–95 percent effective, at a cost premium of 8–12 percent;
- combustial modifications to reduce NO_X, or catalytic reduction—two methods that are 50–80 percent effective—add 5–8 percent to generation costs.

Alternatively, atmospheric and pressurized fluidized bed combustion are newer technologies that are effective for both SO_2 and NO_X reduction, at costs comparable to the above alternatives.

Depending on the requirements of specific sites, and the combinations of technologies installed, total emissions control costs will vary from the generic costs shown here. These costs will come down as newer, more efficient processes become commercially and technically viable. Also, lower-cost approaches (providing lower performance as

Box 5.3: The Prospects of Nuclear Power in Asia

Nuclear Power in Asia. Asia generates 3 percent of the total nuclear power generated worldwide. Asian countries with nuclear-generating capacity are India, Japan, Korea, and Pakistan, as well as China, which started operating its first nuclear power station only at the end of 1992. A nuclear power plant was almost completed in the Philippines in 1986, but construction was halted as a result of safety concerns. Indonesia continues to explore the nuclear option. Since nuclear power in Asia is projected to grow at only 2.4 percent per year through 2005, its share of Asia's energy use is expected to fall from 4 percent in 1989 to 3 percent by 2005.

In Korea, the nuclear power program has proved to be one of the most economically successful in the world, achieving low costs and good operating performance. Nuclear power accounted for 49.1 percent of the country's total electricity generation in 1990. Two factors that contributed to the success of nuclear plants in Korea are institutional and technological factors. Institutionally, the centralized form of the Korean political and administrative structures enabled the government to maintain relatively coherent nuclear policies and thus to cope effectively with the rapidly changing domestic and international environment. Technically, the dynamic growth of the overall scientific and technological infrastructure enabled Korea to enter into the highly sophisticated nuclear power industry rapidly and effectively. In terms of costs, fossil fuel alternatives in Korea must be imported, and are hence very costly.

Competitiveness of Nuclear Power. Estimates of the costs for nuclear power in developing countries show them to be unequivocally higher than those of fossil fuel alternatives in countries with a fossil-fuel resource base. At the higher discount rates found in most World Bank borrower countries, nuclear power is even less competitive.

In OECD countries, nuclear power capital costs tend to be nearly twice as high as those for thermal power plants. Nuclear plant capital costs range from $1,800–2,000 per kilowatt in France and Canada to $3,000–3,500 per kilowatt in the other five G-7 countries. Actual costs in the United States are even higher, and were running $5,500 per kilowatt in the late 1980s, primarily because construction costs were double those of the 1970s. The operational performance (load factors) of nuclear plants tend to be unpredictable and 10–30 percent lower than projected. The levelized costs of nuclear power are 50 percent higher than fossil-fuel alternatives in the G-7 countries ($.057–$.065 per kilowatt-hour as opposed to $.037–$.044 per kilowatt-hour for coal, in 1987 prices) except for France and Canada, where coal and nuclear are closer to parity.

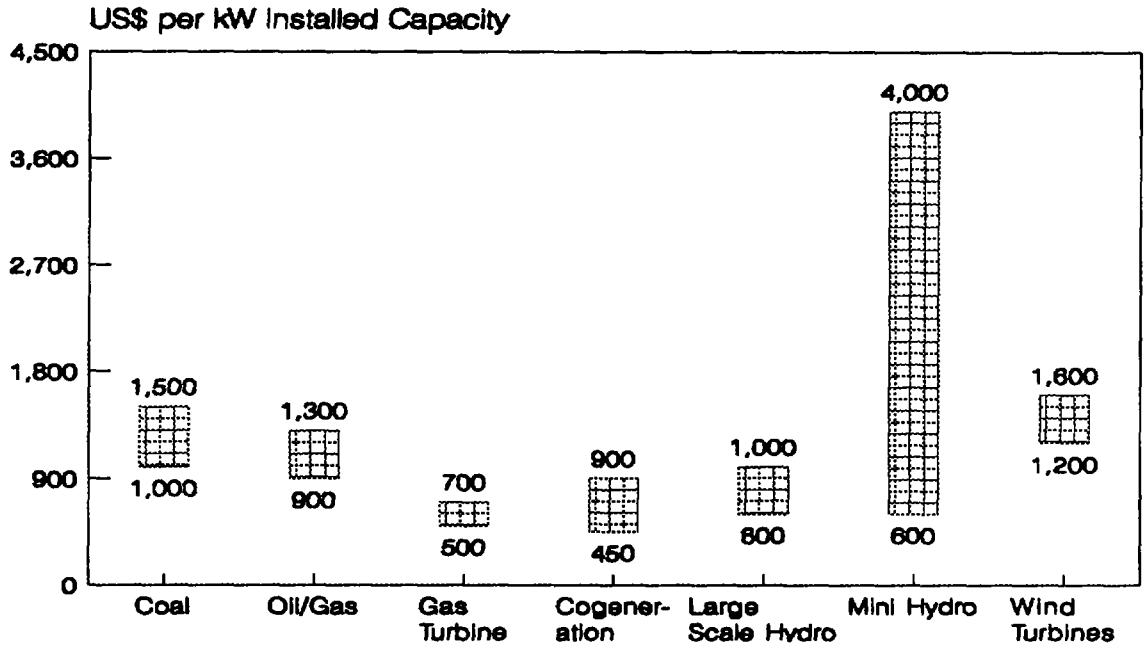
In all countries, nuclear costs vary significantly with the cost of capital, cost of fuels, the scale of the nuclear industry, technical efficiency, the regulatory environment, and waste management costs. In Indonesia, estimates show nuclear options to be significantly more expensive than coal, even when full pollution abatement technologies are installed on coal plants (they currently are not). Also, expected costs are routinely higher than projected costs, primarily due to the great uncertainty that surrounds many installations. Projects are subject to higher safety and environmental standards in the post-Chernobyl era—and ways to meet these standards are not yet fully worked out. Tighter requirements have lead to higher costs, longer delays, and a virtual halt in most OECD countries other than Japan. Public opposition to nuclear technologies is strong in many countries, and has slowed construction as well. Even in Korea, the economics of nuclear power are deteriorating in the face of difficult environmental safety issues, increasing plant construction costs, and the recent socio-political change taking place in the country.

Environmental and Safety Aspects of Nuclear Plants. Although some routine emissions of radioactive material in solid, liquid, and gaseous forms result from nuclear power plants, of greater concern to the public is the handling and disposal of radioactive wastes. The burial of low-level wastes (including tailings from uranium mining, contaminated materials from nuclear plants, and wastes produced from plant decommissionings, in landfills or bunkers) is technically straightforward. Techniques for high level wastes (primarily spent fuel) are far more difficult and costly, and long-term solutions are still being sought. Hence, the disposal of high-level wastes is a complicated and technically demanding undertaking that is beyond the reach of many developing countries possessing or aspiring to a nuclear power program.

The World Bank and Nuclear Power. The World Bank has not lent to any nuclear projects since lending to Italy in the 1950s, and is not currently considering doing so. For this to change, the Bank would need to be convinced that nuclear power was the least-cost solution, that environmental concerns were fully addressed, that supplier export credits were not available (and they usually are, and at terms more favorable than offered by the World Bank), and that the International Atomic Energy Agency (IAEA) and other parties endorse all safety and management provisions. In the case of rehabilitation of existing plants, the Bank is involved in discussions with several other international parties on appropriate technical and financial strategies.

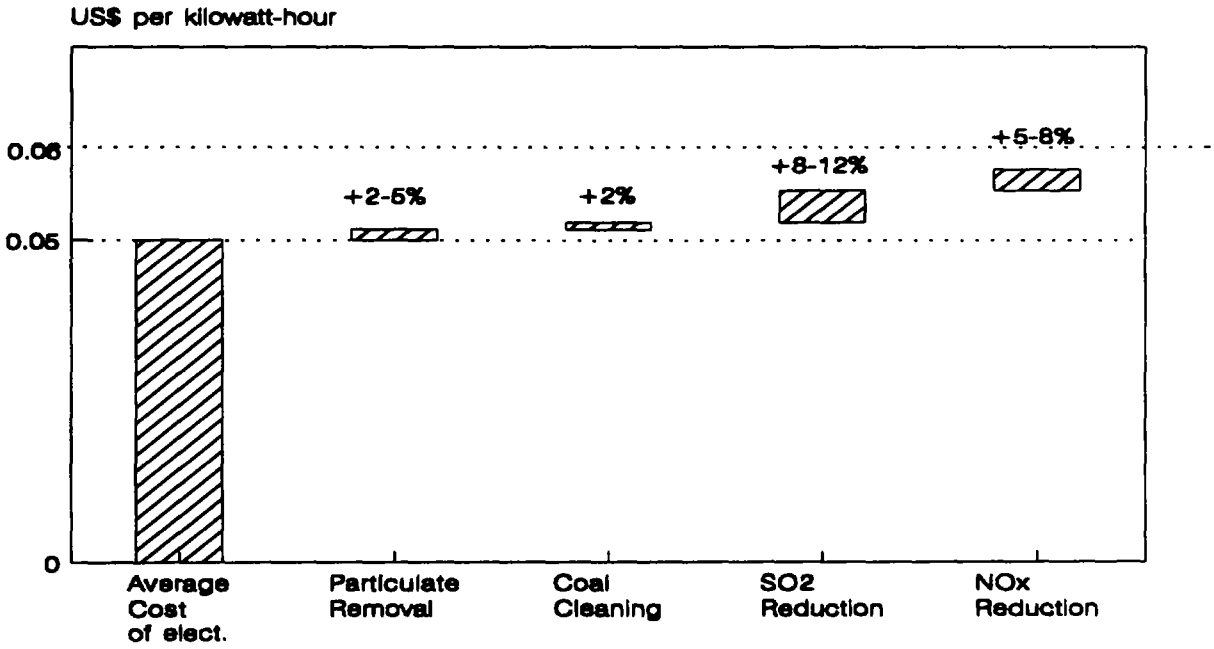
Sources: IAEA 1992; IEA 1992; Park 1992; Adamantides and others 1990; and Adamantides 1991.

Figure 5.8: Range of Costs in Power Generation



Note: Solar power for small installations (not shown) costs $6–$12 per watt of peak output.

Figure 5.9: Range of Incremental Costs of Emission Control (Coal-Fired Power Plants)



Note: Percentages show recommended increased over the basic "levelized" cost.
Source: Adapted from ADB 1991.

well) are under development. As these low-cost systems come on line, their performance will improve and become more predictable—and more prevalent.

An example puts some of these figures in perspective. In China for example, by the year 2000, some 60,000– 90,000 megawatts of new thermal capacity will be required, mostly fueled by coal. SO_2 control is very costly. If Japanese or European standards were applied, the investment for flue gas desulfurization could total $20–25 billion for a high-cost, high-capacity scenario. This cost would have to be financed by an approximately 10 percent increase in electricity tariffs. A lower cost, lower effectiveness process for partial SO_2 reduction is coal beneficiation. The cost of this option, based on United States and European data, is $5–7 per ton of coal cleaned, and $150–200 per ton of sulfur removed.[22] The up-front investment required would be much less, and the tariff increase only one-fifth as much.

For Asian countries seeking to minimize expenditures on pollution control equipment, the first priority should be to curb emissions of particulates. Particulate reduction is relatively cheap—1–2 percent of the total capital costs of electricity generation—and is important for human health. Second priority should go to the most cost-effective solutions to reducing sulfur, which is usually coal beneficiation. Some new technologies are being developed that may compromise some of the high standards of the OECD countries in favor of easier use and lower cost for use in developing countries. Ultimately, however, the choice between more and less expensive technologies should be made on the basis of country-specific cost-benefit analysis, which can take into account the local health costs of air pollution.

Comparative Costs between Conventional and Alternative Energy Technologies

Table 5.4 shows the projected cost of renewable electricity through 2030. The declining unit costs are the result of improved technology, of more aggressive research and development, and of economies of scale as the volume of production increases. Over the past decade, the cost of solar thermal power has decreased over 70 percent, wind power 75 percent, and photovoltaics 66 percent. The rates shown are best compared with avoided costs of conventional power sources, which average $.05 per kilowatt-hour.

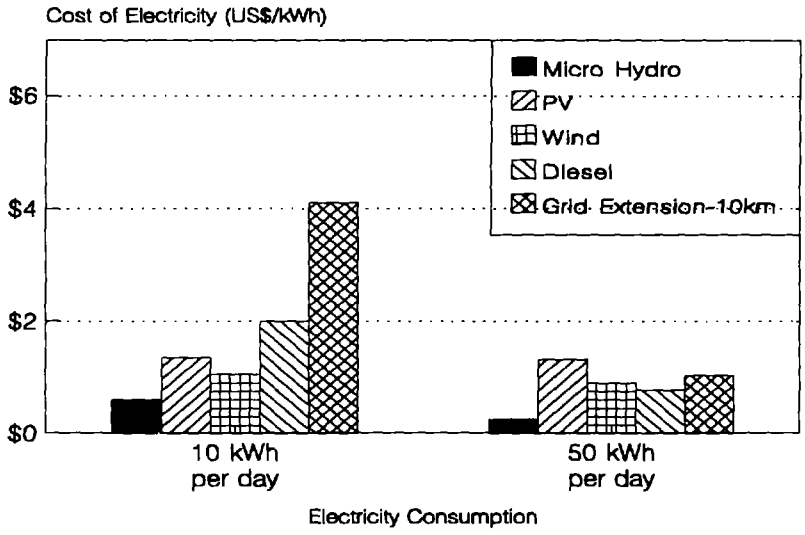
At current cost levels, renewable energy technologies are most competitive with: (a) conven-

Table 5.4: Costs of Renewable Electricity, 1980–2030

Technology	1980	1990	2000	2030
	(dollars per kilowatt-hour)			
Wind	.32	.08	.05	.04
Geothermal (various technologies)	.04–.08	.04–.07	.04–.06	.04–.05
Photovoltaic	.89	.30	.15	.05
Solar thermal				
Trough with gas assistance	.24[a]	.08	.06[b]	n.a.
Parabolic dish	.85	.16	.08	.05
Biomass	.06	.05	.05	.04–.05

Note: All costs are averaged over the expected life of the technology, and assume high returns to government R&D.
n.a.: Data not available.
a. 1984 cost figures.
b. 1994 Cost projection.
Sources: Finnell, Cabraal, and Kumar 1991; World Bank Alternative Energy Unit data.

Figure 5.10: Cost of Electricity in Rural Areas



Source: USAID 1991.

tional power in rural areas that are currently off-grid, and (b) selected wind, biomass and geothermal installations that can be incorporated into the grid. Figure 5.10 compares the costs of providing electricity to remote communities using renewable energy sources with (a) diesel generators and (b) grid extension of 10 kilometers. The levels of electricity consumption—10 and 50 kilowatt-hours per day—represent the needs of 5 and 25 families, respectively. As shown, renewable systems are cheaper than diesel power or grid extension where the renewable resource base exists. At higher consumption levels, micro-hydropower remains the cheapest option, and photovoltaic and wind are comparable to diesel power or grid extension.

The constraints to increased adoption of renewable systems in rural Asia are (a) the capital cost of systems; (b) the availability of financing (long-term loans) to spread out the cost over time;[23] (c) the availability of standardized and proven technologies, especially for wind and mini-hydropower installations; and (d) the availability of local technical support. All of these factors will be less constraining over time, as the volume of installations goes up and the requisite financial and support services expand into the growing market.

Mitigating the Environmental Impact of the Asian Energy Sector

The previous two sections have given a overview of the measures required to improve energy sector efficiency and reduce negative environmental impacts. It is asserted that a concerted effort on pricing and managerial efficiency could lead to savings of 10–25 percent in the raw energy consumed. In a recent study, the ADB projected comparable savings in CO_2 emissions assuming a strong regional emphasis on energy efficiency (table 5.5).[24] More than 80 percent of these savings would be in the form of reduced coal use, with correspondingly decreased emission of particulates, sulfur dioxides, and nitrogen oxides.

Investments in pollution abatement technologies, fuel-switching, and the use of renewable energy sources could *reduce emissions* by another 8–15 percent by 2010, depending on the rate of utilization of natural gas and the adoption of renewable energy technologies. This is a low estimate based on the strategies laid out above. However, the World Bank has outlined a scenario with far greater adoption of alternative energy technologies.[25] In this example, continued reliance on fossil fuels would lead to a tripling of emissions by 2050, whereas with an aggressive shift into renewable energy sources the increase would be only 25 percent. This shift of technologies, which is candidly described as "unprecedentedly rapid," could only occur with dramatic price reforms to reflect economic costs, larger share of energy R&D expenditures in renewable technologies, and financial assistance. In addition, it would be necessary

Table 5.5: Estimated Carbon Dioxide Emissions from the Use of Fossil Fuels in Asian Developing Countries (Metric Tons of carbon)

Region	Actual (1986)	Year 2000		Year 2010		
		Scenario A	Scenario B	Scenario A	Scenario B	Scenario C
East Asia						
Cambodia/Lao P.D.R./Myanmar	3	6	6	10	9	9
China	549	938	790	1,353	1,047	994
Indonesia	26	5		111	101	89
Korea, DPR	36	54	43	72	51	44
Korea, Republic of	48	99	90	127	107	93
Malaysia	9	16	16	29	26	23
Pacific Islands	2	4	3	5	4	3
Philippines	7	18	17	28	26	24
Thailand	12	44	43	94	92	86
Viet Nam	4	8	8	14	12	12
South Asia						
Bangladesh	3	6	5	8	6	6
India	114	224	218	388	348	330
Nepal	0	0	0	1	0	0
Pakistan	13	31	27	49	38	35
Sri Lanka	1	2	2	3	3	2
Totals	827	1,455	2,024	2,292	1,870	1,750

Scenario A: "Business as Usual"
Scenario B: Emphasis on energy conservation to improve environmental quality.
Scenario C: Energy conservation and fuel switching to improve environmental quality.
Source: ADB 1991.

to include environmental benefits of renewable technologies in the economic evaluation of energy projects.

Finally, efficiency gains can reduce the need for *capacity expansion* by 2000 by 20–30 percent, based on a 10 percent increase in overall efficiency. While these savings are significant (nearly $100 billion), major investments in capacity expansion will still be required.

The World Bank's Role in Energy and the Environment

Past Experience

Projects. The Bank has long invested heavily in power generation, and, more recently, in energy sector adjustment loans. In contrast to traditional loans, sector loans have provided valuable opportunities to address sectorwide efficiency issues, and have allowed the Bank to support institution building, sectorwide efficiency, and policy–based reforms.

Like many other donors, the Bank has invested much less in the areas of demand side management, alternative energy technologies, coal beneficiation, or lending for in emissions control equipment. However, its more recent lending strategy has included several new components, including: (a) energy efficiency and alternative technologies; (b) applied research on technical and policy

Table 5.6: Energy Sector Projects with Environmental Components

1990	Philippines, Energy Sector
1991	Bangladesh, LPG Distribution
	India, Private Power Utilities
1992	Malaysia, Power System Development
	China, Daguangba Multipurpose
	China, Ertan Hydro
	China, Yanshi Thermal
	China, Zouxian Thermal Power
	Indonesia, Surabaya Thermal Power
	India, Maharashtra Power II
	India, Power Utility Efficiency Improvement
	Nepal, Power Sector Efficiency
	Sri Lanka, Power Distribution II
1993	India, Renewable Energy
	India, Jharia Mine Fire Control TA
1994	Philippines, Leyte Luzon Geothermal
	Philippines, Leyte Cebu Geothermal
	China, Sichuan Gas Development
	Pakistan, Karachi Hydrocarbon
1995	Philippines, Casecnan Transbasin
	Vietnam, Energy Sector
	India, Coal Sector Restructuring
	Pakistan, Private Sector Energy II Development

issues; and (c) regional and global activities in the energy sector through the GEF. Table 5.6 lists World Bank energy projects with environmental components in Asia.

The region's largest program of energy/environment lending is in China. This program is being integrated with parallel programs for urban and industrial environmental management, including pollution control, institution building and some financial restructuring. India is also making significant investments in energy efficiency and alternative energy sources, as part of its large power investments in recent years. Most other Asian countries have had power projects with some environmental component during the 1989–92 period (Bangladesh, Indonesia, Malaysia, Nepal, Pakistan, the Philippines, and Sri Lanka), with additional lending scheduled over the next three years.

Box 5.4: Innovative World Bank Alternative Energy Projects

India Renewable Resources Development Project. The World Bank's first stand-alone project for developing renewable energy and other resources was approved in India in December 1992. The project, which has GEF support, has total funding of $450 million. A $280 million renewable-energy component will be financed through a combination of loans, credits, grants and private sector equity. The project will finance over 185 megawatts of small-hydropower, wind and solar photovoltaic projects.

Thailand Promotion of Electricity Energy Efficiency Project. The proposed $188.5 million project, supported by the GEF, comprises a five-year (1993–1997) demand-side management (DSM) plan for improving energy efficiency and reducing future CO_2, NO_x and SO_2) emissions. The Thai program has a savings target of 238 megawatts and 1427 gigawatt-hours of electricity per year by the end of 1997. The project is a large scale demonstration of the potential for electricity savings in the industrial, commercial and residential sectors, and the ability of the electric power sector to realize these savings.

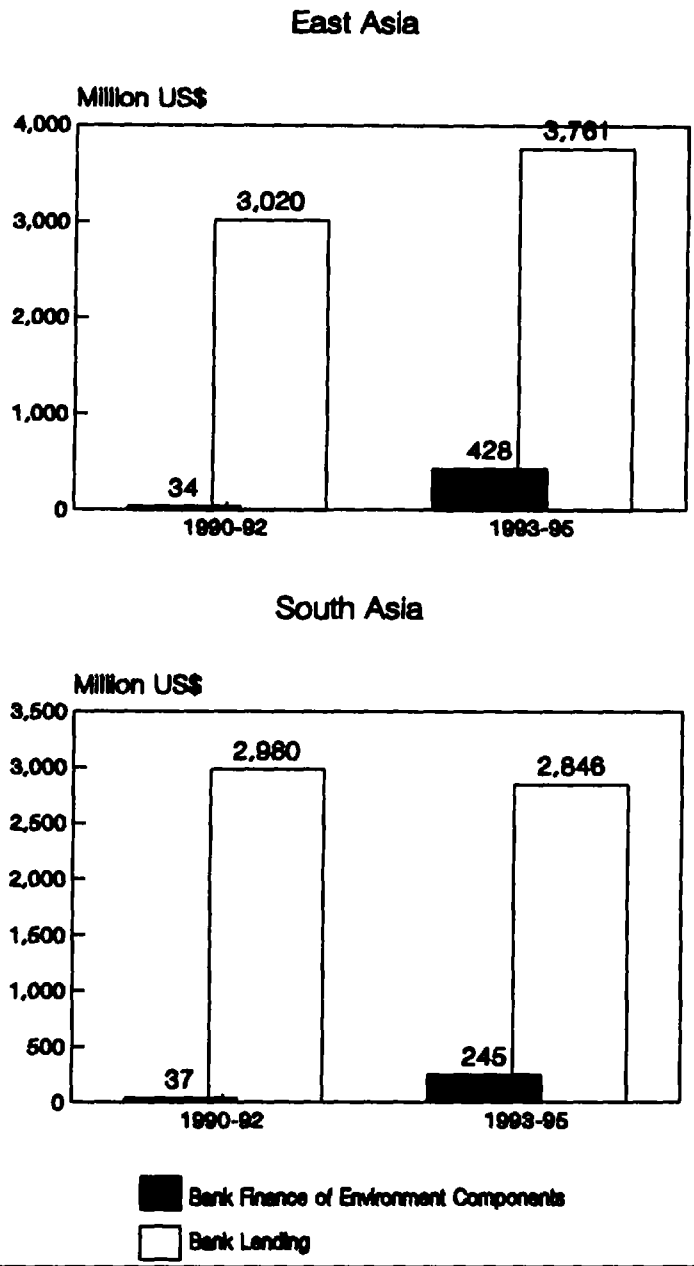
In January 1992, the Bank established the Alternative Energy Unit in the Asia Technical Department (ASTAE), which is devoted to incorporating energy conservation and renewable energy options in sector strategies and lending in Asia. ASTAE is active in most borrowing countries in Asia. Operational programs include: preparation of renewable energy project components (including solar photovoltaic, mini-hydropower, and wind) in India, Indonesia, Lao PDR and Sri Lanka. A major energy efficiency/DSM project is being supported in Thailand. Further analytical work is being undertaken in Malaysia (energy efficiency); Thailand, Philippines, and Indonesia (market studies); Korea (a DSM strategy); and China (renewable energy aspects of the greenhouse gas study). Two innovative alternative energy projects are described in box 5.4.

The two priority areas for World Bank support to renewable energy sources are: (a) rural areas that remain off the national grid and (b) stand-alone installations based on favorable local conditions (such as geothermal or wind resources)

that can be linked into the national grid. The Alternative Energy Unit is endeavoring to expand its activities through a process of successful demonstration projects, promotion of necessary regulatory changes, and financially sound analysis.

Figure 5.11 shows Bank expenditure on energy-related pollution control equipment, demand side management, and renewable energy. There is little projected increase across Asia in these areas, and more should be done. However, much of the Bank's work in the energy sector is for sector-wide price reform and efficiency gains, which are important parts of any strategy to reduce energy sector environmental impacts, even if they stop short of full involvement in pollution abatement lending.

Figure 5.11: Total Bank Lending and Bank Finance of Environmental Components for Energy Projects in the Asian Regions Fiscal 1990–92 and Fiscal 1993–95



Analytical and Demonstration Work. Analytical sector work in the energy sector has generally proceeded along two fronts: country-specific work that addresses sector development strategies, pricing, and institutions; and regional and global work focussing on emissions issues, mostly funded by the GEF. In terms of the Bank's more traditional sector studies, significant analytical work has been done in the important areas of fuels, pricing, and institutions. This work is essential to a policy-based approach to energy efficiency, financial strengthening, and private sector participation—all key elements of an environmentally appropriate energy strategy. Two regional studies that relate to the measurement and management of acid rain precursors are:

- **Acid Rain and Emissions Reduction in Asia.** This multiple-donor study has three components: (a) to improve current estimates of SO_2 and NO_x emissions in the Asia region

and make projections based on scenarios of economic and energy growth; (b) to assess where the emissions of SO_2 and NO_x will ultimately be deposited as acid rain; and (c) to estimate the impact and cost of acid rain deposition on croplands, forests, soils, water, animals, materials, and humans.

- **Siting Thermal Power Plants**. As part of the Zouxian electric power project in China, and financed by the Japan Grant Facility, this project will study the optimal siting of thermal power plants—including ways to minimize local and regional air pollution problems originating in China's coastal provinces. If successful, this effort could prove useful to other countries for similar siting exercises.

The GEF provides an opportunity to study the national and regional environmental impact of the power sector, and to follow up with demonstration projects—in areas of emissions reduction, energy efficiency, and renewable technologies. Projects include a demand-side management project in Thailand, a renewable energy project in India, greenhouse gas studies in China and India, and a landfill gas collection project in Pakistan.

GEF-funded studies concerning greenhouse gases are being undertaken in China and Asia-wide. The China study, begun in 1991, focuses on a least-cost strategies for investment, including two detailed technological case studies concerning the improvement of coal quality and the upgrading of boiler efficiency. A similar India study is under consideration. The Asia regional study will be concerned with establishing a standardized methodology for estimating sources and sinks of greenhouse gases. Such analysis is a necessary prerequisite to the establishment of international accords to deal with greenhouse gas emissions.

Future Directions

The objectives of increased macroeconomic efficiency, energy sector efficiency, and environmental protection are to a large extent consistent. The role of the Bank has been and will continue to be strong in several areas that can help reduce the environmental impact of the energy sector: policy-based reforms, with an emphasis on pricing; private sector power development; and supply side efficiency. A recent World Bank policy paper argued that government commitment to improving sector efficiency should be a precondition for a World Bank loan.[26] The study identified transparency and consistency of decisionmaking, pricing, and demand-side management as integral to an acceptable framework. It further argued for aggressive commercialization and corporatization of, and private sector participation in, developing country power sectors. These strategies are appropriate to Asia and should be adhered to in countries where the energy framework is unacceptable.

However, the important areas of demand-side management—large-scale renewable energy installations connected to the main grid and small-scale renewable energy technologies for rural areas—are much less prominent in the Bank's program. Although expenditure in these areas is rising slightly, it should be expanded further.

The level of Asian investment in pollution control equipment will be determined by governments through emissions standards and their timetables for meeting those standards. In order to bring all power generation facilities planned to be built in Asia during this decade up to European standards, an incremental investment of up to $50 billion will be required. This investment—with or without a significant share of World Bank funds—will not be made unless Asian governments are convinced through clear economic and social analysis that they will accrue commensurate levels of benefits. An important role for the World Bank, therefore, is to assist in the efforts of Asian countries to analyze their energy-related environmental costs, benefits, and priorities—and to help put in place regulatory systems designed to achieve their target pollution standards.

Notes

1. Bates and Moore 1991.
2. British Petroleum Company 1991.

3. For example, costs estimated by the Asian Development Bank (ADB 1991) are about 20 percent higher than those used here, and those by the World Bank (Moore and Smith 1990) are 50 percent higher. The point remains that the magnitude of the required investment—hundreds of billions of dollars—far exceeds public sector and donor resources, and requires private sector involvement.
4. Anthropogenic CO_2 is the result of fossil fuel consumption and various industrial processes such as cement manufacturing. Other major sources of atmospheric CO_2 are deforestation and agriculture, which are not included in these estimates.
5. Foell and Green 1990.
6. Smith 1988, pg. 19.
7. For a review of these studies see Smith 1987.
8. Chen and others 1990, pp. 127–138.
9. Although this appears counter-intuitive, the main factors operating at cross-purposes seem to be burn rate and temperature, which are optimally lower for increased efficiency and higher for reduced emissions (Smith 1987, pg. 315).
10. World Bank 1992d.
11. World Bank 1992a.
12. Derived from World Bank data by the Asia Technical Department, Energy Division.
13. World Bank 1992b, pg. 57.
14. The efficiency of a carbon tax would be higher than a sulfur tax, for the reason that carbon emissions, for a given fuel, are less easily effected by a actual technology employed than is sulfur. In the case of sulfur, several scrubber and flue gas desulfurization technologies can be used to reduce emissions. Therefore, a tax on sulfur content in fuels would penalize the plant operator that invested in desulfurization technology.
15. Private power investments are being made on a trial basis in several Asian countries. Examples include a 200-megawatt gas turbine under construction and a 300-megawatt coal-fired BOT (build-operate-transfer) plant under bid in the Philippines. In Pakistan, the government hopes to provide 35 percent or 2,300 megawatts of new generation capacity from private sources over the next 10 years. In India, the government is encouraging the private sector to build 20 percent of new generation (including 7,800 megawatts in coal and hydropower capacity in Karnataka). In Thailand, the government is developing guidelines for private power through industrial cogeneration and a 55 megawatt plant is currently under development. Finally, in China, a policy has existed regarding private power since 1988, and the pace of private power investment in China is accelerating in response to the increasingly urgent need for capital. In November 1992, the Chinese Ministry of Energy identified 32 projects (48,000 megawatts) for private investors, and formally announced the goal of "developing various models for [private sector] cooperation in the power sector." To encourage private investment, China has approved many policies and regulations relating to the protection of foreign investment.
16. The most common price basis is "avoided cost," which is the marginal cost of energy the utility is not required to produce because of the amount supplied by the private seller. The avoided cost can change by time of day and time of year, depending on the load shape. A third incentive provided in the United States involved tax incentives for private investment, but these were largely repealed in 1987. They are not necessary to stimulate private investment in the power sector.
17. Thermal efficiencies of 33 percent are standard, and are achieved in Indonesia. Higher efficiencies are achieved in Korea, Malaysia, and Thailand.
18. *U.S.-Philippine Business News, Sept-Oct. 1992, pg. 4.*
19. Even some biomass systems can be an improvement over traditional energy sources. For example, an ambitious biomass scheme for China has been proposed, based on substituting wood for coal, that could theoretically generate significant CO_2 savings. Wood, as a fuel, emits comparable levels of CO_2 as compared with coal. The source of the CO_2 savings would be carbon sequestration in the forest areas producing the wood, combined with careful harvesting of the wood to avoid rotting—which would otherwise release carbon.
20. Capital costs in Asia, based on World Bank appraisal reports, are often 20 percent less than worldwide average costs estimated by the World Bank. See note 3.
21. The cost figures cited here refer to levelized costs, which incorporate both operating costs and amortized capital costs. Specific operating costs are difficult to forecast because of site specific char-

acteristics such as capacity factor, heat rate, fuel costs, and labor.

22. The amount of sulfur removed depends on the nature of the coal, but is typically in the 5–40 percent range. A more expensive beneficiation process called "advanced physical cleaning" is required to remove 35–85 percent of the sulfur, at an average cost of $800–$1200 per ton of sulfur (ADB 1991, pg. 149).
23. Even in cases where financing is available, and where monthly payments are comparable to what families might pay for kerosene, communities are reluctant to invest in a renewable system. An investment in a renewable system requires a long-term commitment of future income, whereas the purchase of kerosene is more discretionary, month by month.
24. ADB 1991, pp. 57–62.
25. World Bank 1992a, pp. 161–3.
26. World Bank 1992d.

6

NATURAL RESOURCES MANAGEMENT: LAND, FORESTS AND BIODIVERSITY

Arable land resources in Asia are facing intense pressure from farmers seeking to maintain food self-sufficiency. Forests and marginal lands are suffering from serious degradation for a variety of reasons, including excessive conversion to agricultural land, commercial logging, and over-exploitation of firewood and fodder. Asia faces the difficult problem of trying to secure production increases in agriculture and forestry without destroying remaining land, forest, and habitat resources.

This chapter provides an overview of these "green" sector issues, and identifies the key elements of a strategy to address the problems of land degradation, deforestation, and loss of biodiversity. While these key elements may not be uniformly applicable to all Asian countries, the elements themselves—policy, institutional, and technical priorities—should be a useful and consistent basis for country strategies.

Land resources are common to agriculture, forests, and habitats (with the exception of aquatic habitats), and one theme of this chapter is that agriculture, forestry, and habitat preservation benefit by being looked at as a continuum of natural resource management issues. Intensified agriculture is at one extreme of land use, and natural ecosystems are at the other. Between is a complete spectrum of lower-yielding land uses, including rainfed agriculture, grazing land, and all types of non-natural forests (such as commercial, mixed-use, and degraded forests). This chapter addresses the natural resource management problems of these lower-yield land uses as much as the more familiar problems of intensified agriculture and destruction of natural forests and other ecosystems.

This chapter is organized into five sections. The first reviews the land resource base in Asia and discusses major resource problems by land, forestry, and biodiversity issues. The second section discusses the underlying causes of natural resource degradation. The third section presents general policy and institutional responses to addressing these problems; and the fourth section reviews technical approaches and needs. The last section reviews the relevant past and future role of the World Bank.

Land Resource Problems

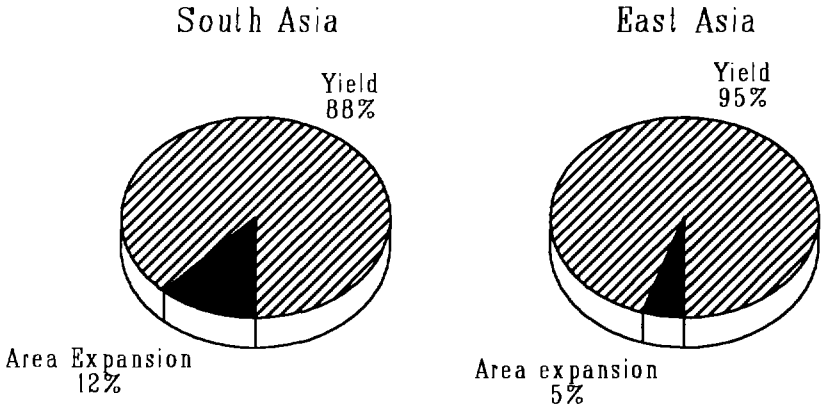
Land Use

The total land area in Asia is about 2 billion hectares. About 390 million hectares (20 percent) has been brought under cultivation and classified as cropland; about 500 million hectares (25 percent) is classified as forest or woodlands; permanent pastureland accounts for another 500 million hectares (25 percent); and the rest (30 percent) is classified as other land, which includes mountains, deserts, wetland, unused grassland, and built-on areas.

Cropland. During the last three decades the net expansion of cropland has been minimal (about 6 percent) and growth in food production was primarily achieved through intensification (higher yields per hectare). In East Asia, yields have increased 2.5 times and account for 95 percent of the increase in food output over the last three decades (figure 6.1). Though the yield effect was less pronounced in South Asia, yields nearly doubled, and accounted for 88 percent of the output growth.

Irrigated cropland, which currently accounts for one-third of the cropland in Asia, has made food

Figure 6.1: Cereal Production Increase, Broken Down into Yield Increase and Area Expansion, 1961–90



Source: Calculated from World Bank data.

self-sufficiency in Asian countries possible. The other two-thirds of the cropland is rainfed, and still supports large sections of the rural population. For example, in the Philippines, while about 40 percent of the area under paddy cultivation is rainfed, it contributes nearly 30 percent of the total paddy production. Less productive cultivation (with traditionally longer fallow periods) is also done on marginal land resulting from conversion of forests or grassland.

Grassland. Nearly a quarter of the land, or about 500 million hectares are grassland in Asia (table 6.1). Northern and Western China contain the world's most extensive grasslands, which occupy more than a third of the country. In tropical and subtropical regions, most grasslands are the result of forests being converted (following, perhaps, a period of swidden agriculture) to pasture land, commercial grass production—or, as in many areas of Southeast Asia, simply being overtaken by *imperata cylindrica*, an aggressive climax grass. However, even man-induced grasslands can be highly productive, and provide important economic and ecological services.

Forests. Nearly a quarter of Asia (approximately 500 million hectares) is forest land, either closed or open. Tropical forests account for nearly 90 percent of the total productive natural forests in the region (and are a quarter of the world's tropical forests), and are most common in Southeast Asia (Indonesia, Malaysia, and the Philippines). Deciduous forests are found mostly in South Asia and continental Southeast Asia, while temperate forests are most common in India's Himalayan region and in Northeast China. Table 6.2 shows the amount of land under forests in Asian countries. The classified forest areas also include forest lands under shifting cultivation, degraded to grassland, or hacked for fuelwood and fodder.

Asian exports of forest products were $8.5 billion in 1991. Three countries (Malaysia, Indonesia, and the Philippines) have traditionally accounted for the dominant share of the of the

Table 6.1: Countries in Asia with Extensive Grassland

Country	Extent of grassland (million hectares)	Percentage of total land area
China	319	34
Mongolia	124	80
Afghanistan	30	46
India	12	4
Indonesia	12	7
Pakistan	5	6
Nepal	2	15

Source: World Bank data.

Table 6.2: Forest Areas in Asian Countries, 1989

Country	Forests (,000 hectares)	Percent of Total land
With more than 100 million hectares		
China	124,600	13
Indonesia	113,433	63
With high percentage of forested land		
Papua New Guinea	38,230	84
Malaysia	19,100	58
Cambodia	13,372	76
Lao P.D.R.	12,800	55
Korea	6,485	66
Bhutan	2,605	55
Solomon Islands	2,560	91
Fiji	1,185	65
Vanuatu	914	75
With low percentage of forested land		
Mongolia	13,915	9
Afghanistan	1,900	3
Maldives	1	3
Pakistan	3,500	5
Others		
India	66,736	22
Myanmar	32,418	49
Thailand	14,240	28
Philippines	10,550	35
Viet Nam	9,800	30
Nepal	2,480	18
Bangladesh	1,950	15
Sri Lanka	1,747	27
Western Samoa	134	47

Source: World Bank data.

region's timber export revenues (over 90 percent in the 1980s, and 80 percent in 1991). This small decline is partly accounted for by the depletion of Philippine reserves, as well as the increase in exports from Myanmar, Lao P.D.R., and Cambodia.

Land Degradation

Estimates are that nearly 20 percent of the vegetated area in Asia has been affected by human induced land degradation since 1945.[1] One estimate of the magnitude of soil degradation in Asia is shown in table 6.3, although this data is on the high end since it includes all land (including deserts, wetlands, and mountains) that is degraded, non-arable, or highly susceptible to erosion. Given the wide range of soil conditions that constitute degradation (see box 6.1), consistent estimates of only that amount of land that has been degraded by human activity are not available across Asia.

Table 6.3: Estimates of Land Affected by Soil Degradation in Selected Asian Countries

Country	Estimated degraded land (,000 hectares)	Percentage of total land area
SOUTH ASIA		
India	148,100	50
Pakistan	15,500	17
Bangladesh	989	7
Sri Lanka	700	11
EAST ASIA		
China	280,000	30
Indonesia	43,000	24
Thailand	17,200	34
Vietnam	15,900	50
Lao P.D.R.	8,100	35
Philippines	5,000	17
Myanmar	210	3
Western Samoa	32	32
Tonga	3	5

Source: ESCAP 1992.

Box 6.1: Types of Land Degradation

Land degradation can occur in a variety of ways: nutrient depletion, structural decline and compaction, biological decline, chemical deterioration (acidification and salinity), and soil erosion. Nutrient status of the soil declines if the losses—outputs in crops and animal products, leaching, runoff, erosion, mineralization and volatization—exceed the gains from the weathering of parent rock, atmospheric accession, biological fixation and fertilization. Loss of organic matter, often hastened by cultivation, leads to loss of soil structure that can reduce soil moisture-holding capacity, increase runoff, and reduce aeration within the soil.

Soil conservation measures should do more than prevent erosion: they should also address broader soil fertility, crop protection, structural, and moisture conservation aspects.

While data on soil degradation caused specifically by loss of vegetation, nutrient depletion, and structural decline is not available, there is increasing evidence on soil erosion, waterlogging, and salinity. Although it can be safely generalized that soil degradation is a significant problem across virtually all agro-ecological zones in Asia, both the nature and scale of this degradation varies widely among and even within countries in the region.

Soil Erosion and Fertility. Both water and wind erosion are important problems in the Asia region, although wind erosion hazards are mainly restricted to Mongolia, western China, and the drier parts of India and Pakistan. The most widespread hazard is water erosion, principally caused by excessive exposure of bare soil (from poorly managed logging operations, indiscriminate land clearance, widespread use of annual crops in farming systems, bare fallowing, overgrazing, and stripping the land of vegetation or fuelwood), and inadequate management of runoff. In addition, parts of Asia have highly erodible soils, such as loess soils in China, limestone-derived soils in Malaysia and southern Thailand, dispersible soils such as those associated with the Pelambang formation in eastern Sumatra, and geologically young soils in Nepal.

The impacts and costs associated with soil erosion can be severe. Onsite impacts include reduction of yields due to degraded soil structure, surface sealing and crusting, and desertification. In India, the average annual loss of plant nutrients from eroded soil is estimated to account for a loss of 30 to 50 million tons of agricultural production.[2] In Java, it was estimated (1988) that the onsite costs of soil erosion amounts to $315 million annually. In the hills of Nepal, overall yields of cereal fell by over 1 percent per year from 1970–71 to 1980–81. While the influence of erosion for this decline is not clear, in the Terai where erosion is less significant, yields were constant.

Soil erosion can cause serious offsite impacts as well. Some of the eroded soil may be deposited in drainage channels, irrigation ditches or reservoirs, thereby reducing capacity and causing them to overflow more frequently. Erosion can also result in changes in the hydrology of catchment areas, which can increase flood frequency, flood severity, and reduce availability of surface water during dry seasons. As a result, floods during the rainy season can be followed by worsened droughts during the dry season. In Indonesia offsite costs of soil erosion from degraded upland forests and rainfed agricultural land on Java were estimated at $26 million–$91 million per year.[3] Costs would be much higher in India, where flooding is worse, and where erosion and sedimentation have significantly reduced lives of reservoirs.

As noted above, soil erosion is only a subset of soil degradation issues, which also include loss of soil fertility due to loss of vegetation, nutrient depletion and structural decline (such as compaction). Some argue that erosion has been over-rated in comparison to these other more pervasive problems. Technical approaches to soil and moisture conservation encompass this broader problem definition.

Waterlogging and Salinity. Badly designed and managed irrigation systems and practices can lead to waterlogging and salinity—which are separate phenomena but are often linked in areas predisposed to such problems. The consequences can be severe. Unlined canals and other water channels contribute to groundwater recharge. When water is used for irrigation in excess of crop requirements, it also leads to waterlogging and groundwater recharge. The rising groundwater table then draws up the salts found in the soil, and then deposits them on the soil when the water evaporates or transpires through plants. Also, irrigation with poor quality groundwater can lead to salinity or sodicity of soil. In time, the top soil accumulates a high salt content and becomes less fit for cultivation.

In Asia most of the waterlogging and salinity occurs in China, India, and Pakistan. Data on salinization and waterlogging are limited. India has the highest area of land affected by waterlogging and salinity—by 1988 the productivity of nearly 20 million hectares of cropland (30 percent of the ir-

rigated cropland) had been seriously affected,[4] and farmers had to abandon 10 million hectares of productive cropland.[5] In Pakistan, about 3 million hectares (20 percent of irrigated land is affected by waterlogging and salinity (see box 6.6). In China, 7 million hectares (15 percent of the irrigated cropland) is feared to be suffering from waterlogging and salinity.

Increased waterlogging and salinity in soils leads to a reduction in output, loss of irrigated lands, and increased salt loadings on return flows and aquifers (which, if used for irrigation, spread the damage to other farm lands). Whereas average yields exceeding 6 tons per hectare can be achieved under well-irrigated systems, yields in saline areas can be only about 1.5 to 2.0 tons per hectare.[6] Also, standing water provides a breeding site for vectors that transmit diseases such as schistosomiasis and malaria.

Agrochemical Pollution. The green revolution in Asia was achieved through use of high-yielding varieties and increased application of chemical fertilizers, pesticides, and water. The environmental impacts of increasing agrochemical use is evident in some locations (particularly China), although the absence of data makes a characterization of the extent of the problem very difficult. In the most impacted areas, overapplication of chemical fertilizers has lead to eutrophication in nearby surface waters and some accumulation of phosphates and heavy metals in soils.

There is growing evidence of declining yields in response to increased application of agricultural inputs, under current technologies. For example, a study of 146 rice farmers in Suphan Buri, Thailand, showed that between 1982 and 1988 increases of 24 percent in nitrogen fertilizer, 53 percent in pesticides, and 35 percent in seeds led to a mere 6.5 percent increase in yields.[7] As a result, further yield increases are either going to require proportionately much larger applications of inputs, which would have significant adverse environmental impacts, or be the result of new technologies and overall improved farm management techniques.

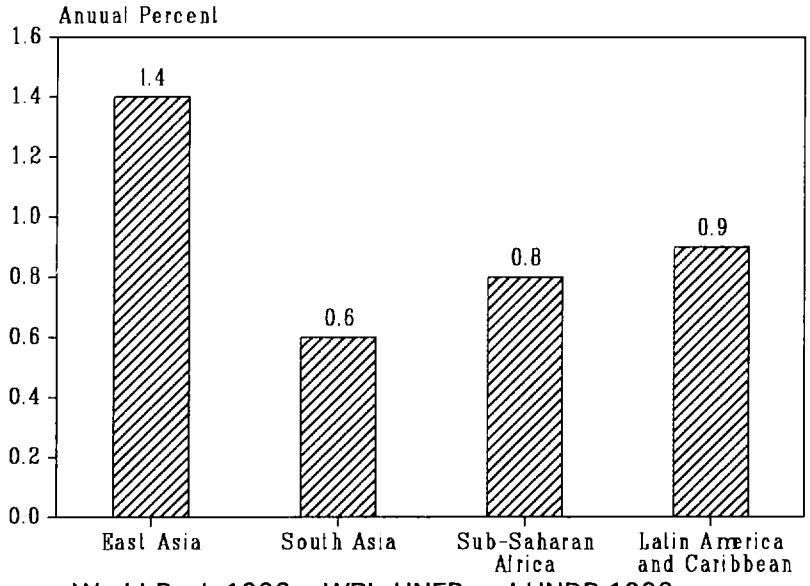
Poorly-managed pesticides have health impacts through contact during transport and application, through ingestion of contaminated food or water, or through release of chemicals via runoff into surface- and groundwater. Contact during use is probably the most severe problem. Although the chronic impact and long-term effects on health are not very well understood, increasing exposure and build up of toxins in the body are causes for concern. For example, in India, HCH[8] is widely used as a pesticide on many crops including rice, and increasing residues have been noticed in food and in mother's milk. In Indonesia, the widespread use of endosulfan in rice is believed to cause a significant problem of fish kill, and the growth of vegetation in ponds and rivers has significantly altered fisheries and habitat. The risks of pesticides in surface water are clearly greater if sensitive production systems, such as aquaculture, are located downstream.

Increasing use of pesticides has also led to growing pest resistance and reduction of the pests' natural predators, forcing a vicious cycle of stronger and more frequent applications. While an extensive documentation of pest resistance is not available, specific instances in the region indicate the widespread prevalence of the problem. In Indonesia, the brown plant-hopper outbreak in the mid-1980s ultimately led to the banning of several dozen pesticides and helped usher in integrated pest management. In Shandong Province (China), deltamethrin was first introduced in 1982 to combat heliothis armigera affecting the cotton crop. By 1985, resistance had developed and spraying was increased from five or six times per year to twenty-five times. The same problem exists with the cotton crop in Andhra Pradesh in India.

Environmental Issues in Forestry

Among all tropical regions, East Asia experienced the highest rates of deforestation during 1981–90 (1.4 percent per year, see figure 6.2). Furthermore, deforestation rates in East Asia *increased* during the 1980s, in contrast to other tropical regions of the world. Deforestation rates were the highest in

Figure 6.2: Deforestation, 1981–90



Sources: World Bank 1992a; WRI, UNEP and UNDP 1992.

continental southeast Asia (Cambodia, Lao P.D.R., Myanmar, Thailand, and Viet Nam), followed by insular southeast Asia (Indonesia, Malaysia, Philippines). South Asia has lower deforestation rates (0.6 percent) due to far fewer forest reserves. Across Asia, some open forest areas where trees are widely spaced, and forest fallow and shrub areas (which comprise about 180 million hectares in the region) are being further degraded.

The major causes of deforestation include commercial logging, conversion to agricultural land, and demand for fuelwood and fodder, although it is difficult to assign proportionate blame to these factors. Also, not all deforestation is environmentally or economically inappropriate. It is inevitable that large amounts of forests in Asia will continue to be converted to alternative land uses. The economic and environmental objective of sustainability is to allow conversion where it leads to higher-yield land uses without imposing unacceptable or irreversible environmental costs.

Commercial Logging. It is estimated that about 2.1 million hectares of forests are newly logged every year in Asia. This number represents over half of the total estimated area being deforested (see above). Logging operations are the major contributor to deforestation. In addition, logging has other cascading effects that lead to deforestation, the most important being the use of forestry access roads by migrant settlers.

Commercial logging across Asia is increasing, even as some countries are depleting their resource base. Official data on commercial logging, moreover, seriously underestimates the magnitude of operations. Nevertheless, FAO data indicates that between 1978 and 1989, annual industrial roundwood production in East Asia has increased by 28 percent, and in South Asia by 30 percent. Of all East Asian countries, only Korea and the Philippines show a decline in output. In South Asia, only Bhutan shows a decline in output.

Uncontrolled logging causes extensive unnecessary damage to forests. For example, a study by FAO carried out in Sarawak (Malaysia) showed that subsequent, significant soil erosion took place after logging on about 40 percent of the logged area, because the soil had been left denuded.[9] Also, when only the most valuable trees (selection felling) are logged for commercial timber, other trees are damaged. The same FAO study found that for every twenty-six trees cut and removed per hectare, thirty-three others were broken or damaged.

Excess logging is induced by the high profits offered to concessionaires through government policies designed, in part, for that purpose. The nexus of the ruling oligarchy with logging inter-

ests has been a major obstacle to outside efforts at reducing rampant logging.

Conversion of forest land to agricultural land. It is estimated that 30–80 million people are involved in shifting cultivation affecting 75–120 million hectares of land.[10] The practice is widely prevalent in the northeastern and drier central states of India, Kalimantan island in Indonesia, the central highlands in the Philippines, and parts of Myanmar, Thailand and Bangladesh (table 6.4).

Swidden agriculture with long fallow periods, as traditionally practiced by indigenous groups, did not lead to ecologically severe impacts. The main impact of long fallow agriculture is that primary forests change to secondary formation, with only localized reduction in biodiversity.

However, for fundamental socio-economic reasons, traditional swidden agriculture has become less prevalent, and new migrants, primarily from more densely populated lowlands, practice short fallow swidden with more negative long term effects. Here, the composition of the forest initially changes from a high forest to a low profile secondary forest as in the case of the long fallow system.

Table 6.4: Area Affected by Shifting Cultivation in Asia

Country	Area affected by shifting cultivation (thousand hectares)
Indonesia	35,000
Viet Nam	8,000
Thailand	4,000
Malaysia	4,700
Papua New Guinea	4,000
Lao PDR	3,000
India	2,696
Philippines	2,000
Myanmar	1,420
Sri Lanka	1,000
Bangladesh	1,000
Fiji	200
Solomon Islands	1

Source: ESCAP 1992.

Then, continued disturbance leads to a different vegetative form such as grasslands or complete degradation and desertification. This process is widely observed in India, Nepal, the Philippines, and Thailand.

Most land converted by migrant farmers is land outside established farming areas that is not subject to effective control. In densely populated areas like Java, these peripheral lands are usually unsuited to sustainable agriculture (due to excessive slope, instability, infertility, and so forth). In less densely populated areas, the peripheral land is soften designated by the state for other purposes, such as conservation or forestry. In either case the result is basically the same, incompatible land use.

Demand for Fuelwood and Fodder. Of the more than 1 billion cubic meters of wood that Asia harvests per year (1988), 77 percent is used for fuelwood. Fuelwood production in the region grew at an average rate of 2 percent per year over the last decade, and accounted for more than 90 percent of total roundwood production in all of South Asia, and Cambodia and Lao P.D.R.. Among the rural and urban poor, most energy needs are met through the use of fuelwood and other biomass. Where fuelwood is not available, grass, crop residue, cattle dung and other biomass is substituted—depleting an important source of fertilizer.

Deforestation caused by cattle grazing in forests for fodder is especially acute in India, where forests are the only places for cattle to find vegetation. India is home to 15 percent of the world's cattle, 10 percent of its sheep and goats, 50 percent of its buffaloes, but has only 4 percent of the global land area.

Loss of Biodiversity

Nearly three-quarters of the natural habitat in Asia has been lost or irreversibly degraded (table 6.5). It is estimated that Asia will lose a higher proportion of its species and natural ecosystems than any other region during the next twenty five years. Biodiversity status and trends, key elements of biodiversity conservation, and a regional strategy

Table 6.5: Loss of Original Habitat in the Indo-Malayan Realm

Region	Loss of original habitat (%)
Bangladesh	94
Sri Lanka	83
India	80
Viet Nam	80
Pakistan	76
Philippines	79
Cambodia	76
Thailand	74
Lao PDR	71
Nepal	54
Indonesia	49
Myanmar	43
Malaysia	41
South China	39
Bhutan	34

Source: MacKinnon and MacKinnon 1986.

for conservation are presented in the recent World Bank report, *Conserving Biological Diversity: A Strategy for Protected Areas in the Asia-Pacific Region.*[11]

There are a wide range of factors leading to habitat loss. Some relate to rural activities, including habitat destruction from clearing and burning forests, conversion of natural ecosystems for agriculture, desertification of natural grasslands, reclamation of wetlands, and poaching and illegal harvesting of animal and plant wealth. Others relate to urban and industrial development, such as sprawling urbanization, coastal development, and pollution. Other direct mechanisms for loss of biodiversity include introduced species, industrial agriculture and forestry, and (potentially) global climate change. Genetic erosion, which is the end result of biodiversity loss, can result from monocropping practices in agriculture and animal husbandry. Over 40 percent of Asia's farms adopted the green revolution's high yielding varieties within fifteen years of their introduction; and now more than 80 percent of the farmers in Indonesia and the Philippines plant these varieties. It is feared that in Indonesia over 1500 local rice varieties have been lost during the last 15 years.[12]

About two-thirds of forest areas have been lost in this century. More than half of Asia's wetlands have been lost, and of those remaining of international significance, more than half again are under threat—especially in Bangladesh, coastal China, Malaysia, the Philippines and Sri Lanka. The majority of mangroves in the Indo-Malayan realm have been lost, mainly for aquaculture. Offshore habitats are also being degraded: pollution and destructive fishing practices have significantly degraded reefs in Indonesia, Malaysia, the Philippines and Thailand. Fishing industries are overharvesting resources, especially in the eastern Indian Ocean and in coastal waters from Viet Nam to beyond Korea.

Within individual countries, overall habitat losses have been most acute in India, Bangladesh, southwest Sri Lanka, coastal Myanmar, south China, Indo-China, the island of Java in Indonesia, and the central islands of the Philippines. In the Oceanic realm, while the destruction has not been very widespread, lowland rainforests have been destroyed in Western Samoa and Tonga, and are threatened in Fiji, the Solomon islands, and parts of Papua New Guinea. However, because of the high proportion of endemics in the area and the small population sizes of many isolated species, threats of extinction are among the highest in the world. Only on the island of New Guinea (Irian Jaya and Papua New Guinea) are there large expanses of pristine ecosystems.

Underlying Causes of Natural Resource Degradation

The underlying causes of land degradation, deforestation and biodiversity problems include: (a) market and policy failures—such as underpricing of resources, input subsidies, and lack of information about viable technologies on marginal lands—that lead to resource-degrading externalities; (b) a rapidly growing population that exerts pressure on land resources for both subsistence and commercial needs; (c) resource tenure structures that en-

courage short term exploitation rather than longer-term conservation; and (d) institutional weaknesses that encourage mismanagement of resources. The mix and influence of these factors vary widely from location to location, given the wide diversity in Asia.

Population Pressure

The link between population and resource degradation is not straightforward, since it cannot be said that population density, per se, leads to resource degradation. There are examples of densely populations with relatively low degrees of erosion, and less densely populated areas—where there are fewer incentives for resource protection—with widespread degradation[13]. For example, the highly populated island of Java reveals relatively fewer problems with erosion than with pollution, although admittedly Java does not exhibit high degrees of biodiversity. Overall, population pressures have exacerbated fundamental market failures that have gone unaddressed for years when resource demands were smaller (see next section).

The most significant pressure exerted by population on Asia's natural resources is the ever-increasing demand for food, followed by the demand of both rural and urban poor for fuelwood. These demand-induced pressures on natural resources require that governments take basic decisions concerning extensive versus intensive supply strategies for land, food, and energy.

Total food requirements. Although there has been an increase in per capita cereal production in several Asian countries, this does not necessarily mean that there is enough to eat. Assuming a basic dietary requirement of 2350 calories per person per day (U.N. recommendation), many Asian countries fall short of meeting the dietary requirements of their populations by 10 percent or more, especially in South Asia (table 6.6). In addition, Asia's population is expected to add 1.5 billion more people by 2025, an increase of 60 percent.

Need for intensification. To maintain the current per capita production, cereal output will have to increase at the same rate as population growth, or 1.3 percent per year. Given the shortage of underutilized agricultural land in Asia, output increases will continue to be dependent (as they have been historically) on yield increases. This implies, in turn, that yields will have to increase at the same rate as population growth, 1.3 percent per year, to simply keep up.

Achieving this target presents an enormous challenge and exceeds current projections. Projected yield increases from plant breeding in rice and wheat are expected to be about 1 percent per year in high potential irrigated areas and about half of that in low-potential rainfed areas. While yield levels in marginal areas can be increased by expanding irrigation, most easily irrigable areas in Asia are already irrigated. New irrigation systems are expensive and often accompanied by environmental and social impacts.

The difficulty of achieving Asia's food target can be looked at from a land perspective as well. If yields increase at only half the required rate (0.65 percent), Asia would need to add another 30 per-

Table 6.6: Countries in Asia Which Do Not Meet Basic Dietary Requirements

Country	Dietary energy supplies 1986-88 (calories per capita per day)
SOUTH ASIA	
Afghanistan	2110
Bangladesh	1925
India	2104
Nepal	2034
Pakistan	2167
EAST ASIA	
Cambodia	2162
Maldives	2140
Philippines	2238
Thailand	2288
Viet Nam	2217
Papua New Guinea	2227

Note: the U.N. recommended level is 2350 calories per day.
Source: Calculated from FAO 1991.

cent to its cropland by 2025 to remain food self-sufficient. Such an expansion is unrealistic: one recent study estimated the potential for cropland increases to be only 8 percent in Southeast Asia, and zero in South Asia.[14]

The trade option. Of course, food self-sufficiency need not be a top priority of Asian economics, as the food needs of Asia's growing population can be met by importing food from surplus regions of the world. Pressure from the world's grain exporting countries for increased exports to Asia will increase, as production costs rise in Asia. These pressures will be opposed, however, by the avowed goal of food self-sufficiency in many Asian countries.

The rural poor. The increasing rural population is an important factor leading to degradation of marginal lands in both South and East Asia (see above), but is particularly acute in South Asia. Surprisingly, the East Asian rural population may have already peaked (see chapter 1, figure 1.7). The South Asian rural population may not peak before 2015.

In both regions, even if rural populations were steady, the pressure on the resource base would continue due to the ongoing process of land degradation that forces even existing populations to migrate onto underutilized lands. In the face of this pressure, efforts to reduce overall population growth rates, create nonfarm employment opportunities in rural areas, and facilitate urban growth through improved planning and resource pricing, all have positive benefits on rural lands.

The fuelwood crisis. Growing populations lead to increased demand for fuelwood. The resulting fuelwood deficits are estimated to rise from a current level of 150 million cubic meters per year (excluding China) to 500 million cubic meters by 2000. Although these estimates do not take price effects and the possibility of fuel substitution into account, the poor have little capacity to rely on commercial fuels for their domestic needs. Acute shortages will worsen in many parts of Bangladesh, China, India, Java (Indonesia), Nepal, the Philippines, Sri Lanka, and Thailand. Solutions to this crisis must be based in more careful market definition and pricing, which would create incentives for more efficient stoves, forest rehabilitation (including on communal properties), and research into alternative energy sources.

Market and Policy Failures

Market failures combine with population pressures and lead to overexploitation of land and forest resources (see chapter 2). For example, market economics of commercial logging and subsequent conversion to subsistence agriculture do not capture the value of the foregone environmental services provided by the forest–biodiversity, carbon sequestration, hydrological buffering, soil stabilization, biodiversity, nonwood products, and recreation (box 6.2). In Asia as elsewhere, the costs of deforestation are mostly external to present-day markets for timber and forested land. Similarly, market incentives facing subsistence upland farmers emphasize short-term gains and do not capture the environmental costs of longer-term degradation, such as the loss of future onsite productivity, or the cost of downstream effects (siltation, flooding).[15]

Policy failures compound these market externalities. In the case of agriculture, subsidies and market supports encourage farming on marginal land that might not otherwise be farmed, as well as excess application of inputs (box 6.3). Poorly defined and executed land tenure—another policy failure, discussed below—is perhaps the single largest barrier to stabilization of marginal lands. In the case of deforestation, government policy failures lead to unsustainably low forest-stumpage fees, trade policies that encourage overproduction, and failure to adequately restrict access to public resources (see chapter 2, box 2.3).

Asian governments have progressed significantly in reducing agricultural subsidies, but much less so in correcting such policy failures as forestry pricing and resource tenure. Beyond asserting these

Box 6.2: Impacts of Deforestation

The economic impact of deforestation can be partially measured in terms of the income foregone due to inefficiency, overexploitation of resources, and loss of future production. A natural resource accounting framework estimated the cost of forest depletion in Indonesia, Papua New Guinea and the Philippines to be nearly $50 billion in six years between 1980 and 1985 (in 1985 prices). A more immediate indicator of the impact of deforestation is the estimate of future import requirements by countries that have traditionally been wood exporters. Based on current trends, imports of timber and forest products will cost Asian countries nearly $20 billion a year by 2000.

There are other indirect economic impacts of deforestation and degradation, most of which are not easily quantifiable. Deforestation impoverishes rural populations dependent on nearby forests for their basic needs (including nonwood products like protein and shelter, in addition to fuelwood and fodder). In upper watersheds, deforestation is associated with increasing soil erosion and floods in the wet season followed by droughts during the dry season. In the Philippines, studies showed that uncontrolled logging of one 7,830 hectares watershed imposed net costs on the economy in excess of $43 million, primarily because of damage caused to downstream fishing and tourism activities. Forests play an important role in sequestering carbon, and hence mitigate global warming. It is estimated that the destruction of tropical rainforests in Asia accounts for over 6 percent of global atmospheric loading of carbon. Finally, deforestation is the most important cause of habitat loss leading to loss of biodiversity.

Box 6.3: Subsidies on Agricultural Inputs

Agricultural input subsidies became widely prevalent in Asia and elsewhere after the oil shocks of the 1970s as a measure to cushion the impact of rapidly increasing prices of agro-chemicals. These subsidies, over time, have become a burden on government budgets. The subsidies on fertilizers are often the most widespread. For example, the fertilizer subsidy bill in India has grown nearly 40-fold (in constant 1990 dollars) from $57 million (in 1990 dollars) during 1973–74 to $2.63 billion by 1989–90. As a share of GDP, these subsidies increased from 0.06 percent to 1.2 percent over the same period. In Indonesia, subsidies on fertilizers and pesticides during 1983–84 were about $330 million (in 1990 dollars), rising to a peak of $643 million in 1986–87 (in 1990 dollars). The pesticide subsidy was abolished in 1988–89 due to environmental concerns and the reduced effectiveness of broad spectrum pesticide applications and the introduction of integrated pest management. By 1990–91, total agricultural subsidies had fallen back to about $380 million. In Bangladesh, agricultural subsidies have been relatively small, and nominal rates have declined between 1970 and 1990.

Sources: Raju 1992; Renfro 1992; and World Bank data.

general themes here, however, policy reform agendas must be very country and location-specific. They must also be reinforced with localized incentives that encourage greater investment in sustainability, as discussed in the next section.

Economic Incentives

Farmers and communities in Asia, as elsewhere, are profit maximizers. They often invest less of their time, effort, and money in resources management than are required for sustainability. The reasons for this divergence are widely known: lack of adequate land and resource tenure; relatively short time horizons on investments and low profitability of alternatives;[16] high aversion to risk, given the uncertainty of alternatives; market and policy disincentives; failure to recognize future problems associated with degradation; lack of appropriate location-specific technologies; and low levels of education among rural farmers. Therefore, the lack of conservation-oriented investment by farmers and communities is a result of inadequate incentives and information to change current practices.[17]

Current behavior is also affected by land tenure. There is a positive correlation between tenurial rights—whether through direct ownership, stable sharecropping arrangements, or long-term use rights—and investments in conservation measures (see box 6.4). Although past empirical work in Asia does not show the relationship to be as strong as is commonly presumed, worldwide and historically, marginal lands have been stabilized

Box 6.4: The Relationship Between Land Tenure and Conservation in Asia

Land tenure includes the formal (state-recognized) and informal (customary) rights of access to land, the rights to control products of that land, obligations to maintain the land, the rights of transfer, and the rights to determine changes in the use of that land. Some of the common types of tenure types in Asia are:

- stable land-tenure systems, such as those found in Java or Taiwan (China), where there are few communal lands, more or less clearly demarcated state-owned lands, and complex owner-cultivator and tenant-cultivated arrangements;
- ancient, state-recognized land-tenure systems, such as those found in parts of China, India, Myanmar, and Nepal, where common property resources are an important part of the formal and customary tenure rights;
- frontier areas, in the outer islands of Indonesia, Malaysia, the Philippines and northern Thailand, where a limited proportion of cultivators has state-recognized tenure rights, and a large proportion of forested and unforested land is designated as state forest. Cultivators in such areas include indigenous ethnic minorities who have a long-standing land use tradition and informal tenure based on ancestral rights; settlers, often belonging to the major ethnic group whose actual tenurial arrangements tend to emulate those elsewhere in the country; and recent migrants on newly cleared land.

Research in Asia supports the argument that with secure tenurial rights, farmers are more likely to invest in erosion control techniques. Conversely, the absence of these rights discourages such investment. In Java, a transition from a shifting cultivation system with poorly defined property rights to an agroforestry system with well-defined rights resulted in high levels of investment for preventing soil erosion.[18] In Viet Nam, policy reforms giving long-term land leases to farmers have led to an increase in soil conservation measures.[19] In India, there is strong evidence that where land is farmer-owned, land prices reflect conservation improvements, and thus provide a real incentive.[20] Tenure also affects a farmer's access to credit for land improvements where written title is a prerequisite for credit-worthiness.

Therefore, titling or land consolidation on private land in areas with socially recognized tenure rights, and increasing tenurial security in frontier areas, provides some incentive to farmers to invest in resource conservation. Also, in areas with traditions of common property resources, ownership can be recognized and management systems strengthened. Clarification of property rights becomes more critical as population pressure increases and as open access and communal property rights systems break down.

when land is individually owned and enclosed.

To alter current behavior, more profitable farming systems are required, especially on marginal lands. There are primarily technical, information, and tenure issues. Even where sufficiently low-cost technologies for conservation appear to be viable, the process of technology transfer and adaptation has proven to be ineffective, and adoption rates remain low. As a result the technical and tenure issues loom prominently in achieving more sustainable agriculture, as elaborated in the next sections.

Ineffective Institutions

The final major cause of excess natural resource degradation is weak institutions. Public institutions devoted to natural resource management have directly contributed to unsustainable practices in agriculture, forestry, and degradation of habitats in protected areas. In agriculture, examples are irrigation authorities with a bias towards investment over management, and agricultural institutions that played a major role in research, training and extension services for intensified agriculture during the green revolution but neglected low potential cropland and cropping models for upland agriculture.

Institutional weaknesses are even more pronounced in the forestry sector. Forest institutions in many Asian countries suffer from their colonial heritage—they manage forests as a source of raw material for large industry. Their emphasis has been on revenue maximization, enforcing technical regulations on loggers, collecting licensing fees, and preventing people from trespassing. Their charters and mandates have not forced them into such new areas of forest management as involving local people in managing forests, mediating in conflicting demands between agriculture, industry, and ecological needs, or conducting research in sustainable forestry practices. Attempts to improve forestry management by a proliferation of legislation have often been counterproductive, putting unin-

tended obstacles in the way of responsible private investment, rights of forest dwellers and local people, and activities of NGOs. Also, forest institutions have very low status in the government hierarchy with weak bargaining position in relation to other agencies. The skills commonly available within these institutions are not capable of addressing the diverse problems associated with managing forestry.

While technical issues in agriculture have received a certain level of attention, they have been inadequately addressed in forestry. Research and adoption of new technologies in forestry has lagged far behind agriculture. It is estimated that fewer than 1,000 scientists (not including those in China) conduct forestry research in Asia, compared to 5,000 scientists working on rice research alone. In India, expenditures on forestry research are less than 0.01 percent of the value of forest products consumed annually. As a result, policy is based on inadequate understanding of forest ecosystems. Also, while improvements in technology can be rapidly adopted in agriculture, it is much slower in forestry, largely due to the long term nature of forestry outputs and predominantly state ownership of forests.

Finally, agencies charged with managing parks and protected areas are hampered by weak legal frameworks, extremely limited operational capabilities and political influence, insufficient prestige to resolve local conflicts, inadequate financial resources, and inadequately trained staff. Other than India and Sri Lanka, most Asian governments have yet to institute policies or devise land management systems that will secure the conservation of protected areas in the future.

A General Strategy for Natural Resource Management

The proposed strategy for addressing natural resource degradation in Asia addresses both the short and long terms. The immediate strategic objective is to stabilize areas of rapid land, forest, and habitat degradation. The more fundamental and longer-term objective is to minimize the underlying causes, including causes in areas broader than agriculture and forestry, through such broader social reforms as land reform, population planning, and poverty alleviation.

The strategy applies across the spectrum of rural land use, from intensified agriculture to degraded forests and grassland. On a strategic level, the same principles apply. It is on the technical level that issues pertaining to specific land uses and land types become important.

The Strategy

A sixfold strategy for breaking out of the current patterns of natural resource degradation is:

- Aggressive promotion of locally relevant technical innovations that promote sustainable resource management, primarily through better targeted research (see below), technology transfer, extension services, and expanded roles for farmer and community groups in these areas. A commitment to further agricultural intensification is a necessary result of population growth.
- Modification of policy and regulatory frameworks that encourage inappropriate resource use, such as price distortions in agriculture and forestry. Forestry pricing reform is particularly important given the trade bias in some Asian countries that encourages excess logging.
- Strengthened land tenure. Clarification of property rights is critical as population pressure increases, open access and communal property rights systems break down, and land values increase.
- Improvements in the public sector capacity to design, target, implement and ensure compliance with resource management programs. In addition to agricultural and forestry institutions, agencies charged with managing protected areas also need support.
- Encouragement of public participation in decisionmaking through the promotion of education, mass-media coverage, NGO involvement, consultation with community-

based farmer and land management groups, and local conflict resolution.

- Promotion of social programs in education, health, and population planning to help settle rural populations, and provide options that enable them to take a longer-term perspective in managing their family and land resources.

Implementing the Strategy

To undertake this ambitious strategy, the serious weaknesses and biases in public institutions noted in the previous section must be addressed. From the outset, it should be recognized that this strategy will fail in the absence of strong political commitment to rural sustainability. The agenda is too complex (requiring, for example, long-term commitment to introducing new production technologies) and politically charged (because of the high political cost of reducing "rents" in the forestry sector, of addressing community conflicts in protected areas, of facing the equity aspects of strengthened land tenure, and so on) to succeed otherwise.

To undertake this ambitious strategy, serious weaknesses and biases in public institutions must be addressed. Examples of shortcomings were cited above. It is not recommended that the powers of public sector agencies involved in agriculture, forestry, and park management be greatly expanded. Rather, existing institutions need to be recast and made more responsive to the wider range of issues at hand, including extension and other forms of information dissemination, applied research, decentralization, and participation.

Applied research and extension and other forms of information dissemination. The single greatest institutional need is to strengthen the ability of both agricultural and forestry institutions to conduct applied research, and provide information and extension services to farmers and foresters on locally relevant technical innovations. This alone is an enormous challenge. The lack of area-specific trials and demonstrations, particularly on marginal lands, has contributed to current degradation. Traditional extension services have not been adequate, and innovative approaches—such as FAO's bottom-up, or "learning by doing" integrated pest management approaches in Indonesia and the Philippines—are only now being tested in new and varied circumstances. There are expanded roles that the private sector can play in providing information to farmers as well. The technical agenda for research and demonstration is elaborated in the next section on technical issues.

Institutional requisites of strengthening resource tenure. Even though broad-based land reform is not on the Asian political agenda, more modest approaches are being pursued. Most involve forms of community management, improved land titling (which may be very difficult in the cases of traditional peoples and recent migrants), revised terms on leasing arrangements, and the creation of land markets. Legal channels to enforce land ownership and lease arrangements will become even more important. Since land reform is often contrary to equity considerations, the need for a rural safety net to address the needs of the landless poor will also be needed.

Expanded professional skills within forestry agencies. The professional focus of forest agencies needs to be widened to include management objectives other than production. Policy analysts need to link forestry issues with issues raised by agriculture, livestock and water agencies. Staff trained to deal with social and participation issues—including modes of linking local communities and commercial forestry interests—are in short supply. In spite of the economic and social importance of forests in Asia, forestry agencies do not yet command the full range of issues that need to be addressed.

Legal and administrative strengthening of agencies charged with protected area management. Legal, physical, and financial means are needed to improve the ability of agencies to manage protected areas. The legal and political support given to park managers is typically weak, particularly in terms of enforcement against encroachment. Conservation responsibilities normally reside in forestry

ministries and agencies with a production focus rather than conservation. Improved physical techniques involve incorporating communities on the perimeter of protected areas in integrated conservation and development projects (ICDPs). To date, there have been few initiatives to resolve conflicts between protected areas and people, or to involve community groups and NGOs in protected area management. Improved financial management includes broadening the agencies' financial base to support parks and protected areas, through such channels as direct fundraising, international NGO support, and ecotourism development.

Decentralization of decisionmaking and public participation. The design and implementation of agricultural, forestry, and integrated conservation and development projects benefit from the devolution of planning down to the local level. Techniques such as rapid rural appraisal can be used in problem definition, and participation in project design and implementation. Agricultural and forestry technologies, particularly on marginal lands, are highly location specific, and the greater involvement of local organizations in trials, demonstrations, and dissemination of results is important.

Public infrastructure investments. One last issue concerning rural land use is the need for better analysis of the impact of public infrastructure investments—such as roads, irrigation, electricity, and markets—on land use and settlement patterns. In the absence of direct controls on land use (such as zoning in urban areas), decisions on public investment and leasing of public lands have profound land use impacts. More careful assessment of the environmental and social impacts of investment projects, together with more careful attention to the economic incentives awaiting those coming in the tracks of infrastructure development, are recommended.

Technical Approaches to Land Resource Management

The technical objective of land resource management is to try to match actual land use with the agro-ecological characteristics of the land. Earlier, this report divided rural land types into: (a) high-yield irrigated cropland; (b) lower-yield lands, covering a complete spectrum from rainfed agricultural land, to grasslands, to degraded forests, and to combinations of the above; and (c) natural forests and other natural habitats. Far less technical research and development has been focussed on marginal lands (category b) than on high-potential land, although both are important for food production. In the case of natural forests, technical questions center around the need to balance the wood and nonwood requirements of industry and society with the urgent need to protect pristine habitats and biodiversity.

Irrigated Cropland

The objective of sustainable intensified agriculture in high yielding irrigated cropland areas is to achieve an equilibrium between high output and conservation of the resource base, through careful management of external inputs. Priorities are to: maximize biological fixation, increase efficiency of fertilizer use, improve weed control, improve water management at the farm level, and substitute agronomic and biological tools for chemicals to control pests. There are two priority environmental problems that need to be addressed in irrigated areas: sustainable intensification, and waterlogging and salinity.[21]

Sustainable Intensification. Intensified agricultural systems in Asia's high-potential lands will be increasingly science-based. Increased attention to sustaining soil fertility is crucial. More careful calibration of fertilizer needs—such as the balance between the three main components of fertilizer—can lower application rates while improving yields. Integrated agricultural and livestock systems, involving both foraging and use of manure, are promising in some irrigated areas as well as in rainfed areas with integrated livestock. Improved germplasm will contribute to local yields not only in foodcrops, but in specialty cash crops and perennials.

Improved crop protection combined with reduced pesticides use is important for both financial and environmental reasons. This can be achieved without sacrificing pest control, given sufficient understanding of local pest "hot-spots" and integrated pest management (IPM) (box 6.5). However, since conventional pesticides will not be eliminated, better safeguards are needed: while countries in Asia generally have pesticide regulations, implementation is often weak.

Controlling Waterlogging and Salinity. In saline soils, excess salts can be removed from the root zone by simultaneously leaching with water and lowering the water table (box 6.6). Drainage is an important component of any reclamation strategy. Prevention of waterlogging and salinity is similar to rehabilitation: it is achieved through more frequent but light irrigations, higher soil moisture regimes, and conjunctive use of both surface and groundwater.

Irrigation water is widely subsidized in Asia, a major cause of the inefficient irrigation practices and overuse of water that leads to salinity and waterlogging. While charging the economic price for water may not be a practical option, it is important to move at least toward recovering operating and maintenance costs as a measure to reduce

Box 6.5: Elimination of Pesticide Subsidies in Indonesia

In 1985, the Government of Indonesia was subsidizing pesticides at 82 percent of the retail price at a total cost of $128 million. This encouraged intensive use of pesticides by farmers: between 1976 and 1985, use of pesticides increased by 76 percent. Pesticide resistance set in. In Sevin, pesticide use wiped out the natural predators of the brown planthopper and as a consequence millions of tons of rice were lost to a pest considered not a serious threat a few years ago. In 1976 alone, 364,000 tons of rice valued at $100 million were lost.

In 1986, the Government banned fifty-seven brands of insecticides, twenty of which were heavily subsidized by Government, and restricted use of others. Integrated Pest Management was declared as a national pest control strategy. Three planting seasons later, FAO reported a 90 percent reduction in pesticide use, and average yields increased from 6.1 tons per hectare to 7.4 tons.

Source: ADB 1991b.

Box 6.6: Salinity Control and Reclamation Projects (SCARPS) in Pakistan

Problems of waterlogging and salinity, resulting from extensive canals and irrigation, were identified as crucial environmental problems in Pakistan as early as the 1950s. Out of the gross command area of 41.2 million acres in the Indus Plain, it was estimated that about 6.6 million (16 percent) were affected by severe surface salinity, and about 13.8 million (33 percent) by moderate surface salinity. About 15 million acres were estimated to have water tables less than 10 feet from the surface, much of it with water tables of less than 5 feet. As the Plain is underlain by a vast highly transmissive aquifer, vertical drainage by tubewells is the best means to lower the groundwater depth. In most of the aquifer area, the groundwater is still usable for irrigation directly or by mixing with canal supplies—thus allowing the water being pumped for drainage to be used beneficially to supplement irrigation supplies. It is only in the saline groundwater areas that the disposal of the saline effluents poses problems.

In 1961, Pakistan initiated the first large-scale SCARP. Subsurface and drainage facilities have been completed in 14.4 million acres at a cost of $1.7 billion (1990 dollars). Investments in usable groundwater areas had a demonstration effect, with the result that the installation of private tubewells also increased dramatically since the early 1960s. Presently there are over 280,000 private tubewells on the Indus Plain, two thirds of which are located in the irrigated areas. While primarily installed for supplementing irrigation supplies, they also have positive impacts on lowering the water table. Private tubewells pump out an estimated 24 million acre feet of water annually as compared to 11 million acre feet from the 14,996 public tubewells.

By 1980, the combined SCARPs and private tubewells have had some impact on salinity, as the severe areas had fallen by half, to 8 percent of the total area. Some previously affected lands were brought into production. However, SCARP performance during the 1980s has declined due to poor management and reduced pumping. In 1990, there were still about 6 million acres in 1990 with a water table depth of less than 5 feet—an increase over previous years. Although the government still encourages private pumping, there is no private incentive to do so in saline areas. Further public investments of $340 are currently underway, and still more will be required. The waterlogging and salinity problems in Pakistan are not yet solved.

Sources: Ahmad and Kutcher 1992; ESCAP 1992; Mott MacDonald 1992.

the demand for water. Besides efficiency considerations, this will also ease the pressure for new water development projects. An integrated approach to water resource management is discussed in chapter 7.

Marginal Lands

The emphasis in Asia on agricultural intensification should be matched by a parallel, and in many ways more difficult, emphasis on appropriate cropping on marginal (upland and rainfed) agricultural lands. Priority lands are those that are *not* yet heavily degraded, but rather still suitable for sustainable use provided that adequate conservation steps are taken. In the case of marginal lands, as elsewhere, prevention is much cheaper than reclamation.

For marginal lands remaining in production, the strategy for more sustainable use should be: (a) encourage productive activities that suit the land's potential, are profitable, and are environmentally sustainable; (b) encourage farmers to invest in soil conservation, through research and demonstration of low-cost, short-term measures; and (c) protect (and over time, upgrade) forest reserves on marginal lands that have high biodiversity value and/or little potential for agriculture. Each of these topics is addressed below.

Appropriate cropping on marginal land. Rainfed cropland is not one land type. Rather, there are infinite gradations of lands that can be, at one extreme, profitably cultivated on a sustainable basis, to low potential land that should revert to managed shrubs, trees, or grassland—or, at a minimum, a long fallow system. Therefore, it is difficult to discuss cropping on marginal land in any degree of generality.

Nevertheless, various models exist for developing agriculture on marginal lands, usually involving systems of diversified combinations of shrub, tree and other crops. Perennial crops are ideally substituted for annuals, given their much greater drought tolerance and soil conservation characteristics. In degenerated swidden areas, there are opportunities for taungya cultivation (crops are cultivated between tree plantings, and as the trees grow the farmer is given a new piece of land to repeat the process), fallow period management, intensive mixed cropping and perennial cropping. The difficulty of this strategy is that such cropping models are highly site-specific, and need to be tested and adopted locally—preferably as part of a strengthened extension system working with farmers. They also cannot be considered outside of available markets and the need to return profits.

Soil Moisture and Erosion Control. Lack of vegetative cover and cultivation without conservation practices is the major reason for soil erosion. Erosion can be checked by controlling either the detachment or transportation of soil particles. Detachment can be controlled by relatively inexpensive agronomic measures such as mulching (assuming local supplies of excess biomass), cover cropping, strip cropping or relay planting. These also benefit the soil by building up organic matter, which helps protect it from erosion by absorbing and binding the soil together. However, in areas where rainfall is heavy and slopes are steep, run-off is unavoidable and will still carry loose soils away.

Structural measures such as bench terraces, check dams, gully plugs, and diversion ditches, are widely used in Asia to control runoff, but mainly on higher potential land. They are far less cost-effective on lower potential land, for a variety of reasons: (a) high investments in terms of capital and labor are required (the cost for terracing in Indonesia is estimated to be about $400–1000 per hectare); (b) failure to relate soil type, rainfall, and crop characteristics results in structural failure; (c) inadequate drainage increasing runoff and damage (farmers are often reluctant to lose the 3–5 percent land that is required for adequate drainage); and (d) the construction process usually exposes infertile subsoil, which reduces yields in the early years of the structure and is an additional cost to the farmer.

On marginal lands, therefore, alternative approaches to soil erosion control that are low-cost, short-term, and easily adopted by farmers are far

more attractive. Some of the most promising approaches involve vegetative technologies (contour planting, plant grass and legumes, vegetative crop cover management, contour hedges and contour farming) and forestry investments (afforestation, community forestry, wasteland plantations, fuelwood plantations). Several species have been proposed for conservation use, including napier, vetiver grass, and the tree species Leucaena. Vetiver grass seems particularly well suited for this application (box 6.7).

Vegetative systems have other advantages over structural systems than their low cost. Unlike structural measures which require detailed site planning, vegetative measures require relatively less technical input. Individual farmers can proceed under their own initiative. Data from Maharashtra, India, show that soil loss decreased by 38–73 percent with the use of vetiver grass. Data from Karnataka, India, shows that on a contour cultivated field with vetiver grass, the soil's wilting point was delayed by 14 days, yields of finger millet without fertilizer increased by 25 percent (and with fertilizer increased by 57 percent). It is likely that a significant proportion of the yield increase attributed to vetiver grass system results from the accompanying practice of contour cultivation.

Rehabilitation of degraded forest land. Large-scale reforestation and afforestation projects are becoming increasingly viable in mildly degraded areas of China and India, for reasons relating to both financial profits and environmental protection. Higher-yield commercial plantations managed by the private sector reduce the pressure on natural forests. In India, new policies forced industry to get supplies of forest raw materials from private farmers and through community-based social forestry schemes. On private farmlands, dramatic changes have taken place with individuals practicing agroforestry and block planting. Thus, forestry programs have demonstrated the ability of the rural population to respond privately and collectively to opportunities and incentives.

Box 6.7: Vetiver Grass

A plant suitable for use as a vegetative barrier has to possess a variety of morphological characteristics: the root system should be aggressive and deep so as not to spread out of line; the crown should be below the surface for protection against fire and overgrazing; the culms tough and unattractive and tough to animals and pests; and the flowers, if any, essentially sterile so as not to permit spreading by seed.

A plant, in use in India as hedges for nearly two hundred years, meets all of the above criteria. Vetiveria zizanoides (vetiver grass) is a densely tufted, awnless, wiry, glabrous perennial grass that is a "shy breeder" and is considered sterile outside its natural habitat of swampland. It is easily adapted to a wide range of climatic and soil conditions and hence persists for a long time without any maintenance. It is propagated by root slips which the farmer may plant himself in roughly surveyed contour lines. Given moderately favorable conditions, the hedge would be complete after three growing seasons, fewer with higher fertility, high rainfall and close planting.

Vetiver has been tested in field in many countries with success—Australia, Brazil, China, India, Indonesia, Madagascar, Nigeria, and the Philippines, to name a few. Soils and climates vary tremendously within this group. For example, in China, vetiver is being grown as hedges on 60 percent slopes to protect tea and citrus crops on low pH (4.1) red soils. In India, it is being used successfully on black soils (severely cracked vertisols) on slopes of 2 percent or less. Recently, the King of Thailand expressed his intention to encourage vetiver planting to control erosion in the hills of North East Thailand.

Establishing and maintaining the system is low-cost and can be carried out entirely by the farmer with very little external inputs or cooperation with neighboring farmers. Costs for establishing vetiver grass hedgerows in India are estimated to be about $18 per hectare. Economic returns can be quite high: recent analysis shows that while the economic rate of return from earthen bunds is about 22–28 percent, vetiver grass is in the range of 87–95 percent.

Source: World Bank 1990c.

Natural Forests

Management and technical issues concerning natural forests center around the need to balance the wood requirements of industry and society with the urgent need to protect pristine habitats and biodiversity. As previously mentioned, tropical forest wood is significantly underpriced by governments in almost every Asian country with substantial forest resources. A more full-cost pricing policy would both raise revenues and encourage more careful management of remaining natural forests along commercial, environmental, and social grounds.

Within Asia's natural forests, the rights and concessions of indigenous people need protection. At the same time, to relieve pressures on natural forests, it is imperative to research and demonstrate natural forest management approaches among indigenous and local populations. Such approaches, although widely discussed, are not often viable. Additional work on local management techniques and/or contractual concessions with outside commercial interests is required.

While sector reforms and investment priorities need to be country specific, the World Bank recommends two modes of strategic interventions, based on whether a country is has (a) a forest-surplus or (b) a forest-deficit status (those importing wood and wood products).[22] While the emphasis in forest-surplus countries should be on natural forest management, the focus in deficit countries should be on afforestation and compensatory forestation programs.

Forest-Surplus Countries. Fiji, Indonesia, Lao P.D.R., Malaysia, Myanmar, Papua New Guinea, and the Solomon Islands have significant areas of tropical rainforests remaining, and are capable of exporting wood in significant quantities. These countries demonstrate poor compliance with terms and conditions of logging concessions; inappropriate logging incentives; weak coordination of forestry, industry and trade policies; pricing and institutional policies that result in poor public land management; unresolved problems of land-use classification; and inadequate capacity to delineate and manage protected conservation areas. In these countries, the Bank recommends maximizing the area retained as functioning forest cover and preserving adequate areas for biodiversity, catchment, and dwelling sites for indigenous people. Commercial policies, including fees, trade policies, and regulation of public lands, need to be put onto a more-sustainable footing, using a more complete accounting of the economic costs of current practices.

Forest-Deficit Countries. The remaining countries in Asia, including China and India, are forest-deficit countries. Most of the wood consumed in this group is for fuelwood, paper and building purposes. Large reforestation and afforestation projects are expanding in order to meet local market requirements, and to avoid potentially far costlier wood import bills. On the basis of recent rates of deforestation and plantation establishment, it is estimated that total investment requirement for plantation management in Asia will be about $4 billion per year. Large-scale reforestation is also needed in forest deficit areas of some of the forest surplus countries, such as peninsular Malaysia and parts of Indonesia.

Conserving Biodiversity

The most effective way to protect biodiversity in the region is through the provision of secure habitats. The general strategy to improve biodiversity conservation (summarized above) emphasizes the institutional requirements to improve protected area management. This section looks more into the selection of protected area sites.

Asia has made solid progress in the allocation of land for protected areas. The number of protected are sites has increased from 300 (covering 477,000 square kilometers) in 1960, to 873 (covering 836,000 square kilometers) in 1992.[23] However, as indicated above, the presence of protected areas is in no way an indication of biodiversity protection. Many of these areas are paper parks, and some do not correspond with con-

centrations of significant biodiversity. Also, many important habitats such as wetlands and marine areas are not adequately protected.

The selection of protected area sites should be based on a variety of factors—the importance of each resource and degree of threat; availability of information; institutional strength and absorptive capacity; local conditions; ability to mobilize resources; and social and political factors. Also, the use of endowments or trust funds should be explored for countries where financial resources are limited. Most urgent biodiversity needs in Asia are being addressed through the preparation of Biodiversity Action Plans in China, India, Indonesia, Nepal and Viet Nam.

The highest priority countries for biodiversity interventions are those with the greatest species and ecosystem diversity—China, India, Indonesia, Malaysia, Papua New Guinea, and the Philippines. Countries or areas with large number of endemics also belong to the high priority category—Bhutan, Nepal, Sri Lanka and the Pacific Island nations.

Countries in mainland southeast Asia with modest species richness and endemism— Cambodia, Lao P.D.R., Myanmar, Thailand and Viet Nam—have lower priority for international intervention in biodiversity. Nevertheless, in this region, there is an important need to study the linkages between logging and biodiversity protection among these countries. In Bangladesh, another lower-priority country, attention is needed to manage and protect the Sunderbans mangrove swamps.

The World Bank's Role in Natural Resource Management

The Bank has played a key role in natural resource management in Asia, through a variety of sectors: irrigation, agriculture credit, tree crops, social forestry, technology development and dissemination, and agricultural and forest sector reform. During 1990–92, the environmental components of agriculture, forestry, and biodiversity projects were $512 million (about 24 percent of the total lending in land resources), divided between $334 million in East Asia and $178 million in South Asia (figure 6.3). Projected lending for fiscal 1993–95 is nearly double (92 percent higher), divided between $696 million in East Asia and $286 million in South Asia. In both regions, lending for forestry and watershed projects is greater than lending for soil conservation and sustainable agriculture.

Cropland Management

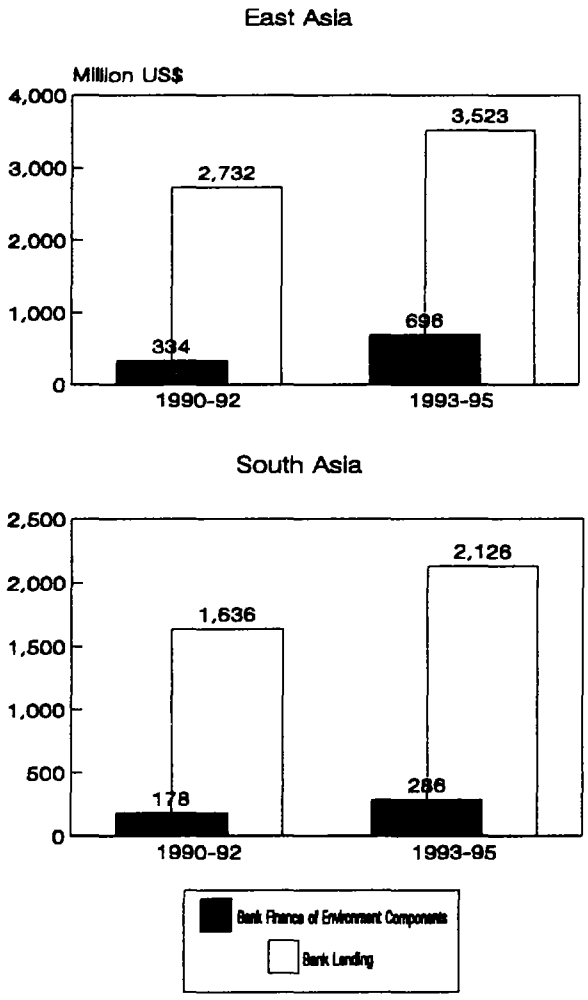
In East Asia, prior to China's membership in the Bank, much of the lending was for perennial tree crop development, agricultural credit, irrigation and drainage, and technology development and dissemination. In South Asia, the Bank has made major investments in irrigation. Long-term support by the Bank has also resulted in significant expansion of extension services in all South Asian countries, as well as some research and training.

However, many of these developments took place at a time when environmental problems were not considered and the objective was to exploit natural resources as rapidly as possible to accelerate economic development. The Bank, with some exceptions, did not fully appreciate the level of depletion taking place. Most investment projects were viewed in isolation from wider contextual issues. For example, irrigation projects diverted water at the expense of other sectors, without adequate analysis of the impacts.

Past approaches were heavily centralized, top down and generally did not include the participants in project planning and implementation. Work on institutional issues—such as credit allocation and loan recovery; subsidies, particularly for fertilizer; irrigation management; organizational efficiency; land tenure; and appropriate roles for public and the private sector—was in early stages of development. As a result, many agricultural development projects failed to achieve the environmental, social and economic benefit levels that had been expected.

During the 1980s, Bank agricultural, forestry and rural development projects began including components to deal with environmental problems. Soil erosion, especially in the uplands, was recognized as a serious problem affecting productivity,

Figure 6.3: Bank Lending in Land Resources in the Asian Regions, Fiscal 1990-92 and Fiscal 1993-95



Note: includes irrigation, drainage, agriculture, forestry, biodiversity, and watershed management.

and was addressed through watershed development projects. However, resource transfers and incentives for upland farmers to undertake improved conservation measures rarely worked. Technical and institutional approaches that are low cost and easily adopted by farmers proved most successful (box 6.8). It was also learned that it is important to get the scale of the watershed interventions right:

Box 6.8: Vetiver Network

The Agricultural Division in the Asia Technical Department has established a Vetiver Information Network. The network publishes the Vetiver Newsletter to disseminate information and experiences with vetiver for soil and moisture conservation purposes. The network also gives Vetiver Incentive Awards to farmers who demonstrate innovative conservation measures with vetiver, and to researchers for work related to the area. The King of Thailand contributed to the 1993 awards.

recent watershed and soil conservation efforts have focussed on micro-watershed investments which are profitable at the local level, rather than larger investments that are only beneficial when one includes downstream benefits.

Irrigation efficiency issues are addressed through Irrigation Systems Rehabilitation and other Water Management projects. Building on the Pakistan experience (see above, box 6.6), waterlogging problems have been addressed in India through drainage components in irrigation projects since the mid 1970s. Major components were included in the Narmada Water Delivery and Drainage Project (fiscal 1985) and the Punjab Irrigation and Drainage Project Phase II (fiscal 1990). In recent years, some Bank-assisted projects in China contained components to deal with irrigation and drainage problems. Bank assistance in IPM has been limited—in Asia, the only project carrying an IPM component was the Pakistan Agricultural Research II Project (fiscal 1990).

Forestry Management

Early forestry projects were timber extraction projects, land settlement projects, logging operations and some technical assistance. Beginning in the 1970s, following the energy crisis and with the focus on poverty alleviation, the lending focus shifted. From 1979 to 1990, nearly 52 percent of forestry lending was for social forestry. In India and Nepal, the focus has been on social forestry to increase fuelwood, small timber, fodder, and other forest products. In Bangladesh and Sri Lanka, the

emphasis has been on improving the management of existing forests and plantations, establishing plantations, and training. The focus on plantations has been strongest in East Asia (China, Indonesia, Malaysia, and the Philippines).

The emphasis on forestry as part of an integrated approach to address rural poverty through social forestry components led the Bank to give lower priorities to other aspects such as international trade, industrial raw material, rational exploitation of existing forests, efficient utilization of forest revenues, and environmental problems. The Bank has worked largely within the institutional structure of the borrowers' forestry sector, and their level of technology. Unlike tree crop and agriculture projects, the Bank's forestry projects did not place sufficient emphasis on the use of high quality planting material and good nursery practices.

The recent *Strategy for Asian Forestry Development* (1992) is more systematic. In Asia's forest-surplus countries, the Bank will not be involved in direct investment in logging in primary moist tropical forests. However, the Bank will assist in the adaptation and management of environmentally sound harvesting techniques in areas to be managed for sustained yields. The Bank will also support price and revenue policy reform, involvement of local communities, and development of management techniques to encourage sustainable management of forests.

In the forest-deficit countries of India and Sri Lanka, and to a lesser extent Bangladesh, the Bank plans to continue to assist sector reform, institutional development, concession management, and research. In Nepal, lending will focus on forestry development in the Terai, where there is encroachment on forest areas by farmers. In China, the National Afforestation Project drafted environmental guidelines for plantation management that address species mix, soil conservation, pest and fire control, and biodiversity.

Biodiversity Conservation

The 1986, the World Bank adopted a Wildlands Policy stating that it would not finance any project that would convert wildlands of special concern. In 1991, the Bank adopted a policy that "the Bank will support initiatives to expand forest areas allocated as parks and reserves and to institute effective management and enforcement in new and existing areas."[24] The *Asia Regional Forestry Strategy* (1992) also supports maximizing the area retained as functioning forest cover, and preserving adequate areas for biodiversity. The biodiversity strategy paper (Braatz 1992) underscored the Bank's comparative advantage in policy analysis and suggested that the Bank can contribute to biodiversity protection through country studies and national biodiversity action plans. The Bank is also well placed to support efforts to reconcile the needs of people with those of conservation.

The Bank's involvement in projects or programs directly focussed on conserving biodiversity dates from the late 1980s. Between 1988 and 1992, there were fourteen Bank projects in Asia with substantial biodiversity components, in Bangladesh, China, India, Indonesia, Malaysia, Nepal, Pakistan, Papua New Guinea, the Philippines, and Sri Lanka. Recent economic and sector studies have addressed biodiversity issues in China, Indonesia, the Philippines and Sri Lanka.

The single most influential factor for the increase of the Bank's involvement in biodiversity (together with UNDP's and UNEP's) has been the establishment of the Global Environmental Facility (see chapter 2, box 2.7). GEF has increased awareness and provided incremental resources for biodiversity programs and projects. Most biodiversity project components to date focus on wildlife protection and protected areas management as part of agriculture and natural resource (mostly forestry) projects. Also, in cooperation with the World Wildlife Fund-US, the Bank initiated the Human Resource Development for Protected Areas Management Program to develop conservation training programs for countries in the region.

Notes

1. WRI, UNEP, and UNDP 1992, p. 290.

2. ESCAP 1992.
3. World Bank 1990a.
4. Some observers indicate that this estimate is high.
5. ADB 1991a.
6. FAO 1989.
7. Pingali 1989.
8. HCH is a brand name for the pesticide benzene hexachloride (BHC), which is banned in the United States.
9. FAO 1989.
10. FAO 1989.
11. Braatz 1992.
12. World Resources Institute, World Conservation Union, and UNEP 1992.
13. See, for example, recent work on the poverty and environment nexus and the economics of the "frontier," such as articles by Mink (1993) and Schneider (1993).
14. Crosson and Anderson 1992, p. 19.
15. Slade found systematic evidence that environmental externalities lead to the underpricing, and hence overproduction and use, of natural resource commodities (Slade 1992b).
16. This argument applies to both the rural poor and the larger landholders who may allow sharecropping, but for different reasons. For the rural poor, the short-time horizon is a consequence of the struggle for day-to-day survival. Larger landholders often have well-diversified interests in other sectors, such as commerce and industry, and the rate of return on investments in natural resource conservation falls well below the opportunity cost of their capital.
17. Anderson and Thampapillai 1990, p. 11.
18. Pingali 1989, p. 253.
19. Crosson and Anderson, 1992, p. 82.
20. Grimshaw and others 1993.
21. The broader issues of soil degradation, including erosion, compaction, loss of moisture retention, and loss of nutrients, are addressed under "marginal lands."
22. World Bank, 1992b.
23. Braatz 1992, pg. 14.
24. World Bank 1991a.

7

WATER RESOURCE MANAGEMENT

Water resource management is critical to Asia's economic growth. More than a third of the cropland is irrigated, and produces nearly three quarters of the region's food. Nearly 20 percent of electricity is generated from hydro-electric sources. Domestic consumption and sanitation, industry, transport, fisheries, and aquaculture all place requirements on water resources. The quality of available supplies is decreasing, exacerbating the gaps between supply and demand is increasing. Public efforts to close these gaps require large water resource development projects. While these projects provide economic and social benefits, they can also have adverse social and environmental impacts that must be considered. This chapter outlines the magnitude of water resource and water related environmental problems in Asia, and describes approaches to environmentally and socially sound water resource management.

Water Resource Problems

The most important problems in the water sector are water scarcity caused by increasing demand and deteriorating quality, and water allocation between sectors. These problems are evidence of the strains placed on Asia's water resources by rapid population, urban, and industrial growth. The magnitude of investment—tens of billions of dollars—proposed to keep abreast of these problems is evidence of their immediate cost on the economies of Asia.

Water Scarcity

On average, water resources are relatively abundant in the Asia, except in Afghanistan, Pakistan, and the semi-arid regions of northwest India and northwest China. There are also local scarcities, especially in the more-developed regions which have moderate rainfall and large populations, such as south India and north China. The long-term problem in India is illustrated in box 7.1, where projected demand for water in 2025 is about 45 percent of total renewable resources—a proportion that is significantly higher than can realistically be developed without extraordinary investment in infrastructure.

Many large Asian cities such as Beijing, Jakarta, Madras and Karachi, have water scarcity problems that are particularly acute. In the North China Plain, available water resources are simply inadequate to serve the projected populations and industries of Beijing and Tianjin without sacrifice of water supplies to agriculture. Jakarta has long overdrawn its groundwater—leading to saltwater intrusion—and faces the need for large expenditures to develop distant surface water sources.

Water Supply. The total renewable water resources (average annual flow of rivers and recharging of groundwater) in Asia is several times annual withdrawals. However, since rainfall and population are spread unevenly, per capita availability varies from 200,000 cubic meters in Papua New Guinea to below 3,000 cubic meters in Afghanistan, China, India, Korea, Pakistan, Sri Lanka and Thailand (figure 7.1). The low per capita availability in India and China it is due to large populations more than aridity.

Rivers, the most frequently used source of freshwater supply, have highly variable flows and need regulation by dams and reservoirs to develop their full potential. Such regulation often has social and environmental impacts, and is particularly problematic when the river is, as often the case in Asia, shared by two or more countries. Figure 7.2

Box 7.1: Water Demand in India

The total amount of water available to India is about 2,085 billion cubic meters, 1,850 billion of which is from internal sources and 235 billion from international rivers. The amount of runoff in India's various basins vary widely, reflecting the spatial distribution of annual rainfall. Most river flow is during the monsoon. In peninsular India, where there is no snow melt runoff, river flows fall off dramatically toward the end of the dry season.

Demand for water is projected to nearly double by 2025 (see below), rising to 45 percent of total available water. The largest increases in demand are expected in agriculture (a 64 percent increase over 40 years) and industry and urban (a combined increase of 135 percent). Agriculture is expected to consume 83 percent of the total. Some conflicts between industry and irrigation are already developing, as in the Bihar part of the Subarnarekha basin. While the domestic water requirement is not high in relation to India's total water resources, local areas of high demand create problems. The megacities of Bombay, Delhi,, and Madras, and the large cities in peninsular India suffer from water scarcity. In the drought-prone areas of India, the provision of domestic and livestock water supplies are a problem during extended dry seasons. The following chart shows trends in water demand projected through 2025.

	1985 Demand		2025 Demand	
Sector	(billion cubic meters)	%	(billion cubic meters)	%
Agriculture	470	94%	770	83%
Livestock and domestic	17	3%	40	4%
Industry and Urban	14	3%	120	13%
Total	501	100%	930	100%
Total demand as percentage of total availability		24%		45%

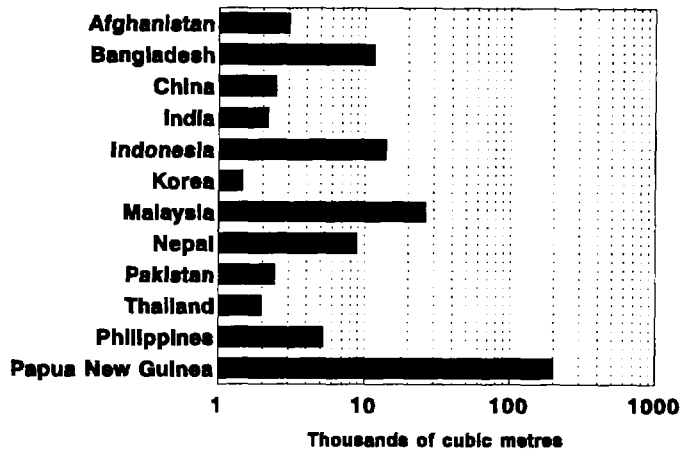
To meet future demand, there are plans to construct additional dams and water transfer projects. It is estimated that about 160 dams higher than 30 meters are under construction in India. Future large dam construction, however, will encounter increasing problems associated with environmental impacts and high social resettlement costs. Large water-transfer schemes have also been designed to address shortages in peninsular India and the Ganges basin, although implementation is still subject to careful economic, environmental, and social assessment. Transfer schemes also create tensions between political jurisdictions, a factor in the Narmada series of dam, water supply, and irrigation projects. However, at least three smaller water-transfer projects are underway: (a) the Telugu Ganga, to transfer water from the Krishna to the Pennar for irrigation and then to Madras for water supply; and (b) two schemes to transfer water from west-flowing rivers in Kerala to Tamil Nadu.

Overall, India's current policies do not fully address the larger supply and demand issues. Projected demand—45 percent of available supplies—is an unrealistic goal given the high cost of resource development that this percentage implies. A broader set of instruments and policies, utilizing pricing, conservation, and integrated resource planning, will be required to reduce both projected demand and the overall cost of increasingly expensive infrastructure investments.

shows the drainage area and per capita flows of the major Asia river basins. Lakes are important sources of irrigation and water supply in some areas, such as Laguna de Bay in the Philippines, Lake Songkhla in Thailand, and Lake Dongting in China. Many areas of Asia have high volume groundwater aquifers but these can be over-exploited. For example, it is estimated that Indonesia has an exploitable groundwater potential of over 450 billion cubic meters per year, yet overexploitation in the Jakarta region has caused salt water intrusion and contaminated wells as far inland as 5–10 kilometers from the coast.

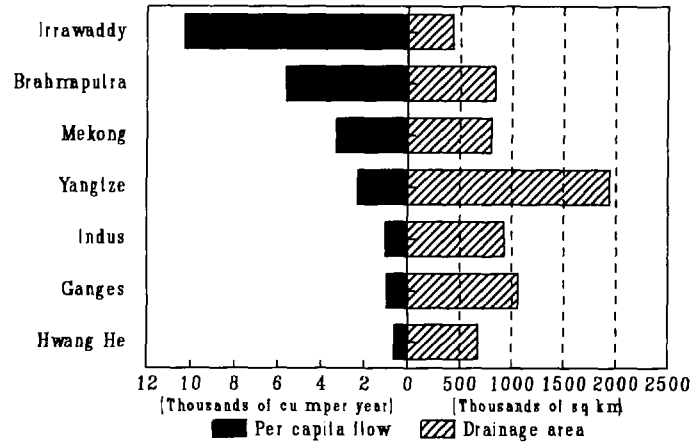
Water Quality. Water quality and water scarcity issues are closely linked: downstream water supply scarcities—and costs—are directly affected by the pollution generated by upstream activities (box 7.2). (While there is very little surface water anywhere in the world that can be consumed without treatment, the degree of surface water pollution obviously dictates the extent of treatment required, or the magnitude of the effort to tap alternative sources.) Downstream users can either increase their expenditures to avoid or treat the effects of upstream pollution, or they can try to limit upstream pollution. To date, the former is the more common

Figure 7.1: Per Capita Availability of Water in Selected Asian Countries



Source: WRI, UNEP, and UNDP 1992.

Figure 7.2: Major River Basins in Asia



Source: ESCAP 1992.

response.

Deteriorating water quality is probably the most serious environmental problem in Asia. Polluted water, in light of the limited coverage of treated water supply in Asia, is a leading cause of morbidity and mortality, particularly among children (see chapters 1 and 3). While untreated sewage is the most significant source of organic pollution, industrial pollution contributes a much wider range of pollutants (chapter 4).

In several urban areas in Asia, water *quality* is a more binding constraint than water *quantity*. Box 7.3 illustrates the case of Shenyang, China. In Bangkok, the city water intake in the Chao Phyra is being moved upstream to avoid the industrial wastes now degrading the present intake. Although low levels of domestic waste in the municipal water sources can be removed at reasonable cost, heavy metals and other toxins found in industrial waste and agricultural runoff can not. Groundwater, the primary alternative to polluted surface water, is increasingly contaminated by human waste, leaching of chemicals, and saline intrusions caused by overpumping.

Impacts on the Marine Environment. In addition to direct impact on human health, polluted water has deleterious consequences for the water ecology, affecting both biodiversity and human welfare. Asian inland fisheries are economically important, but harvests (which have increased from 4 million tons in 1975 to 8 million tons in 1987) are approaching nonsustainable levels. The coastal marine ecology suffers seriously from urban and industrial pollution, most of which originates from the high concentration of Asian populations along coastal zones (box 7.4). Waste from ships is also is a serious source of marine pollution especially near ports and along shipping lanes.

Water Demand. The largest demand for water in Asia is from irrigated agriculture, which accounts for 60–90 percent of the annual withdrawal in most countries in the region (figure 7.3). Only in Bhutan and Malaysia is the share of agricultural use below 60 percent. Water consumption for domestic purposes (drinking, cooking, washing, and sanitary purposes) ranges from 20 liters to 200 liters per capita per day, depending on the level of affluence

Box 7.2: Water Quality Constraints in the Hun-Taizi River Basin

The Hun-Taizi River Basin forms the heartland of Liaoning Province in northeast China. It has a population of 12.5 million people and contributes significantly to China's heavy industrial output in iron and steel, coal, power generation, petroleum and petrochemicals, metallurgy and machinery. Most of this activity is based around the six urban centers in the Hun-Taizi Basin: Shenyang, Fushun, Benxi, Laioyang, Anshan and Yingkou. The Basin is also an important agricultural area, with well-developed systems for surface water irrigation.

Due to shortages in freshwater supply, irrigation water already includes large proportions of municipal and industrial wastewater. More than 80 percent of the urban wastewater is returned to the river basin untreated, and 60 percent of the wasteflow consists of industrial effluent. Because of the increasing need to reuse surface water due to the limited availability of freshwater in the basin, and the very high cost of diverting water from other basins, surface water quality was identified as a constraint in a comprehensive water resources study conducted in 1988. The study called for selected investments to provide safe municipal drinking water supply for these cities, and wastewater schemes for three additional cities.

Box 7.3: Increasing Costs of Water Supply in Chinese Cities

It is estimated that the cost of water supply to Shenyang will increase from $0.04 to $0.11 per cubic meter between 1988 and 2000, a 200 percent increase. The main reason is that the groundwater from the Hun Valley Alluvium, the current water source, has to be rejected as a source of potable water for reasons of water quality. As a result, water will have to be conveyed to Shenyang by gravity from a surface source 51 kilometers from the city. In another city, Yingkuo, the average incremental cost of water diverted from the nearby Daliao River is about $0.16 per cubic meter. However, because of the heavy pollution, this source cannot be used for domestic purposes. As a result, water is currently being transported into the city from the more distant Bi Liu River at a cost of $0.30 per cubic meter. In Shanghai, water intakes have already been moved upstream more than 40 kilometers at a cost of about $300 million.

Box 7.4: Pollution in Hangzhou Bay and Zhousan Fishing Area

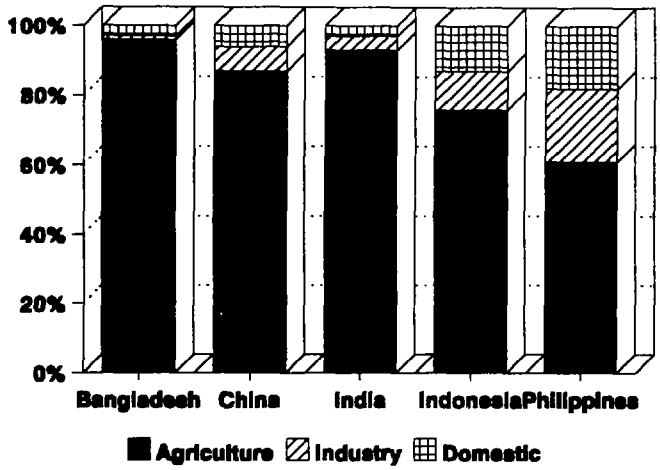
The Hangzhou Bay and Zhousan Fishing Area are located on the east coast of China, immediately south of Shanghai and the Yangtze River delta. This important riverine and marine environment are experiencing various degrees of water pollution due to disposal of urban and industrial wastes, contaminated agricultural runoff, and the oils and wastes discharged by marine vessels. Eutrophication is evident, together with annual red tides. The pollution is threatening important fishing grounds and other living marine resources in the Bay, and may even cause deterioration of the East China Sea, to which the bay is connected.

of the population. In contrast, a typical farmer may use up to ten to twenty times that amount to irrigate crops. Water for industry is used primarily for cleaning and cooling; although most is discharged and not consumed, it is often contaminated.

The trends in future water demand are clearly upward. In agriculture, irrigation has been one of the factors responsible for the success of the "Green Revolution." Given Asia's growing population, and given its constraints on further cropland expansion, the likely response will be to increase cropland under irrigation. Similarly, the high pace of industrialization is increasing the industrial sector's demand for water, particularly in mining, metal industries, and chemical industries. Finally, a rapidly growing urban population, combined with urban affluence, is demanding more water and better services for domestic needs.

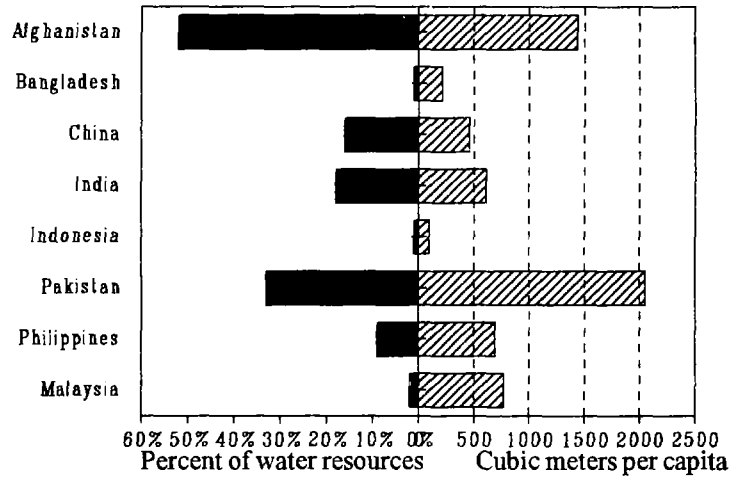
The ratios of withdrawal to renewable water resources in the region are quite low (20 percent or less; see figure 7.4), because the bulk of the annual flow occurs within a short monsoon season. The exceptions are Pakistan and Afghanistan, where more than a third of available water resources are being utilized. The two largest countries in the region, India and China, have the next highest withdrawal ratios (24 percent and 16 percent, respectively). In the less-industrialized countries of Asia—Bhutan, Cambodia, Fiji, Papua New Guinea, Solomon Islands and Viet Nam—per

Figure 7.3: Freshwater Withdrawals by Sector in Selected Asian Countries



Source: WRI, UNEP and UNDP 1992.

Figure 7.4: Annual Withdrawal of Water Resources



capita withdrawals are very low (below 100 cubic meters per year), and supply vastly exceeds demand.

Conflicting Needs

With development and population growth, there are increasing conflicts between sectors. For example, the water supply for the city of Hyderabad (India) is now in direct conflict with irrigation during low-flow years, and the city water supply has been given priority. In Indonesia, municipal water demand for the Jakarta region and Surabaya are in conflict with irrigation demand in the surrounding basin areas. In the Philippines, the water supply and power demands of Manila are beginning to have an adverse impact on irrigation in the Central Luzon region during drought years.

In addition to serving the agricultural, industrial, and urban sectors, water serves other important but potentially conflicting purposes. Given the rapid growth of the power sector (chapter 5), hydropower will remain an important part of energy strategies in the region. An often understated service of river water (box 7.5) is to maintain saline balances in estuaries, especially during low-flow periods when there are competing demands. Reduced downstream flows into estuaries and other wetlands, decreased sedimentation, and incursion of saline water into estuaries lead to changes in the coastal ecology with serious impacts on breeding grounds of coastal fish and other marine life. In sum, there would be a large social and environmental cost to any water resource development strategy that withdraws too much surface water for agricultural, industrial, and urban purposes, and leaves too little in the river for these other nonconsumptive and environmental purposes.

Government agencies have not been effective at resolving conflicting water demands in face of limited supplies and deteriorating quality. Present practices are not effective at meeting needs in terms of both quantity and quality. First, the responsibilities of government in the area of water resource management have typically been fragmented between agencies for irrigation, water supply, power, and transportation—with equally fragmented re-

Box 7.5: Ecological Damage Due to Low Water Flows

The diversion of part of the Ganges River during the low-flow season has done irreparable ecological damage to the delta in Bangladesh. Similar problems exist in the eastern part of the delta in Bangladesh fed by the Brahmaputra and the Meghna. In Thailand's Chao Phyra Basin, dry-season river flows must be expressly managed so as to maintain the saline front in the delta; efforts, to date, are considered successful.

Box 7.6: Overdevelopment of Water Resources in South India

The Ameravathy River, a tributary of the Cauvery, is one of the most disputed major rivers in India. In the absence of riparian agreements, Karnataka, the upstream state, has developed large irrigation schemes, depriving the delta (Tamil Nadu's rice bowl) of its water. Meanwhile, Tamil Nadu has also been developing the Ameravathy. In the traditional agricultural downstream areas, water is often pumped by illegal pumps along the river bank. Though new electric connections are banned, little is done to control the proliferation of pumps, with the result that little water now reaches the lowest commands. Meanwhile new storage dams are being built on tributaries both in Kerala and Tamil Nadu, further depriving not only the old lands but also the new lands and the pump areas.

sults. Second, pricing has not been used anywhere in Asia as an explicit mechanism for allocating water. (De facto pricing does allocate water, however, in those parts of cities forced to buy from private vendors for lack of access to public supplies.) Third, water rights are poorly defined. Property rights problems are further exacerbated by lack of coordination among jurisdictions sharing water. In many cases, this has led to overuse of water resources with concomitant ecological and economic losses. The overdevelopment of the Ameravathy River in South India illustrates one example of fragmented planning, in which the conflicting claims have not been resolved (box 7.6).

Environmental Considerations in Water Resource Development

Water resource environmental problems can be divided into two general categories. First are those caused by activities in other sectors, such as urban, industry, energy, and agriculture. These environmental impacts are discussed in the respective sectoral chapters of this report. Second are those caused by direct water resource management interventions, which are discussed here. Clearly all of these impacts are linked: interventions in one part of the water cycle cause impacts on water quality/quantity in other parts of the cycle.

Over the past several decades, governments in Asia have embarked on ambitious water resource development programs to meet the growing and diversifying needs of their economies. These projects have helped countries in the region make tremendous achievements in agricultural productivity and in enabling the rapid growth of industrial and urban centers. Given the need for further growth, major projects are envisaged for the future. These include transferring water across river basins, and creating large, multi-purpose reservoirs. These projects, while clearly providing economic and social benefits, may also have adverse environmental and social consequences that require attention.

Dams and Reservoirs

Given the seasonality of rainfall in the region, dams and impounded reservoirs are an essential part of the water management system that provide for irrigation, flood control, water supply, and power generation. Given the rapid growth in demand for energy in Asia, hydropower is one of the most sustainable modes of power generation, when compared to the use of dirty coal or nuclear power. Due to these broad benefits, dams are common across Asia, and construction of new dams has hardly slowed. It is estimated that Asia has over 20,000 large dams with heights over 15 meters, more than 90 percent of them built after 1950. There are over 400 dams of over 30 meters in height *under construction* in Asia (as of 1986). About 180 of them are in China, and another 160 are in India (figure 7.5).

However, dams also have local and downstream environmental impacts. These include the

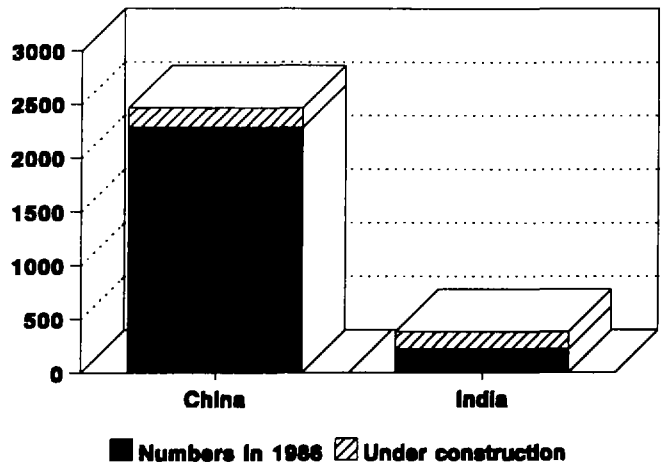
loss of forest, agricultural land, and other natural habitats to inundation. The damming of rivers can adversely affect aquatic life by changing river regimes, migration paths and habitat. Reduced downstream flows impact on estuaries, with changes in the rate of sedimentation that could lead to coastal realignment, and saline intrusion into coastal wetlands. Some reservoirs have posed localized risks to human health. The incidence of some water-related diseases (schistosomiasis, malaria, onchocerciasis, and Japanese B encephalitis) may increase unless precautionary measures are taken. Resettlement of populations is a major social problem associated with dams and irrigation systems—and was the basis for much of the controversy surrounding the Sardar Sarovar Project in India. More than 1 million people could be directly affected by the Three Gorges Project being planned for the Yangtze River, although China has handled resettlement quite well in recent years.

Most environmental effects of dams are preventable, mitigable, or compensable, although with greater effort than is typically being accorded today. All dams represent some tradeoffs—including tradeoffs between costs that are quite local in impact and benefits that may be felt far offsite (such as the benefits of water supplies in lands that would otherwise be drought-ridden, or the benefits of avoided greenhouse gas emissions). Although small dams may fulfill some needs well with less environmental cost, other needs—typically water storage for dry season use and flood control—can only be secured by large dams. As always, only explicit analysis of the relevant costs and benefits will determine their overall advisability.

Interbasin Transfers.

Water transfers from surplus- to deficit-basins are being considered in many Asian countries. For example, the needs of the 300 million people living on the North China Plain could be met by water transfers from the Chiang Jiang 1,000 kilometers to the south; Thailand is considering ways to supply Bangkok with water while accommodating agriculture in the Chao Phyra basin through water imports from the Mekong. In India, the Garland Canal Scheme has been on the books for more than a decade, to link the surplus rivers of North India with the deficit rivers in peninsular India. A part of the feasibility analysis of these schemes, the environmental and social costs must be considered as well (figure 7.6 and box 7.7). For example, in the exporting basin, reduction of downstream flow could lead to changes in the coastal ecology. In the transfer region, ecological and public health impacts could result, requiring mitigative measures.

Figure 7.5: Large Dams in China and India (over 30 meters in height)

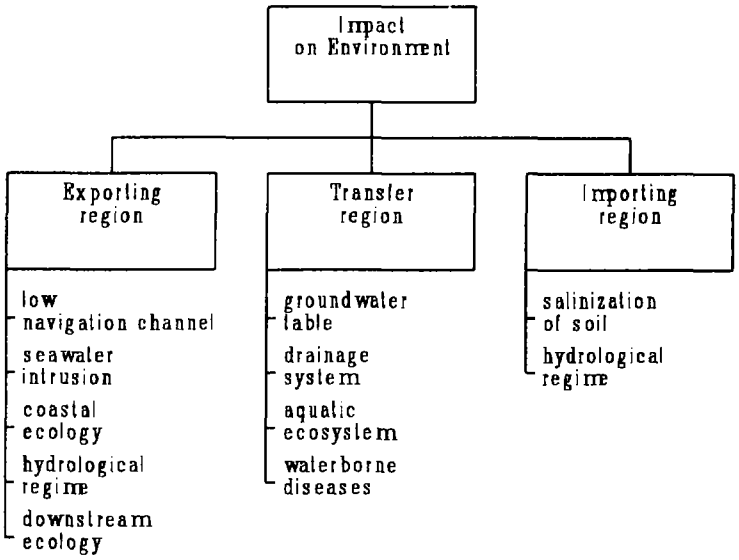


Source: WRI, UNEP and UNDP 1992.

Flood Control

Flooding imparts both benefits and costs to society and the environment. Natural patterns of flooding recharge soil moisture and groundwater, and in arid areas may be the only source of irrigation and soil enrichment. Unexpected or large floods may, however, cause loss of life and property. Flooding and consequent losses are increasing in Asia because of changed watershed characteristics and increasingly

Figure 7.6: Environmental Impacts of Interbasin Transfers



greater numbers of people and properties at risk.

Human responses to flooding may consist of structural measures such as dams, reservoirs and drainage works, and nonstructural measures such as flood plain zoning, building ordinances, warning systems and watershed protection. Structural flood management efforts are usually more costly in economic, social and environmental terms. For example, flood protection embankments in Bangladesh interfered with fish migration and groundwater replenishment. The environmental impacts of dams were mentioned above.

Groundwater Development

Excessive groundwater pumping can lead to lowering of groundwater tables and consequent land subsidence and saline water intrusion. This problem is widespread in China, India, Korea, Sri Lanka and Thailand. In northern China, where groundwater is critical for irrigation and for meeting the domestic and industrial demand for Beijing and Tianjin, levels in some places have dropped up to 80 meters. In Tamil Nadu, in India, overpumping of groundwater for irrigation has led to a drop in groundwater levels by about 30 meters. In Bangkok, increased pumping of groundwater

Box 7.7: South to North Water Transfers in China

Among the various interbasin transfers under consideration in China, the largest and the most important one involves transfer of surpluses from the Chiang Jiang system to the water-short North China Plain more than 1,000 kilometers away, where two large urban centers, Beijing and Tianjin, are located. The increasing water scarcity in this area reflects the area's modest water resources endowment, the highly variable precipitation, and the recent rapid development. The last thirty years has seen a rapid growth in irrigated agriculture in this region, together with rapid industrial and urban growth. The surface water flow to the region has been reduced by interceptions in the upper Hai catchment in the Hebei and Shanxi provinces.

Three separate routes—designated the East, Middle, and West routes—have been identified and studied in detail. They present different engineering, social, financial, and environmental problems. The planners consider it necessary to implement all the three transfers if the water scarcity problems in the North China Plain are to be addressed in the long run. Some of the possible environmental impacts are discussed below.

In the water exporting region, the main impact of the water transfer will occur at the point of transfer and in the river reaches below it. Reduction of flow in the Chiang Jiang, especially during the dry season, could lead to possible seawater intrusion, with negative effects on industrial, agricultural production and municipal water supply in the Shanghai region.

In the transfer region, the canals would pass through major watersheds, significantly disturbing the aquatic ecology. Unless proper lining is provided for the canals, and good drainage systems installed, the transfer could result in secondary salinization of soil. Also, urban or industrial areas along the routes could pollute the water. The water importing area north of the Huang He has soil with high salt content. Increased irrigation with imported water could cause the water table to rise, leading to salinization. In addition, it is estimated that about 200,000 people will be displaced in the transfer region, largely along the Middle route.

caused a decline of about 50 meters in groundwater levels during the period 1955–82 and has led to land subsidence of about 60 centimeters over the last twenty-five years, aggravating the flooding problem (box 7.8).

A Comprehensive Framework for Water Resource Management

In recognition that past performance has been less than satisfactory and that demands on limited water resources are increasing, developing countries and the international support community are focusing increased attention on how to better manage water resources relative to the environment. In 1992, the United Nations–sponsored International Conference on Water and the Environment attracted some 500 representatives from more than fifty-five countries, twenty international agencies and thirty NGOs, and produced the Dublin Statement on water resources and environmental principles. The World Bank's *World Development Report 1992* devoted a chapter to water resources and the environment, and the central policy group and both the East and South Asia Regions are all working on water policies and strategies.

The emerging consensus at Dublin, the World Bank, and elsewhere is that improved water resource management and environmental protection of water resources are mutually reinforcing. Sound water resource management inherently incorporates concern and action for environmental problems, including protecting water quality and using water effectively. Also, the desire to minimize alterations to natural waterways is implicit in the environmental aspects of water resource management. The integrated water resource management approach adopted in Dublin and by the World Bank recognizes the complementarities between improved water resource management and environmental sustainability.

This section discusses development goals and how they provide the setting for water resource planning and strategy. The strategy then combines these goals with economic, social, environmental, and governance principles to make recommendations for national level strategies for water resource management.

Economic and Social Goals

Compatible Goals. Most countries embrace economic growth and social equity as central development goals, and look to the productive sectors of agriculture, industry and natural resource exploitation to achieve them. Adequate water resources, sustainably managed, are fundamental to achieving these goals.

However, meeting these goals involves conflicts and tradeoffs. For example, increasing agricultural yields and rural incomes in India requires investment in water resource infrastructure that entails high involuntary resettlement with social costs. Promoting groundwater irrigation in Bangladesh raises farm incomes but could threaten groundwater availability and quality. Improving water supply while pursuing cost recovery through user charges could place essential services beyond the reach of the poor. A country's policies and actions should be formulated with such interdependencies in mind. Fortunately, other choices invoke fewer conflicts: sustainable forestry management in Indonesia preserves watersheds, sustains water yields and prevents erosion and siltation; and industrial development in China through restructuring improves water use efficiency and reduces water demand and water pollution.

Box 7.8: Land Subsidence in Bangkok

In Bangkok, the high level of groundwater pumping has resulted in the lowering of ground levels and the development of a major subsidence bowl. Though the bowl is shallow, with an average depth of less than 0.5 meters, it covers an extensive area of the city and its suburbs. For example, the areas encompassed by the 10 centimeters per year subsidence contour extends over 250 square kilometers in eastern Bangkok. Assuming that neither groundwater recharge nor the construction of polders is undertaken, predictions are that at current rates of groundwater extraction, by 2000 parts of this area will be below sea level.

Source: ESCAP 1992.

Water as an Economic Good. In the past, water resource development and allocation has been in an era of abundance. As a result, water development was supply driven and its allocation was by administrative or political decision. Wastes were disposed to abundant water bodies at levels that could be readily assimilated. However, the growing scarcity of water, the increased quantities of wastes, and the increasing financial and environmental costs for incremental water resource development, have all forced recognition that water and its waste assimilation capacity have scarcity values and should be treated as economic goods. Recognizing the economic value of water will help ensure rational development and allocation among competing uses and promote efficient use within sectors.

The economic cost of water use (including capital, operating, social, and environmental costs of providing supply and preserving quality) and the benefits derived from water use are the most important decision parameters employed in water resource analysis. For example, cost analysis in China revealed that the economic rate of return to a unit of water for agriculture is less than 10 percent of the return to municipal and industrial users—information that is useful in deciding water allocation. Correctly costing both environmental and social attributes will help to ensure that both favorable and adverse impacts of pending decisions are taken into account.

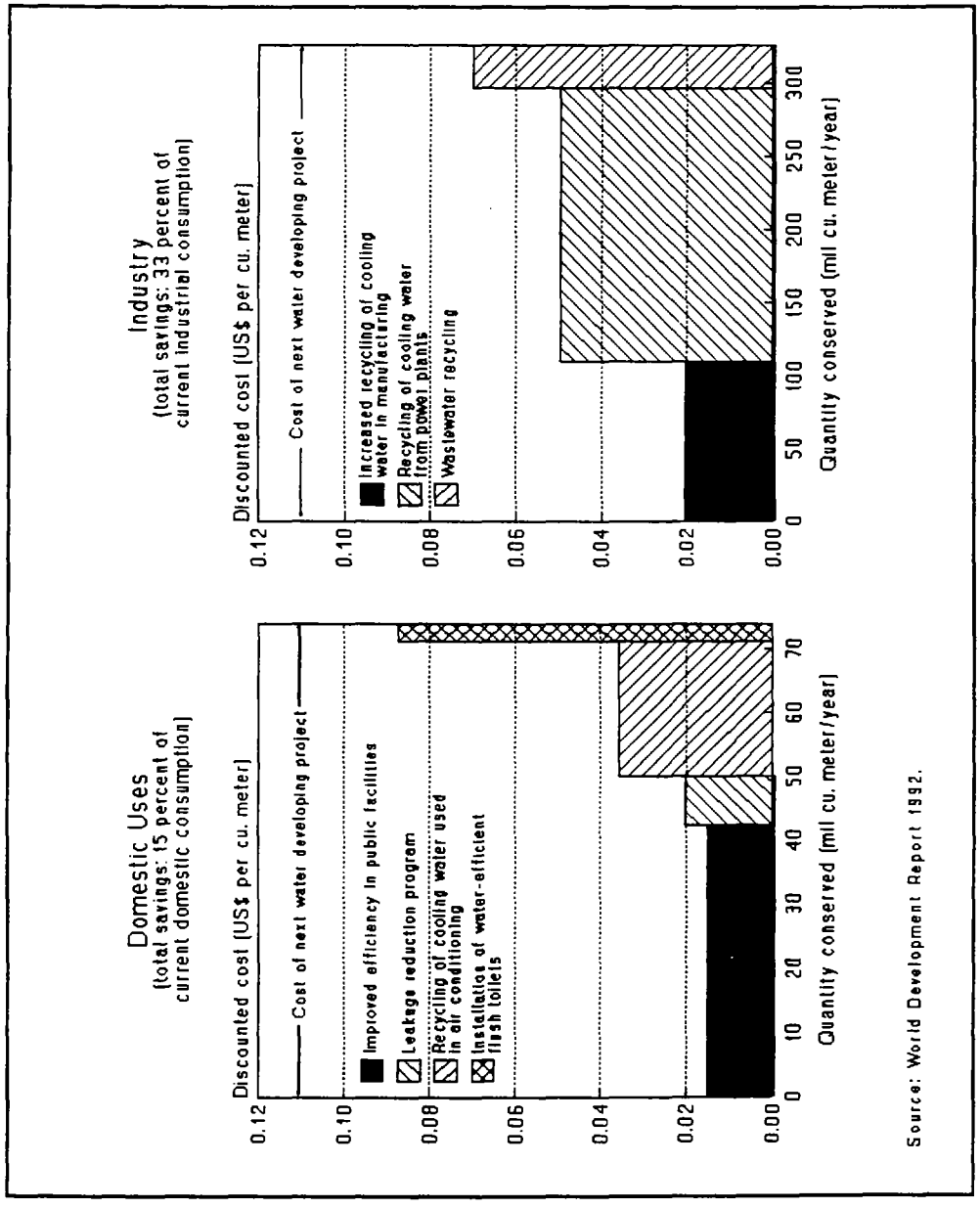
Pricing. Charging for water and waste disposal at or near cost is not common in developing countries, although it is done more in the municipal and industrial sectors than in agriculture. Water pricing is fundamental to sectoral efficiency, financial strengthening of water companies, and reduction of public subsidies. In addition, the imposition of charges often reduces demand, thereby conserving resources and postponing the need for investment. The environment stands to gain as conserved water is freed for other uses, including the maintenance of ecosystem health. Postponing water resource development investments frees financial resources for other developmental activities (such as environmental protection or improving water services to the poor), postpones negative social and environmental impacts of construction, postpones conversion of land use, and buys time for the development of improved technologies. An example of the advantages of demand management and conservation over investment is shown in figure 7.7.

In the United States, studies have shown that price elasticities for water range from -0.1 to -0.3 for domestic consumption, -1.0 to -3.0 for industrial use, and as high as -3.0 to -6.0 for food processing firms. Even though urban domestic consumption is highly inelastic, price reforms often involve doubling or tripling water prices—implying a 10–30 percent reduction in demand in the domestic sector alone. Reductions in industry would be proportionately much greater.

Demand management through pricing is appealing because the user decides how much water to use and how to achieve conservation. But pricing is not without complications. Pricing in the agricultural sector may be difficult for cultural and technical reasons. Pricing in urban settings will meet social resistance, and care must be taken to insure that the underprivileged are provided basic water and sanitation at affordable prices. Ecologic systems whose users and beneficiaries may be dispersed, unorganized, or poor, may not be able or willing to pay for environmental protection. Therefore, cultural constraints, the prospects for technologic innovation, the feasibility of continued (albeit limited) subsidies, and judgements on the intrinsic value of healthy ecosystems, are considerations that may temper pricing decisions.

Institutional Implications. The increasingly accepted paradigm that efficient, sustainable and socially equitable development is founded upon the participation of the beneficiaries implies reexamination of traditional institutional arrangements. As governments recognize the advantages of moving from centralized to decentralized administration

Figure 7.7: Conserving Water as an Alternative to Expanding Supply in Beijing



Box 7.9: Water User Associations

In Sri Lanka, during the early 1980s, USAID funded the Gal Oya Water Management Project to rehabilitate the Left Bank. Gaining the trust of the farmers, the institutional organizers began organizing large farmer groups along the distribution channels. These groups consulted together and communicated their problems to the government irrigation department officials. This process has helped reduce conflicts between farmers and helped them communicate better with the government. The improved system has provided greater water supply to all tail enders. In one area, cooperating farmers cleared a canal allowing cultivation of 1,000 hectares in the dry season, which had been previously left fallow. This benefitted over 300 families and demonstrated that participation, flexibility, and consensus were keys to the project's success.

and action, the structure of the water resource sector is affected. Decentralization to the lowest appropriate level is desirable because public participation and intersectoral coordination is facilitated, development and operations are more responsive to the needs of users, and a sense of ownership is engendered. Participation through water user associations can help ensure that design choices and management practices are consistent with local requirements, and thus valued and maintained by the local population (box 7.9).

Under decentralization the important central role of providing guidance and setting appropriate standards must continue. In Indonesia, the environmental protection mandate (except for large, centrally administered projects) is at the provincial or district level where local conditions are best understood and impacts are directly felt. Since decentralized entities may not be technically able to evaluate issues, analyze alternatives, or operate systems, capacity building at local levels is essential.

Another facet of decentralization is the move towards more commercialized types of institutions for building and operating systems. These may be of government, private or mixed ownership. Advantages are the potential for financial and political autonomy, with clear and quantifiable criteria for evaluating performance. Although such entities are usually more efficient at delivering services (and government bureaucracy is reduced), their commercial orientation may cause neglect of the poor and the environment. Therefore, in the commercialization of the water sector, the public regulatory role may have to be strengthened and the regulators kept separate from those engaged in development and operations. An example of this is the water pollution control agency in Indonesia that does not develop or operate systems, is independently governed by a board, and which is intended to be self-financing through the use of waste discharge tariffs.

Policy Planning

Water resource policies, strategies, and planning are weak in many Asian countries, factors that have led not only to financial waste and poor service but also to environmental damage to watershed land and water resources. With the exception of some strong agencies in China, Korea, and Pakistan, the dominant role of single-purpose public development agencies, and their failure to consider sectoral interdependencies from headwaters to estuaries, has led to these problems. Investment inefficiencies have also resulted from the failure to link water resource development with land use patterns and trends, especially in urban areas. While water pricing and other financial incentives will be increasingly featured in providing supply and managing demand, sound policies and planning are still crucial to shaping how efficiently water resources are developed and managed.

The starting point for better water resource management is for each country to define a national strategy which provides an appropriate legal, regulatory, and administrative framework and guides water allocation. The strategy should spell out water service priorities, water rights, pricing and cost recovery policies, public investment guidelines, environmental guidelines and regulations, and roles of government and non-governmental organizations.

Detailed analysis and planning should not be limited to political or administrative jurisdictions, but be done on the basis of river basins. The rec-

Box 7.10: Environmental Impact Assessment of the Pak Mun Hydropower Project in Thailand

The Pak Mun hydropower project (World Bank-assisted), situated in the northeastern region of Thailand, is being constructed on the Mun River about 5.5 kilometers upstream from its confluence with the Mekong River. It involves construction of a 17 meter high, 300 meter long concrete dam, creating a reservoir submerging an area of approximately 6,000 hectares. The power plant will comprise four 34-megawatt generator units operating at a gross nominal head of 11.5 meters. The project creates the potential for irrigating about 25,000 hectares of land.

The original design for the dam was based on maximizing the project's power benefits, and called for a Full Supply Level (FSL) of 112 meters, with the dam located at Kaeng Tana Rapids. An EA was carried out for the project in 1982 based on these parameters. In order to reduce the project's adverse environmental impacts (for example, submergence of rapids that are tourist attractions and displacement of a large number of persons), the project parameters were substantially revised, at the expense of power benefits. The dam was relocated to Ban Hua Heo thereby preserving the downstream Kaeng Tana rapids and the operating regime of the power station was redesigned to preserve the upstream Kaen Saphu rapids. The FSL was lowered from 112 meters to 108 meters. The number of people to be resettled was reduced from over 20,000 to 1,500.

ommended process is not rigid centralized planning, but an indicative process that is derived from national economic and environmental strategies. It should be multisectoral (that its, integrating agricultural, urban, industrial, and ecologic needs), and rely upon economic analysis which incorporates environmental and social benefits and costs.

On a more technical level, planning should integrate physical systems with non-physical measures such as demand management, zoning, and drought management; take into account ground and surface water interactions; consider water reuse as an alternative water source; recognize the stochastic nature of water and environmental phenomenon and apply risk and sensitivity analysis to that end; phase and prioritize actions, thereby reducing investment costs, risks and impacts while enabling learning and mid-course corrections; and focus first on pivotal issues and actions, especially those which may prevent irreversible ecological harm.

While environmental concerns should be integral to the planning process, there may be a need to conduct a stand-alone EA for projects with major impacts, or if environmental issues were not adequately addressed beforehand. An EA can go a long way in preventing the wrong investment choice and in many cases can also help develop mitigatory measures to reduce impacts (box 7.10). Finally planning should be done in consultation with water users, non-water sectors and impacted groups to help ensure social and environmental needs are fulfilled.

All planning and design is done on the assumption that facilities will be operated and maintained to provide services over time. However, even in situations where long-term planning is adequate, operations and maintenance (O&M) plans and management often fall short. The importance of O&M planning is often under-estimated, and should be given equal priority to long-term investment planning.

These policy and physical planning imperatives have favorable environmental effects. The river basin framework will help to ensure that downstream environmental assets are not sacrificed for upstream benefits; the incorporation of environmental and social costs in decision analysis will help to ensure that adverse impacts are minimized; non-physical measures avoid environmental impacts of construction; and consultation with affected groups would draw upon local knowledge of environmental conditions and strategies for reducing environmental risks.

A Water Resource Management Strategy

This section recommends a five-element water resource management strategy for Asian countries to engage in better and more environmentally sound water resource management. The sequential elements are: take immediate actions to prevent irreversible ecological harm; define water sector policy; adjust legislation and institutions; plan pro-

grams and projects; and build capacity.

The first element is to take immediate actions—to the extent possible, given financial resources and technical feasibility—to conserve and protect untainted environmental assets and to prevent further irreversible damage to ecologic systems. One example is to enforce the protection of watershed areas already delineated as parks and protected areas from further encroachment. Another example is to keep persistent toxic substances from entering groundwater (even if investment in temporary storage is required prior to agreement on longer term policies and treatment facilities). Tens of millions of Asians rely on untreated shallow groundwater as their source of drinking water. For now and in the foreseeable future, toxic groundwater decontamination is not possible within reasonable cost. Protection need not be expensive and could include: removing agrochemical subsidies and educating farmers on use; prohibiting waste-producing industries from locating in recharge zones; and investment in common treatment facilities for groups of industries are relatively low cost, appropriate measures for addressing this problem.

The second element is to discuss and decide upon water-related policy issues and related management strategies. These were outlined earlier in this chapter. Policies adopted within the water sector should be complementary to pollution abatement policies being adopted in other sectors (especially in industry, municipalities, and agriculture). Donors can facilitate this policy formulation stage through preparation of country and sector strategy papers, and, more recently, national environmental action plans. Occasionally the process is, as it should be, highly participatory (see the case of Sri Lanka in chapter 8, box 8.3). Policy implementation is easier if stakeholders are consulted and involved.

Implementing policy will require some legislation and/or institutional change, the third strategy element. The most difficult institutional issues appear to be the careful definition and empowerment of a balanced cluster of required institutions, such as (a) a centralized body for setting standards and policy; (b) a river basin planning entity for water pricing, allocation, investment planning, and (perhaps) service management; (c) a decentralized agency for water quality enforcement, with the power to impose fines; (d) water service companies; and (e) local user organizations. Change will meet resistance from affected parties and incentives may be necessary.

The fourth element is to prepare programs and projects which are consistent with policy objectives, generally in the following sequence:

- Because their relative cost-effectiveness is usually superior, identify, promote, and implement nonphysical measures for achieving sustainable water resource management. These include demand management through water and waste discharge pricing to promote conservation and efficiency in water use and waste management; land use controls to prevent deforestation and industrialization of ecologically sensitive areas; and farmer education to encourage erosion control and safe agrochemical usage.
- Because existing facilities are often not used to their full design capacity or efficiency, repair and upgrade existing infrastructure, improve maintenance and introduce real-time system management. With regards to system operation, ensure that ecologic needs are fulfilled (for example, that adequate flows are maintained below dams).
- From a list of alternative and competing prospective development projects, prioritize and select programs and projects in terms of a complete accounting of economic, social and environmental costs and benefits. Nonquantifiable attributes, such as the maintenance of water quality for human and ecologic health, and base flow quantities sufficient for ecologic purposes, should be a part of the selection criteria.
- Plan and design the selected programs and projects and prepare operating rules, management procedures, and monitoring plans that cover, among other things, environmental

concerns. Phase the plans to capture early benefits during the course of implementation.

- Build selected projects while ensuring that environmental safeguards are part of the construction process. Examples are ensuring that erosion is controlled, fish migration paths are maintained, and downstream or groundwater quality is not affected by construction activities.
- Monitor midpoints and outcomes, including economic, social, and environmental impacts, and adjust activities and operations if necessary. Prepare future plans, designs and operations to reflect lessons learned.

The fifth strategic element, capacity building, is in recognition that comprehensive water resource management requires well-trained and qualified personnel. Institutional reform may necessitate retraining and improved working conditions to build morale and retain trained personnel. Training is required for the regulatory as well as sectoral planning and operating agencies, and at both central and local levels of administration and management.

One important area for capacity building is to improve the ability of staff to carry out analysis that incorporates full environmental and social costs and benefits. Decision makers are often deterred from taking appropriate decisions because these more difficult costs may not be included in the analysis. In the case of protecting watershed areas and water quality, this problem is particularly acute in underestimating the environmental cost of doing nothing. As described in chapter 2, due to valuation problems in quantifying environmental degradation, the cost of "business as usual" has long been underestimated.

Another area of priority capacity building concerns data collection and dissemination. Availability of Asian data on water quality and upper watershed land degradation is not adequate. However, data collection is costly, and data systems (collection, storage, analysis and dissemination) must be designed with cost effectiveness in mind. The problem is not always lack of data—virtually all water and pollution control entities collect data. Improving the system requires an analysis of who is collecting what, how reliable it is, and to what use it will be put. A river basin orientation for integrated water resource planning suggests that extensive multi-sectoral data will be required. Data access should be facilitated through an institutional context that fosters uniformity, coordination, and efficiency. Countries should explore options for this, one of which is to keep separate sectoral and agency data banks, but to introduce unified control and oversight.

The World Bank's Role in Water Resource Development

Past Activities

The Bank's role in water resource management in Asia has been extensive and diverse. The lending program has supported investment projects in almost all related sectors and subsectors—irrigation and drainage, flood control, fisheries, hydropower, water supply, sanitation, urban drainage, inland navigation, and port development. Most projects have been sector specific, with the exception of some multipurpose dams. Financial intermediary operations providing agricultural credit have had large water-related components for the development of private sector irrigation facilities. In recent years, the Bank has increased its emphasis on the operations and maintenance of irrigation systems. Finally, Bank assistance in other sectors has clear linkages to ensuring water supplies (such as watershed management and reforestation programs) and improving water quality (such as urban water supply and sanitation projects).

In terms of number of projects, irrigation and drainage projects constituted the bulk of Bank water resource lending, followed by water supply and sanitation, and single purpose hydropower projects (table 7.1). Most water supply and sewerage projects have assisted urban communities, but projects in China, India and the Philippines have also targeted rural areas. Bangladesh has been the main recipient of Bank support for flood control

Table 7.1: Bank-supported Water Resources Development Projects by Country and Type (1948–90)

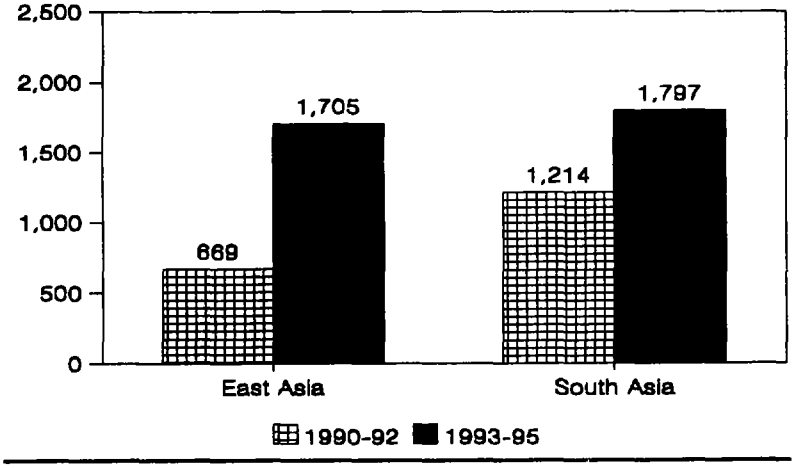
Country	Type of Project: Multi-purpose	I&D	FCD	WS&S	Hydro-power	Inland navigation	Inland fisheries	TOTAL
Bangladesh	--	12	10	5	--	2	2	31
China	--	2	1	1	3	-	1	8
India	2	42	1	13	6	--	--	65
Indonesia	1	22	3	7	2	--	--	35
Korea	1	3	--	4	--	--	--	8
Laos	--	--	--	--	--	--	--	1
Malaysia	--	4	--	4	1	--	--	9
Myanmar	1	2	3	--	--	1	--	7
Nepal	--	10	--	4	4	--	--	18
Pakistan	4	14	3	5	--	--	--	26
Philippines	3	15	--	12	3	--	--	33
Sri Lanka	1	8	1	3	1	--	--	14
Thailand	--	10	--	2	5	1	--	18
Vietnam	--	1	--	--	--	--	--	1
TOTAL	13	155	22	60	26	4	4	274

I&D Irrigation and Drainage
FCD Flood Control and Drainage
WS&S Water Supply and Sanitation
Source: Compiled from Bank Statements of Development Credits and Loans.

and drainage projects. The Bank has also supported inland navigation projects in Bangladesh, Myanmar, and Thailand, and inland fisheries projects in Bangladesh, China, and India. Although Bank involvement in major dams has been minimal—estimated at about 8 percent of major dams being constructed worldwide in 1992—its loans have received a disproportionate amount of public attention. In recent years, the Sardar Sarovar project in India, the Kedung Ombo project in Indonesia, and the Pak Moon project in Thailand have each been the subject of heated publicity. (In March 1993, India requested that the Sardar Sarovar dam loan be cancelled, and the Bank agreed.)

The Bank's analytical (economic and sector) work has seldom addressed comprehensive water resource management issues directly, although water issues are covered along with other sectors in general economic and investment reviews. Regionally, the *Asia Water Resources Strategy* (1993) is the first

Figure 7.8: Lending for Water Resources in the East Asia and South Asia Regions (Millions US$)



effort at a broadbased review of water resources. A few individual country strategy papers—on Bangladesh, China, Indonesia, and the Philippines, for example—have included separate sections on water and land use but contain no explicit examination of interdependence. In contrast, NEAPs seek to focus on the relationships between macro and sectoral issues, water and the environment. A spinoff of the Sri Lanka NEAP has been a national water resource master plan and a clean rivers program.

In East Asia, the Bank lent about $670 million during 1990–92 through eight operations (figure 7.8). Four of these were water supply and sanitation projects; one sewerage project; two irrigation projects; and one fisheries project. During 1993–95, the East Asia Region is expected to nearly triple lending in water resources to about $1.7 billion, involving seventeen operations. Three of these will be water supply and sanitation projects; twelve irrigation projects; and two sewerage projects.

In South Asia, the Bank supported fifteen operations (totalling $1.2 billion) involving water resources during 1990–92. Seven were irrigation projects; four water supply and sanitation projects;

Box 7.11: World Bank Role in Water Resource Management

Strategic Element	World Bank Role
1. *Prevent irreversible damage to the water resource base*, to the extent possible through immediate and low cost actions to prevent further degradation in critical areas.	Assist countries in estimating the costs of "business as usual" in terms of health, ecology and economics. Demonstrate benefits of preventing further degradation and reversing current trends. Assist in low-cost designs of mitigative measures.
2. *Analyze and put in place improved policies.* Develop and integrate water policies with land, industrial, agricultural and environmental policy. Use pricing to signal users, promote efficiency, reduce pollution, and advance cost recovery.	Promote water resource policies that are sensitive to social and environmental issues. Ensure that Bank lending and support of other donors is consistent with country strategy papers, ESW and support to NEAPs. Ensure existence of adequate social safety nets.
3. *Review the need for and implement legislative and institutional change*. Shift from centralized to decentralized administration. Strive for financial autonomy of development and operating entities. Rely more on enterprise forms of institutions with performance-based accountability. Separate planning and operations from regulatory functions. Strengthen laws and regulations, including water law, water rights, environmental law and enforcement. Review the role of non-governmental organizations.	Support institutional analysis and reform via technical assistance and policy-based lending. Demonstrate benefits of decentralization and local-level participation, in such areas as project efficiency and favorable impact upon government budgets. Provide examples and case studies from other countries. Promote incentives for change including civil service reform. Help ensure uniform donor approach.
4. *Improve program and project preparation.* Adopt a river basin basis for planning, and explicitly address multisectoral conflicts and needs. Identify, promote and implement non-physical measures; repair and upgrade existing infrastructure; improve operations and maintenance. Incorporate full environmental and social costs in project appraisal, and increase local consultation.	Assist on planning methodologies, including techniques for land management, erosion control, demand management, project appraisal, social impact analysis and resettlement. Condition water resource lending on sound sector policy and project planning (as is being done in the energy sector). Demonstrate efficiency gains by simulation and case studies.
5. *Build institutional capacity.* Improve analytical capability for planning, management, and regulatory functions, especially as the system is decentralized. Improve data collection systems and data sharing arrangements.	Provide assistance through lending, and promote support of other donors. Assist in design of data management framework and cost-effective data systems.

two fisheries projects; one dam safety project; and one inland water transport project. During 1993–95, the South Asia Region expects a 50 percent increase in lending in the water resource sector to about $1.8 billion, through seventeen operations. Eleven of these are expected to be irrigation projects, four water supply and sanitation projects, and two water supply projects.

Future directions

Most governments in Asia are programming high levels of investments in the water resource sector for both small and large projects. Some projects will be controversial, particularly regarding their social and environmental costs and benefits. Through country dialogue, technical assistance, and lending the Bank can be of great value in promoting the principles and strategy for comprehensive water resource management. Listed in box 7.11 are specific World Bank points of intervention in the water sector strategy outlined in the previous section.

All of the elements in box 7.11 are potentially important components of the Bank's involvement with its borrowers in the water sector. Many of the elements could be incorporated into Bank projects. The *Asia Water Resources Strategy* (1993) proposes that the Bank focus on four types of lending instruments for the water resource sector:

- **Country Water Resources Sector Projects**. A country or provincial water resource sector project would introduce water resources conditionality with a river-basin focus. The conditionality would primarily invoke sector restructuring and pricing reforms.
- **Country Water Resources Sector Support Projects**. These projects would provide support to countries to strengthen their water resource management capability. Possible areas for support include: (a) data collection, processing, and dissemination programs; (b) dam safety programs; (c) O&M issues across sectors or in the context of improvements in real-time management of multipurpose projects; and (d) environmental control covering the regulatory framework and remedial works in regions with critical environmental stress.
- **Inter-jurisdictional Development and Management Projects**. The Bank could develop projects to facilitate and assist in developing water sharing agreements in inter-provincial or international river basins in the region.
- **Multipurpose and Single Purpose Sector Projects**. These projects include the more traditional forms of infrastructure projects, whether single sector (irrigation) or multipurpose (dams). They have to be consistent with

Box 7.12: Future World Bank Research Projects

Indonesia. The World Bank has a strong relationship with Indonesia on water resource issues. The Bank has sponsored sectoral and institutional analysis, workshops and seminars for policy formulation and consensus building, and sectoral lending with focus on decentralization, bottom-up planning, operations, and cost recovery. Also, the Bank's Indonesia Country Department has a water resources committee which helps to ensure that multisectoral interdependencies, including environmental aspects, are taken into account. Two projects now under preparation are the Indonesia Water Supply and Sanitation Project for Low-Income Communities (fiscal 1994), and the Karnataka Rural Water Supply and Sanitation Project (fiscal 1993).

India. The proposed India Water Resource Consolidation Project (fiscal 1994) is a time-slice programmatic operation to strengthen the ability of a state irrigation department to address policy, institutional, operational and environmental issues, with components for data collection, river basin planning, feasibility studies, environmental assessments, completion of ongoing high priority projects, improved O&M, improved regulatory functions, policy reforms for cost recovery, and institutional reforms for increased accountability.

China. The proposed Shanghai Environment Project (fiscal 1994) has a policy component and an investment component, some of which address water supply and sanitation. The policy component includes initiatives for environmental master planning, increased water supply tariffs, and action programs for strengthening long term financial viability and economic efficiency of urban services. The investment component includes a program for Huangpu river water quality protection (the municipal water source for Shanghai), incorporating catchment pollution control, water quality monitoring, and solid waste and nightsoil management.

overall water resource objectives, and in most cases should have components for institutional strengthening in key areas of the overall strategy.

Several World Bank country programs are starting to employ a more integrated (multisectoral and market-oriented) approach to water resource management, in place of more centralized and government-centered approaches. This approach will help correct for past excesses in water use and watershed neglect. These newer projects are complementary with other urban and industrial projects that address water pollution issues more directly. Examples are given in box 7.12.

In order to increase the Bank's effectiveness in this area, the Bank is training its own staff in the need and methods for comprehensive water resource management, and creating informal intersectoral organizational arrangements within the Bank to this end. Also, the Bank can encourage donors to ensure that their water sector interventions are compatible with the above strategy.

8

THE WORLD BANK ENVIRONMENTAL STRATEGY

The third objective of this report, after describing the environmental problems in Asia and discussing approaches to solving them, is to recommend priority areas for World Bank involvement. The environmental focus of the Bank's lending program and analytical work has grown over the last several years, and is expected to grow further. However, there are areas in which the Bank can target its efforts, and there are gaps with potential for the Bank to do more.

Setting Priorities—an Ongoing Process

This report has emphasized a framework for improving environmental management in Asia. The first step in that framework is for countries to establish priorities—a process that is analytically and (sometimes) politically difficult. The World Bank, through its analytical work and policy dialogue, can help countries set priorities, accept the consequences of policy reform, narrow the terms of their environmental strategies, and implement selected instruments. With the help of other donors, the World Bank can also assist in capacity building, investment programs, and policy implementation.

Although this report emphasizes priorities, it does not advocate that some sectors require attention while others do not. Priorities across sectors are not a "zero-sum" game, in which attention to industrial pollution implies that reforms in forestry should be deferred. It is more important, within the resource constraints of each sector, to identify sector-specific priorities and to start acting on those. No line ministry should be oblivious to the fundamentals of cost-effective policy reform—which may actually cost very little. In response to sectoral needs and ever-changing budgetary resources, the central government can and will alter the sectoral allocation of public resources.

To better support the priority-setting process, the World Bank has stepped up its environment-related lending, policy dialogue, and research. The final section of this chapter discusses next steps.

Priority Areas for Investment

Environmental Projects

Traditional World Bank lending has not addressed the full range of environmental problems. This is not surprising, since many environmental problems have become widely recognized only within the last decade. In response to these problems, the Bank has significantly increased its lending for the environment and redesigned some of its approaches.

There are several substantive areas on which the Bank places high priority and in which it is pushing to expand its activities (see box 8.1). In the "brown" sectors, these areas are urban and industrial pollution, energy sector efficiency (as an initial priority within a larger energy sector environmental agenda), and urban transit. In the "green" sectors, these areas are soil protection and rehabilitation (requiring dramatically different strategies depending on local conditions) and improved management of remaining forest resources. Comprehensive water resource management—which cuts across the brown and green sectors—is also a high World Bank priority, since the approach has only recently been introduced in Asia. The final area, institutional strengthening, underlies progress in virtually all sectors.

This general list of priority areas does not apply to any one Asian country. Rather, they are areas in which the World Bank expects to target its resources in coming years. It is not possible in this

Box 8.1: World Bank Priorities for the Environment

Sector	Status and Needs
Urban Environmental Management	Bank lending addresses urban pollution in only twelve of the eighty-seven cities in Asia with populations over 1 million. Incremental investment is especially required in India and East Asia. However, activities designed to help improve urban environmental *management*—and to benefit more cities than those receiving Bank loans—should proceed in tandem with investment.
Industrial Pollution Control	Of the twenty-six countries in Asia, eight have serious industrial pollution problems. All need technical and financial assistance to address the problems, particularly in the areas of policies, enforcement, small scale industry, and hazardous wastes. World Bank analysis may be as important as funding.
Energy Pricing and Efficiency	Energy subsidies are still pervasive in Asia and are a barrier to sectoral efficiency and emissions reduction. In addition, only three Asian countries are actively promoting energy efficiency strategies. Efficiency strategies are underinvested on both the supply and demand sides. Again, World Bank analysis may be as important as funding.
Urban Transit	Vehicle emissions and urban congestion are growing exponentially across Asia. Only strategies that increase the cost of using private cars *and* provide alternatives can address both issues simultaneously. Asian investments in public transit, cleaner fuels, and vehicle standards are all increasing. There is a need for more World Bank involvement in these areas—including in mass transit, where viable.
Water Resources Management	Water quality is worsening in Asia generally, with major public and ecologic health costs. Increasing agricultural, industrial, and urban demands are difficult to meet, given the deteriorating quality. Rising costs force efficiency improvements and policy and institutional reform. Bank support for appropriate policies, multisectoral planning within riverbasins, and decentralized management are a 1 1
Sustainable Agriculture	recommended. Agriculture on both irrigated and marginal lands is leading to excessive soil degradation. No country in Asia has the techniques and financing necessary for a concerted effort against soil degradation. Pricing reform and strengthening of land tenure will help but must be combined with strong
Forest Management	commitment to institutional reform and technical research, demonstration, and extension. The World Bank has defined forest-surplus and forest-deficit countries in Asia, with different strategies for each. In forest-surplus countries, pricing and trade policy reform are critical, along with improved management of public lands and research on more sustainable commercial and social forestry. In forest-deficit countries, management, tenure, pricing, protection of remaining reserves, and
National and Local Institutions	reforestation are important. Except for Japan and Korea, no Asian country has successfully implemented its approved standards and enabling legislation. Long-term support (five or more years) for policy implementation, monitoring, and enforcement—using innovative means—are of the highest priority.

document to make a more focused statement of World Bank priorities, since within these categories, they will vary, to a large extent, with the circumstances of each borrower.

The recommended priorities are substantially but not fully represented in the 1993–95 World Bank planned lending program. The largest gaps concern definition of the fiscal and administrative details of cost-effective approaches to urban and industrial pollution; investment in energy efficiency and urban transit (two "win-win" approaches with economic as well as environmental benefits); lending that incorporates integrated approaches to water resource management; projects that address fundamental resource tenure issues in rural areas; and a long-term commitment to strengthening environment-related institutions in Asia. Obviously, the World Bank cannot adequately cover all of these areas single-handedly, and it can make greater efforts to work with other donors and in providing intellectual leadership to its borrower countries.

Currently, the World Bank is more active in brown-sector issues than green-sector issues. This emphasis arises from: (a) the more urgent health costs of brown-sector degradation, which foster a greater willingness to borrow in developing coun-

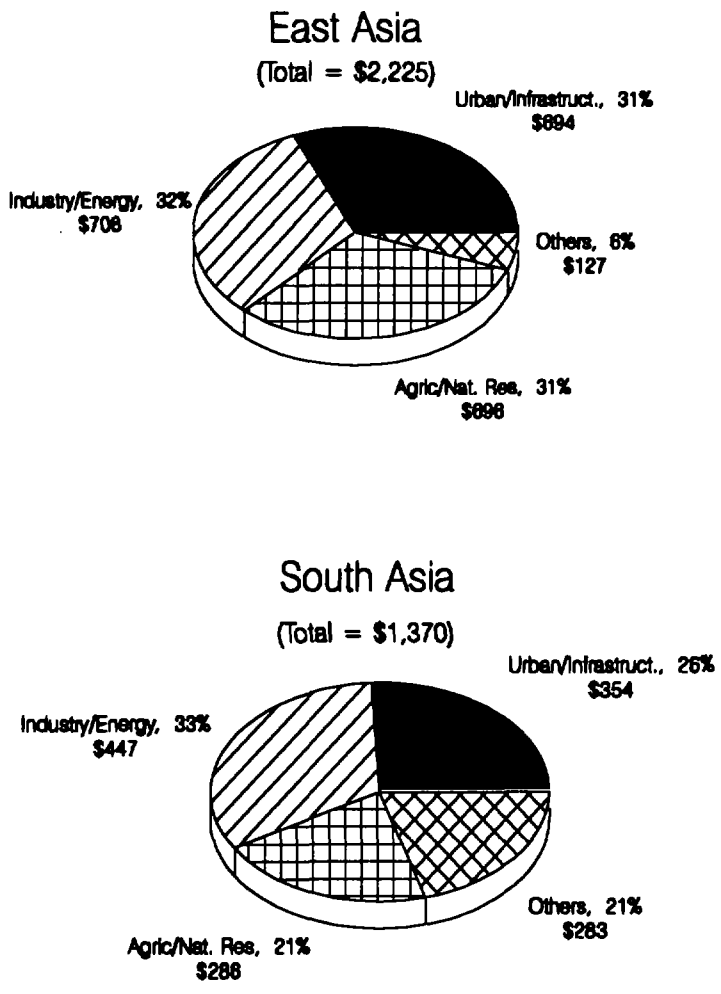
tries; (b) the World Bank's comparative advantage in brown-sector issues, which have better-known and more policy-oriented strategies than the more technical and far more site-specific problems of land use and forest degradation; and (c) the involvement of other organizations (such as GEF, FAO, IFAD, CGIAR, and various bilaterals and NGOs) in rural development, field-level agriculture, and biodiversity.

Environmental lending in Asia will roughly double between 1990–92 and 1993–95, from nearly $600 million to $1.2 billion per year, and from 6–7 percent of total lending to 12 percent (see figure 8.1, and Appendix B for details). The fiscal 1995 estimates probably understate its eventual size, since the program will be partly based on analytical work now being done.

Two-thirds of the Bank's Asian environmental lending will occur in East Asia (figure 8.2). There, the level of lending in the brown sectors (urban, industry, and energy) is more than double that in the green sectors (agriculture and natural resources), although both are growing rapidly. In South Asia, brown-sector lending is also much greater than green-sector lending, and both are expanding at a rate slower than in East Asia. The sectors of lending reflect, to a large extent, the development priorities in the two regions. Not included in these estimates are areas of Bank lending that help the environment through such intermediate interventions as health and education programs, poverty alleviation, agricultural research, and sector reform. Also, the Global Environment Facility (GEF) is not included in these totals.

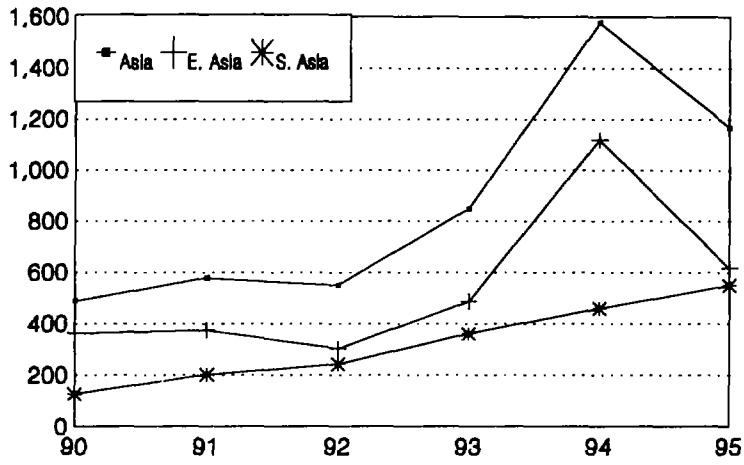
The future project pipeline also shows an emphasis on newer types of lending over the more traditional approaches in infrastructure, energy, industry, agriculture, and forestry. Projects with newer approaches generally have broader activities, are more systematic and institutional in approach, and are more cross-cutting (see Appendix B for details).

Figure 8.1: Amount of Bank Lending for Environment Projects and Environmental Components in the Asian Regions by Sector, Fiscal 1993–95 (Million US$)



Note: "Others" include population/human resources, SALs, and cross-cutting environmental activities.

Figure 8.2: Amount of Bank Lending for the Environment, Fiscal 1990–95 (Millions US$)



Source: World Bank data.

for new approaches to institutional strengthening—with longer time horizons and more sustained resources. Possible approaches to introducing more significant incentives into institutional lending are suggested in box 8.2.

There are several areas of Bank lending that are not within the more narrowly defined scope of this report but that nevertheless complement environmental lending. Population planning falls into this category and is clearly a priority in Asia. Second, efforts at rural poverty alleviation and nonfarm employment, which may help reduce agricultural pressure on marginal lands, are also complementary to the environment. Third, sensible economywide and trade policies are consistent with sustainability; and structural adjustment lending, if and when needed, is complementary to the Bank's environmental agenda.

For example, these cross-cutting aspects are reflected in brown sector lending by: municipal water treatment facilities that are planned in conjunction with local industry; fuel modification for vehicles and industry; demand side energy management programs involving industrial, commercial, and residential users; and recycling programs for solid and liquid waste. Cross-cutting approaches in the green sector address the explicit tradeoffs and local conflicts brought about by attempts to improve land-use management. The distinction between newer and traditional approaches is of interest as an indicator of how the Bank has responded to the environmental priorities emerging in the past few years. In fiscal 1993–95, the $2.2 billion Bank financing of newer environmental projects is 70 percent greater than the financing of more traditional approaches.

Investing in institutions is potentially the most cost-effective component of the Bank's environmental strategy, since the basic policies and institutional characteristics of Asia's fledgling environmental agencies will be largely shaped in the next five to eight years. Unfortunately, past experience with traditional technical assistance (TA) shows it to be the weakest part of the Bank's portfolio. There is a need

Beyond Project Lending

Much of the World Bank's strategy for the environment extends beyond project lending. This section underscores the areas of policy dialogue and Bank procedures that are strategically important.

Establishing an Active Policy Dialogue

One of the Bank's greatest comparative advantages is its analytical capability. This strength is fundamental to helping Asian countries analyze and accept the consequences of policy reform, model more sustainable growth scenarios, and refine the economic and administrative details of policy instruments. As mentioned above, the World Bank—better perhaps than other donors—can help countries set economywide and sectoral priorities.

Integrating National Environmental Action Plans

Most Asian countries are drafting NEAPs, and will complete them in 1993. An important part of this

Box 8.2: Innovative Institutional Strengthening Projects

The traditional approach to institutional strengthening is through technical assistance. However, other ideas involve more hybrid mechanisms that may provide greater and more sustained incentives for institutional strengthening than simple TA. These approaches would adopt larger incentives than TA and would have to have a longer time horizon as well (five years or more).

One approach would be to combine traditional investment lending for environmental institutions (that is, for buildings and equipment) with institutional conditionality linked to targets for environmental enforcement. Such targets could be the monitoring and management of an agreed-upon number of polluting industries, water systems, or forest areas, or the implementation of an agreed-upon approach to environmental management, such as a system of tradable pollution rights or the establishment of a working locally-financed environmental fund.

A second approach would require the close participation of bilateral donors. Under this approach, strong institutional performance or policy reform favoring the environment would be rewarded with increased concessionality on environment-related loans. For example, strong institutional performance on a forestry project would lead to lower interest payments on the investment component of the project.

Under this scenario, it is not expected that the World Bank would be able to offer concessionality on its investments. Rather, financial concessions could be granted by the bilaterals to their own cofinanced portion of the project. The benefits would be: (a) the incentive for strong institutional performance could remain in place as long as the loan was being repaid, as opposed to disappearing once the disbursements were made; and (b) it would encourage environment-related cofinancing arrangements between the World Bank and bilateral donors.

work is to place the environment in a development context. This is a key step, for this links actions on critical environmental issues with broader micro- and macroeconomic variables. Also, a NEAP can help ensure that a balance between top-down and bottom-up activities is preserved. However, the lessons from the first round of NEAPs is not all positive: in the future, more targeted planning exercises, geographically or sectorally, may be less unwieldy and less political.

The priorities for the World Bank in the context of NEAPs are:

- Assist countries to complete their NEAPs, through technical assistance and careful review. Sri Lanka was one of the first Asian countries to complete the exercise (box 8.3).
- Establish linkages between NEAPs and the Bank's country assistance strategies, through closer collaboration between the Bank's environmental units and country operation departments. Both within the Bank and in its client countries there is a need to prevent "environmental separatism."
- Assist countries in implementing NEAP recommendations. The World Bank can help countries, building on their NEAPs, to analyze tradeoffs and recommend priorities that can be acted upon by national decision-makers.
- Assist countries in periodic review of NEAP recommendations, against the backdrop of changing circumstances and priorities. This will also require new analytical and planning work in areas that may be more focused (both geographically and sectorally) than NEAPs.

Strengthening Environmental Assessments

The basic purpose of the EA is to minimize the environmental impacts of proposed projects through creative comparisons of alternative project approaches and mitigatory measures. While EA preparation is the responsibility of the borrower, both the Bank staff and borrower countries should use the EA as a planning tool and as a means of adding to the value of projects. All too often, an EA is viewed as a necessary bureaucratic obstacle, not as an opportunity to improve project design.

To help strengthen the use of EAs, there is a need to provide more sector-specific EA training for both Bank task managers and trainers in borrower countries. Increasing the capacity of key agencies to improve the quality of all EAs—whether tied to World Bank lending or not—is an important long-term goal.

Box 8.3: The National Environmental Action Plan for Sri Lanka

The Sri Lanka NEAP was developed under the guidance of a National Environmental Steering Committee, with World Bank assistance, and was completed in June 1991. It focuses on the eight areas of land degradation and water resources, coastal erosion, gem mining, forestry, biodiversity and wildlife protection, urban and industrial pollution, energy conservation and efficiency, and institutional capacity. The NEAP identifies short- and medium-to-long term issues and actions for the Government, NGOs, and donor community to consider. These recommendations cover policy reform, institutional strengthening, and investment.

The recommendations for immediate action include proposals for strengthening legal frameworks, technical assistance to strengthen environmental institutions, and data collection activities to meet requirements for environmental management. For example, for biodiversity conservation, the proposals include establishing the legal framework of the Wildlife Trust Fund, commissioning a team of tourism specialists to develop nature oriented tourism and compiling a national inventory of wetland resources.

Medium- to long-term recommendations deal with policy reform, feasibility studies, and investment. Again, for biodiversity conservation, the proposals include preparation and implementation of conservation plans for six protected area clusters, pilot projects to test buffer zone protection models, private-public partnerships for wetland management, and preparation and implementation of an elephant management program.

The NEAP also estimates the costs of its recommendations. The estimated cost for studies and technical assistance is $28.8 million, of which $7.4 is for immediate action. The investment capital requirements are estimated to exceed $250 million for the period 1992–2000, an amount that far exceeds the level of donor support for the environment in Sri Lanka during the previous decade.

Strengthening Consultation and Participation

The quality of project design, EAs, and implementation can be considerably improved by increased consultation with and participation by those affected by the project. Consultation refers to the process in which interested groups can express their opinions at discrete points during project design. Participation suggests a broader involvement by affected parties in both project design and implementation. (Participation can lead to the sharing of decisionmaking authority, whereas consultation does not.)

The findings of recent post-project evaluations have indicated that project success is highly dependent on what project stakeholders do within the project context—particularly when a large number of people are involved, as in urban, small- and medium-scale industries, agricultural, and forestry projects. While the current World Bank Operational Directive 4.01 makes it mandatory that the borrower consult with affected groups and NGOs in the process of preparing an EA, field-oriented guidelines for task managers and borrower country officials are lacking.

In response to this, the World Bank Asia Technical Department plans to embark on a program to develop country-specific procedures and manuals on conducting consultation and to organize in-country training seminars using video tapes and other media. The Department also plans to provide technical advice to task managers in preparing terms of reference, selecting consultants (including NGOs) and reviewing reports. This work represents just the first step in a process of participatory design for many projects.

Establishing Appropriate Environmental Standards

The environmental guidelines applied by the Bank in the assessment of urban, industry, and energy sector projects have not been updated in nearly a decade. The older guidelines are now being re-examined in order to make them more flexible and appropriate to project assessment (box 8.4). There is a role for the Bank to also assist Asian countries in adopting new standards, especially in shifting from concentration-based standards to load-based standards in the industry and energy sectors.

Encouraging Private Sector Involvement

Private sector involvement is essential in advanc-

Box 8.4: Revising Environmental Standards

The revised World Bank Industrial Pollution Prevention and Abatement Guidelines, now under preparation, consolidate the standards adopted by the OECD countries, and will present best practices in each of eighteen industries. As a reference, the Guidelines should be of equal usefulness to Asian country governments considering new standards, and to donors appraising projects with environmental impacts.

The Guidelines recognize the distinctions between new and older technologies. Some older technologies, even after renovation, may not be able to meet the standards of the Best Practicable Technology (BPT), which was the common standard adopted in the early 1980s, much less Best Available Technology, Economically Achievable (BATEA), which corresponds to the newest technologies. An example of this is China. Many village enterprises cannot meet BPT, even after upgrading, but neither can they be simply shut down without a well-considered period of transition. Up to the point where polluting plants are closed, efforts should be made to improve the monitoring of local impacts, upgrade technologies and processes, and increase industrial efficiency as a cost-effective way of reducing existing levels of pollution.

ing the key elements of an environmental strategy. A one-sided punitive regulatory approach will be less effective than a collaborative approach in which industry is actively consulted in setting standards and engaged in self-monitoring. A favorable business environment will also help facilitate the mobilization of required capital, technologies, and service industries. The World Bank can reinforce this in its general policy dialogue with borrower countries.

Strengthening Internal Processes

The World Bank can do more to improve its internal processes, especially on projects with environmental or social impacts. As mentioned, the Bank's project pipeline already reflects many of the priority areas for environmental lending. Several topics concerning how projects are designed, such as strengthening NEAPs, the EA process, consultation, and technical assistance to public institutions, have already been discussed. However, even more needs to be done:

- **Strengthening the Bank's role in project implementation**. Within the Bank, the emphasis on loan approval is not matched by equal emphasis on implementation. A recent Bank report—often called the Wapenhans report after the task force chairman (World Bank 1992)—recommends that the Bank pay much greater attention to project implementation. These recommendations are especially important with regard to environmental concerns. Without adequate supervision, the policies and conditions imposed by environmental assessments may not be enforced, and the EA process itself will become severely marginalized. Ultimately, the credibility of the Bank's environmental work would be undermined.
- **Strengthening the Bank's role in policy implementation**. The Bank should increasingly address the "nuts-and-bolts" issues associated with policy implementation—taking into account the compromises necessitated by institutional weaknesses, corruption, and lack of data. Examples of ways to do this are: helping countries calculate optimal levels of pollution taxes, by pollutant; suggesting operational approaches to improved pollution monitoring, auditing, and enforcement; and introducing cost-effective approaches to data collection and use. As mentioned above, institutional strengthening and policy implementation go hand-in-hand and must be viewed as a long-term prospect.

New Analytical Work

Economic and Sector Work (ESW)

The current ESW program concerning the environment shows a clear emphasis on the brown sectors (table 8.1). This emphasis is largely appropriate, given the problems, pipeline lending emphasis, and World Bank priorities identified above.

Nevertheless, there remain gaps in the Bank's knowledge in addressing environmental problems, and additional work is recommended. The most important areas for additional work are presented in box 8.5, below. Consistent with the need to combine both top-down and bottom-up approaches, the

Table 8.1: Current and Planned Economic and Sector Work (ESW) with an Environmental Emphasis, 1993–95

Urban/Industry	Agriculture/Forestry/ Energy	Natural Resources	Population
Regional	*Asia regional*	*Asia regional*	
Intl. pollution guidelines	Atmospheric emissions	Water resources, forestry, biodiversity action plans	
By country	*By country*	*By country*	*By country*
China (env. mgt.)	China (energy conservation, rural energy, and Sichuan energy)	Indonesia (Eastern Islands, forestry)	Bangladesh
Indonesia (env. mgt.)	Indonesia	Laos	
Korea	Papua New Guinea	Pacific Islands	
Malaysia	Viet Nam		
Philippines			
Thailand			
Bangladesh (urban)	India	India (groundwater, forestry)	
Bangladesh (water)	Pakistan	Pakistan	
India	Sri Lanka		
Nepal (water)			
Pakistan			
Sri Lanka			

recommended research programs addresses needs on both levels. It is not assumed that the World Bank alone should undertake or manage all of the above work. However, the Bank, other donors, and countries themselves all have an interest in seeing work done in these areas.

Perhaps the most important work required to improve top-down policymaking are the first four items in box 8.5. Detailed case studies that show (as quantitatively as possible) a negative impact on future growth due to unmanaged environmental degradation today are useful to convince national leaders and financial managers of the importance of more aggressive environmental care-taking. Items 2 and 3, combined, allow environmental costs to be better compared with abatement costs for the purpose of setting investment priorities. From the bottom-up perspective, some of the most important topics for further work are items 5 through 8. Most of the these topics can have fairly immediate payoff in improving project design and institutional strengthening. The last topic, data collection and indicators, will require a longer-term effort.

Better Guidance on Projects that Address Pollution

The World Bank has recently completed strategies for Asian forestry, water resource, watershed management, and biodiversity projects. Similar work remains to be completed in the areas of urban environmental lending, industrial pollution, and energy. (Of the three, however, work on Asian urban guidelines is most advanced.) These strategies are important because even where there is broad agreement on environmental priorities (such as industrial pollution control), there is still often little consensus on the most cost-effective means to target project expenditures.

Next Steps

Pursuing environmental sustainability in Asia is important in light of what is at stake. Local pollution issues affecting Asian cities are approaching

Box 8.5: Priority Areas For Additional Environment-Related Analytical Work

Lessons from Experience	Case studies on how other countries have addressed environmental issues. Lessons learned can help Asian countries establish priorities; illustrate that prevention is cheaper than rehabilitation; draw policy, institutional, and political lessons; and help sequence interventions.
Valuation	Expanded valuation of environmental degradation should be undertaken in both the brown and green sectors. This work is essential to improving the setting of investment priorities, by improving the comparisons between the cost of degradation and abatement costs.
The cost of investing in the environment	More analysis should be done on the financial cost of improved environmental policies and investments, to better analyze the financing or funding role of the public sector, private sector, the World Bank, and other donors.
Approaches to Regulation and Enforcement	Practical guidelines and case studies are needed on the design, implementation, and enforcement of environmental regulations (including on very practical concerns such as corruption), particularly in the brown sectors.
Approaches to Decentralization	Guidelines are needed on decentralized environmental management, including local management and monitoring responsibilities, local fiscal authority, and central-local relations between the central and local agencies.
Public participation, public disclosure, and the role of NGOs	Positive examples are needed of the role of the public in setting priorities, assisting in project design, and securing long-term commitments to environmental management from both the government and the private sector. these case studies can be provided only as experience is gained.
Financing mechanisms	Innovative financing mechanisms for environment-related infrastructure investments should be developed, including ways of sharing costs, risks, benefits. This is particularly important in the case of large sewerage and urban transit investments.
Rural land management	Research is needed on the difficult problems of rural land management, particularly on marginal lands in the context of shifting agriculture, growing population, and rapid deforestation.
Data collection	Practical methods for collecting comprehensive data on environmental problems are needed, particularly on the magnitude of soil erosion and soil degradation,and the magnitude and types of urban and industrial pollution, including hazardous wastes.

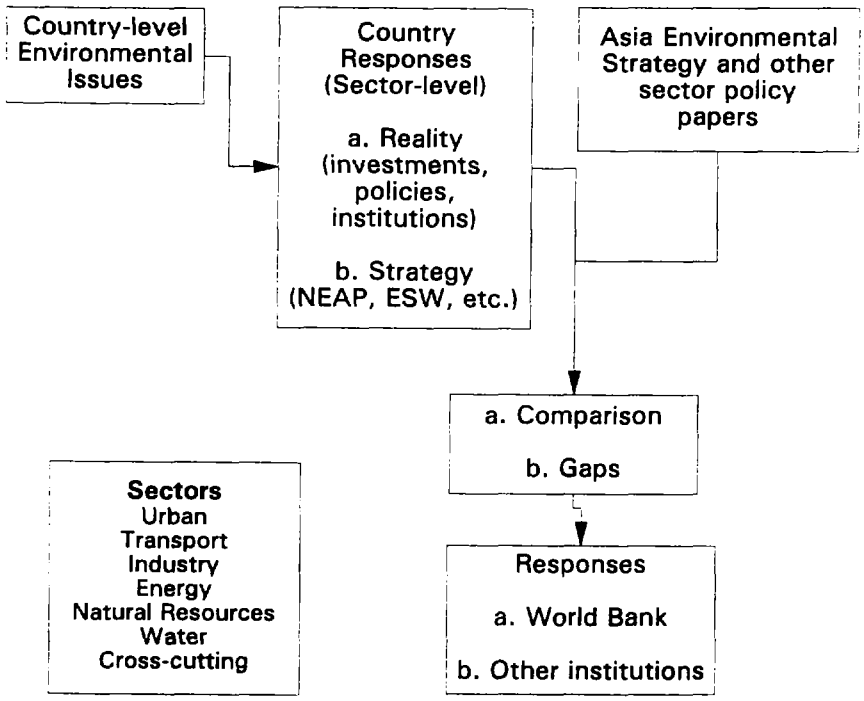
thresholds of unacceptably high social and economic costs. Degrading lands threaten the ability of millions to feed themselves. Also, the future environmental balance in Asia is critical for the global environment, particularly for greenhouse gas emissions, forestry, and biodiversity. The magnitude of the problem requires the concerted efforts of governments, donors, the private sector, communities, and NGOs. Although economic growth in Asian countries has given these countries some room to address environmental issues, the financial and technical resources required are beyond the capacity of any individual country or donor.

Many donors and bilaterals are active in Asia, including UNDP, ADB, ESCAP, the Overseas Economic Cooperation Fund (OECF) (Japan), USAID, and others. As detailed in Appendix C, OECF was the largest of the major funders of Asian environmental activities in 1991 ($652 million), followed closely by the World Bank ($603 million). Together, these two donors accounted for 92 percent of environmental funding. The other 8 percent was made up of USAID ($62 million), UNDP ($27 million), and ADB ($16 million). While OECF has a major program in urban environmental management, the smaller donors have focussed on the green sectors (UNDP and USAID) and on cross-sectoral technical assistance (ADB).

Many donor agencies—including the World Bank—are currently laying the foundations of their environmental work in Asia for the post-UNCED period. For example, UNDP is producing a report to depict the linkages between its programs and Agenda 21 in Asia, and has started a pilot Sustainable Development Initiative in Asia. ADB has commissioned a study to identify funding needs and mechanisms for the environment in Asian countries. ESCAP has convened the Inter-Agency Committee

on Environment and Development for Asia, and is beginning work on an environmental report to develop strategies to address regional environmental issues (to be completed by 1995). The Japanese government has indicated an interest in setting up an Asian Environment Fund, as well as International Environmental Technology Centers (with UNEP).

Figure 8.3: Applying the Asia Environmental Strategy



The World Bank's next step will be to compare current circumstances in each country with the approaches identified in this and other reports, such as each country's NEAP or sector strategies (figure 8.3). The purpose of the comparison is to identify possible gaps in the responses taken by each country to priority environmental issues. The gaps could be at the level of actual interventions (for example, investments, policies, or institutional technical assistance), or at the level of necessary further analysis (such as improved NEAPs or sector studies). Then, once gaps have been identified, country governments, the World Bank, and possibly other donors, can consider appropriate responses. Clearly each of these steps is ongoing and iterative.

Given the magnitude of the environmental problems in Asia, efficiency in all areas—in investments, operations, institutions, and donor interventions—is highly desirable. The more the donor community can agree on priorities and coordinate their approaches, the more likely their work will be complementary and ultimately useful to Asian countries. It is hoped that the cluster of World Bank activities described here, including its analytical work and lending, will help both countries and donors in this important area of donor coordination.

In summary, the World Bank environmental strategy for Asia ties together elements of the Bank's lending pipeline, policy dialogue, technical assistance activities, and internal procedures. Project lending, the traditional yardstick of World Bank involvement, is only one of several equally important components of the strategy. This complexity is due to the cross-sectoral nature of environmental concerns, and to the multipronged approaches required within sectors to achieve environmental objectives. Successful implementation of the environmental strategy proposed here can only be measured in terms of progress across a wide spectrum of policy, institutional, social, technical, and financial indicators.

APPENDIX A

Statistical Profile of Key Environmental Issues in Asia

General

1. Basic Indicators
2. Structure of Production, 1965 and 1990
3. Growth of Production, 1965–80 and 1980–90
4. Total Population and Average Growth Rate, 1960-2025

Urban and Infrastructure

5. Population (1950–2000) of Urban Areas in Asia with 4 Million or More Inhabitants in 1990
6. Urban Population in Asia, 1960–2025
7. Access to Safe Drinking Water and Sanitation in Urban Areas in Asia, 1988
8. Total Motor Vehicles in Use in Selected Asian Countries, 1965–89

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9. Energy Consumption in Asia, 1980-90
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11. Power Sector: Projected Installed Capacity (1999) and Average Annual Growth Rate (1989–1999)

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12. Structure of Manufacturing, 1970 and 1989
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15. Land Use in Asia, 1989
16. Cropland in Asia, 1989
17. Area Expansion and Yield Effects of Cereal Production, 1961–63 and 1988–90
18. Fertilizer Consumption, 1961–63 and 1987–89

Note on Statistical Tables

.. not available.

Regional division used in these tables correspond with World Bank operational departments:

EA1 (Cambodia, Korea, Lao P.D.R., Malaysia, Myanmar, Philippines, Thailand, Viet Nam)
EA2 (China, Mongolia)
EA3 (Fiji, Indonesia, Kiribati, Marshall Islands, Micronesia, Papua New Guinea, Soloman Islands, Tonga, Vanuatu, Western Samoa)
SA1 (Bangladesh, Bhutan, Nepal)
SA2 (India)
SA3 (Afghanistan, Maldives, Pakistan, Sri Lanka)

Table A.1: Basic Indicators

	Population (millions) mid- 1990	GNP per capita Dollars 1990	GNP per capita Average Annual Growth Rate (percent) 1965-90	Average annual rate of inflation (percent) 1965-80	Average annual rate of inflation (percent) 1980-90	Life expectancy at birth (years) 1990
East Asia	1,577.2	600	5.3	9.3	6.0	68
EA1						
Cambodia	8.5	..	..	..	..	50
Korea, Rep.	42.8	5,400	7.1	18.4	5.1	70
Lao, P.D.R.	4.1	200	..	..	..	49
Malaysia	17.9	2,320	4.0	4.9	1.6	70
Myanmar	41.6	..	1.7	8.6	11.4	61
Philippines	61.5	730	1.3	11.4	14.9	64
Thailand	55.8	1,420	4.4	6.2	3.4	66
Viet Nam	66.3	..	..	..	..	67
EA2						
China	1,133.7	370	5.8	-0.3	5.8	70
Mongolia	2.1	..	..	..	-1.3	63
EA3						
Fiji	0.7	1,780	1.9	10.3	5.4	65
Indonesia	178.2	570	4.5	35.5	8.4	62
Kiribati	0.1	..	..	..	..	
Maldives	0.2	450	2.8	..	..	62
Papua New G.	3.9	860	0.1	8.1	5.3	55
Solomon Is.	0.3	590	..	7.7	10.0	65
Tonga	0.1	1,010	..	..	..	67
Vanuatu	0.2	1,100	..	..	4.9	65
Wn. Samoa	0.2	730	..	..	9.2	66
South Asia	1,147.7	330	1.9	8.3	8.0	58
SA1						
Bangladesh	106.7	210	0.7	15.9	9.6	52
Bhutan	1.4	190	..	..	8.4	49
Nepal	18.9	170	0.5	7.8	9.1	52
SA2						
India	849.5	350	1.9	7.5	7.9	59
SA3						
Afghanistan	..	..	..	..	..	42
Pakistan	112.4	380	2.5	10.3	6.7	56
Sri Lanka	17.0	470	2.9	9.4	11.1	71

Source: Bank economic and social database.

Table A.2: Structure of Production, 1965 and 1990

	GDP (millions of dollars)		Distribution of gross domestic product (percent)							
			Agriculture		Industry		Manufacturing		Services, etc.	
	1965	1990	1965	1990	1965	1990	1965	1990	1965	1990
East Asia	92,540	821,230	37	21	32	45	24	34	30	36
EA1										
Cambodia	869	..	..	..	..	..	..	..	..	..
Korea, Rep.	2,996	236,397	38	9	25	45	18	31	37	46
Lao, P.D.R.	..	870	..	..	..	..	..	..	..	..
Malaysia	3,130	42,398	28	..	25	..	9	..	47	..
Myanmar	1,601	22,197	35	57	13	11	9	8	52	32
Philippines	6,010	43,861	26	22	27	35	20	25	47	43
Thailand	4,389	80,172	32	12	23	39	14	26	45	48
Viet Nam	..	9,072	..	..	..	..	..	..	..	..
EA2										
China	67,199	364,903	38	27	35	42	28	38	27	31
Mongolia	..	2,251	..	17	..	34	..	..	..	49
EA3										
Fiji	132	1,228	34	20	25	20	17	10	41	59
Indonesia	5,981	107,293	51	22	13	40	8	20	36	38
Kiribati	..	..	..	..	..	..	..	..	..	..
Maldives	..	101	..	..	..	..	..	..	..	..
Papua New G.	344	3,288	42	29	18	31	..	12	41	40
Solomon Is.	..	155	..	..	..	..	..	..	..	..
Tonga	..	..	..	..	..	..	..	..	..	..
Vanuatu	..	141		19	..	13	..	5	..	68
Wn. Samoa	..	..	..	..	..	..	..	..	..	..
South Asia	64,510	345,640	44	33	21	26	15	17	35	41
SA1										
Bangladesh	4,377	22,884	53	38	11	15	5	9	36	46
Bhutan	..	280	..	43	..	27		10		29
Nepal	730	2,890	65	60	11	14	3	5	23	26
SA2										
India	50,531	254,543	44	31	22	29	16	19	34	40
SA3										
Afghanistan	970	..	..	..	..	..	..	..	..	..
Pakistan	5,450	35,500	40	26	20	25	14	17	40	49
Sri Lanka	1,770	7,250	28	26	21	26	17	15	51	48

Source:. Bank economic and social database.

Table A.3: Growth of Production, 1965–80 and 1980–90

	Average annual growth (percent)									
	GDP		Agriculture		Industry		Manufacturing		Services, etc.	
	1965–80	1980–90	1965–80	1980–90	1965–80	1980–90	1965–80	1980–90	1965–80	1980–90
East Asia	7.3	7.8	3.2	4.8	10.8	10.2	10.3	12.4	8.9	8.0
EA1										
Cambodia	..	..	..	..	..	..	..	..	..	..
Korea, Rep.	9.9	9.7	3.0	2.8	16.4	12.2	18.7	12.7	9.6	9.2
Lao, P.D.R.	..	..	..	..	..	..	..	..	..	..
Malaysia	7.4	5.2	..	3.8	..	7.1	..	8.8	..	4.2
Myanmar	..	..	..	..	..	..	..	..	..	..
Philippines	5.7	0.9	3.9	1.0	7.7	-0.8	6.8	0.1	5.0	2.6
Thailand	7.3	7.6	4.6	4.1	9.5	9.0	11.2	8.9	7.4	7.8
Viet Nam	..	..	..	..	..	..	..	..	..	..
EA2										
China	6.8	9.5	2.8	6.1	10.0	12.5	8.9	14.4	11.9	9.1
Mongolia	..	5.6	..	..	..	..	..	..	..	..
EA3										
Fiji	6.0	1.6	2.4	1.7	4.2	-1.1	3.7	1.1	9.2	2.6
Indonesia	7.0	5.5	4.3	3.2	11.9	5.6	12.0	12.5	7.3	6.7
Kiribati	..	..	..	..	..	..	..	..	..	..
Maldives	..	..	..	..	..	..	..	..	..	..
Papua New G.	4.1	1.9	3.1	1.7	..	2.7	..	1.9	..	1.4
Solomon Is.	..	..	..	..	..	..	..	..	..	..
Tonga	..	..	..	..	..	..	..	..	..	..
Vanuatu	..	3.1	..	2.1	..	..	..	..	..	..
Wn. Samoa	..	..	..	..	..	..	..	..	..	..
South Asia	3.6	5.2	2.5	3.0	4.3	6.5	4.5	6.8	4.5	6.3
SA1										
Bangladesh	1.7	4.3	0.6	2.6	1.5	4.9	2.8	2.8	3.6	5.8
Bhutan	..	7.5	..	4.8	..	14.8	..	15.2	..	7.4
Nepal	1.9	4.6	1.1	4.8	..	..	..	..	..	..
SA2										
India	3.6	5.3	2.5	3.1	4.2	6.6	4.5	7.1	4.4	6.5
SA3										
Afghanistan	..	..	..	..	..	..	..	..	..	..
Pakistan	5.2	6.3	3.3	4.3	6.4	7.3	5.7	7.7	5.9	6.9
Sri Lanka	4.0	4.0	2.7	2.3	4.7	4.6	3.2	6.3	4.6	4.7

Source: Bank economic and social database.

Table A.4: Total Population and Average Growth Rate, 1960-2025

	Total Population (thousands)					Average Annual Growth Rate (Percent)	
	1960	1990	2000	2010	2025	1960-1990	1990-2025
Asia Region	1,483,305	2,776,491	3,312,721	3,771,015	4,348,027	2.1	1.3
East Asia	908,652	1,630,745	1,886,263	2,068,610	2,300,452	2.0	1.0
South Asia	574,653	1,145,746	1,426,458	1,702,405	2,047,575	2.3	1.7
EA1	151,195	299,552	358,594	414,657	486,866	2.3	1.4
Cambodia	5,433	8,246	10,046	11,539	13,989	1.4	1.5
Korea, Rep.	25,003	42,793	46,403	49,459	51,631	1.8	0.5
Lao, P.D.R.	2,177	4,139	5,463	6,838	8,600	2.2	2.1
Malaysia	8,140	17,891	21,983	25,169	30,116	2.7	1.5
Myanmar	21,746	41,675	51,129	60,567	72,619	2.2	1.6
Philippines	27,561	62,413	77,473	92,095	111,509	2.8	1.7
Thailand	26,392	55,702	63,670	71,594	80,911	2.5	1.1
Viet Nam	34,743	66,693	82,427	97,396	117,491	2.2	1.6
EA2	658,451	1,141,250	1,302,027	1,398,934	1,517,414	1.9	0.8
China	657,492	1,139,060	1,299,180	1,395,328	1,512,585	1.8	0.8
Mongolia	959	2,190	2,847	3,606	4,829	2.8	2.3
EA3	99,006	189,943	225,642	255,019	296,172	2.2	1.3
Fiji	394	764	883	994	1,121	2.2	1.1
Indonesia	96,194	184,283	218,661	246,680	285,913	2.2	1.3
Kiribati	41	66	72	78	80	1.6	0.6
Maldives	92	215	283	350	432	2.9	2.0
Papua New Guinea	1,920	3,874	4,845	5,846	7,291	2.4	1.8
Solomon Island	124	320	429	551	743	3.2	2.4
Tonga	65	95	92	91	89	1.3	-0.2
Vanuatu	65	158	206	257	331	3.0	2.1
Western Samoa	111	168	171	172	172	1.4	0.1
SA1	61,690	136,252	176,579	219,494	273,030	2.7	2.0
Bangladesh	51,419	115,593	150,589	188,196	234,987	2.7	2.0
Bhutan	867	1,516	1,906	2,388	3,070	1.9	2.0
Nepal	9,404	19,143	24,084	28,900	34,973	2.4	1.7
SA2							
India	442,344	853,094	1,041,543	1,223,483	1,442,386	2.2	1.5
SA3	70,619	156,400	208,336	259,438	332,159	2.7	2.2
Afghanistan	10,775	16,557	26,511	32,422	40,475	1.4	2.6
Pakistan	49,955	122,626	162,409	205,496	267,112	3.0	2.2
Sri Lanka	9,889	17,217	19,416	21,520	24,572	1.9	1.0

Source: United Nations, 1991, 'World Urbanization Prospects 1990.'

Table A.5: Population (1950-2000) of Urban Areas in Asia with 4 Million or More Inhabitants in 1990

Country/ Cities	(thousands)						Average Annual Growth Rate (Percent)				
	1950	1960	1970	1980	1990	2000	1950-1960	1960-1970	1970-1980	1980-1990	1990-2000
EAST ASIA:											
China											
Beijing	3,913	6,269	8,087	9,029	10,787	14,041	4.8	2.6	1.1	1.8	2.7
Shanghai	5,333	8,839	11,154	11,739	13,422	17,022	5.2	2.4	0.5	1.3	2.4
Shenyang	2,091	2,873	3,493	3,913	4,763	6,308	3.2	2.0	1.1	2.0	2.8
Tianjin	2,374	3,618	5,222	7,268	9,371	12,741	4.3	3.7	3.4	2.6	3.1
Indonesia											
Jakarta	1,969	2,776	3,916	5,985	9,253	13,739	3.5	3.5	4.3	4.5	4.0
Korea, Rep.											
Seoul	1,021	2,361	5,312	8,283	10,979	12,692	8.7	8.4	4.5	2.9	1.5
Philippines											
Metro Manila	1,544	2,274	3,535	5,961	8,475	11,795	3.9	4.5	5.4	3.6	3.4
Thailand											
Bangkok	1,360	2,151	3,110	4,747	7,156	10,256	4.7	3.8	4.3	4.2	3.7
SOUTH ASIA:											
Bangladesh											
Dhaka	420	647	1,503	3,290	6,616	12,162	4.4	8.8	8.1	7.2	6.3
India											
Bangalore	764	1,173	1,616	2,812	4,993	8,219	4.4	3.3	5.7	5.9	5.1
Bombay	2,901	4,060	5,812	8,067	11,169	15,381	3.4	3.7	3.3	3.3	3.3
Calcutta	4,446	5,500	6,912	9,030	11,835	15,680	2.2	2.3	2.7	2.7	2.9
Delhi	1,391	2,283	3,531	5,559	8,766	13,240	5.1	4.5	4.6	4.7	4.2
Madras	1,397	1,706	3,030	4,203	5,702	7,773	2.0	5.9	3.3	3.1	3.1
Pakistan											
Karachi	1,028	1,848	3,119	4,946	7,702	11,658	6.0	5.4	4.7	4.5	4.2
Lahore	826	1,264	1,964	2,850	4,092	5,954	4.3	4.5	3.8	3.7	3.8

Source: United Nations, 1991, "World Urbanization Prospects 1990."

Table A.6: Urban Population in Asia, 1960–2025

	Urban Population (thousands)					Average Annual Growth Rate (%)		Urban Population as Percent of Total Population		
	1960	1990	2000	2010	2025	1960–1990	1990–2025	1960	1990	2025
Asia Region	266,209	840,865	1,296,156	1,752,929	2,473,201	3.9	3.1	17.9	30.3	56.9
East Asia	170,163	543,723	849,409	1,099,939	1,447,547	3.9	2.8	18.7	33.3	62.9
South Asia	96,046	297,142	446,747	652,990	1,025,654	3.8	3.6	16.7	25.9	50.1
EA1	30,662	104,351	145,236	194,922	276,486	4.2	2.8	20.3	34.8	56.8
Cambodia	559	959	1,460	2,276	4,223	1.8	4.3	10.3	11.6	30.2
Korea, Rep.	6,929	30,794	37,773	42,568	46,067	5.1	1.2	27.7	72.0	89.2
Lao, P.D.R.	173	770	1,372	2,229	3,831	5.1	4.7	7.9	18.6	44.5
Malaysia	2,053	7,701	11,255	14,702	20,394	4.5	2.8	25.2	43.0	67.7
Myanmar	4,189	10,316	14,523	21,422	34,365	3.0	3.5	19.3	24.8	47.3
Philippines	8,350	26,602	37,775	51,201	72,940	3.9	2.9	30.3	42.6	65.4
Thailand	3,302	12,609	18,738	26,669	39,772	4.6	3.3	12.5	22.6	49.2
Viet Nam	5,107	14,600	22,340	33,855	54,894	3.6	3.9	14.7	21.9	46.7
EA2	125,234	381,948	616,083	784,709	998,817	3.8	2.8	19.0	33.5	65.8
China	124,892	380,803	614,514	782,538	995,477	3.8	2.8	19.0	33.4	65.8
Mongolia	342	1,145	1,569	2,171	3,340	4.1	3.1	35.7	52.3	69.2
EA3	14,267	57,424	88,090	120,308	172,244	4.8	3.2	14.4	30.2	58.2
Fiji	117	300	378	484	668	3.2	2.3	29.7	39.3	59.6
Indonesia	14,032	56,293	86,401	117,767	167,979	4.7	3.2	14.6	30.5	58.8
Kiribati	7	24	31	39	49	4.2	2.1	17.1	36.4	61.3
Maldives	10	63	106	160	246	6.3	4.0	10.9	29.3	56.9
Papua New G.	51	613	979	1,560	2,791	8.6	4.4	2.7	15.8	38.3
Solomon Is.	11	34	59	106	220	3.8	5.5	8.9	10.6	29.6
Tonga	12	19	23	29	39	1.5	2.1	18.5	20.0	43.8
Vanuatu	6	41	69	107	176	6.6	4.3	9.2	25.9	53.2
Wn. Samoa	21	37	44	56	76	1.9	2.1	18.9	22.0	44.2
SA1	2,958	20,923	38,143	63,065	110,357	6.7	4.9	4.8	15.4	40.4
Bangladesh	2,644	19,005	34,548	56,999	99,078	6.8	4.8	5.1	16.4	42.2
Bhutan	22	81	149	272	584	4.4	5.8	2.5	5.3	19.0
Nepal	292	1,837	3,446	5,794	10,695	6.3	5.2	3.1	9.6	30.6
SA2										
India	79,413	230,269	336,542	480,806	737,155	3.6	3.4	18.0	27.0	51.1
SA3	13,675	45,950	72,062	109,119	178,142	4.1	3.9	19.4	29.4	53.6
Afghanistan	861	3,021	5,884	9,129	16,148	4.3	4.9	8.0	18.2	39.9
Pakistan	11,042	39,250	61,477	93,385	151,529	4.3	3.9	22.1	32.0	56.7
Sri Lanka	1,772	3,679	4,701	6,605	10,465	2.5	3.0	17.9	21.4	42.6

Source: United Nations, 1991, "World Urbanization Prospects 1990."

Table A.7: Access to Safe Drinking Water and Sanitation in Urban Areas in Asia, 1988

	Percentage of Population with Access to:	
	Safe Drinking Water	Sanitation Services
EA1		
Cambodia	..	..
Korea, Rep.	91	99
Lao, P.D.R.	61	..
Malaysia	92	..
Myanmar	38	35
Philippines	100	98
Thailand	67	84
Viet Nam	48	48
EA2		
China	87	100
Mongolia	78	100
EA3		
Fiji	95	90
Indonesia	60	40
Kiribati	..	..
Maldives	..	..
Papua New Guinea	93	54
Solomon Island	82	56
Tonga	..	..
Vanuatu	..	..
Western Samoa	..	..
SA1		
Bangladesh	37	37
Bhutan	100	100
Nepal	66	n/a
SA2		
India	79	38
SA3		
Afghanistan	39	20
Pakistan	99	40
Sri Lanka	87	74
Asia Average	82	77

Source: World Bank data; World Resources Institute, 1992, "World Resources 1992-93: Toward Sustainable Development."

Table A.8: Total Motor Vehicles in Use in Selected Asian Countries, 1965–89

Year	China	India	Korea	Thailand
1965	289,373	..	..	..
1966	322,904	787,973	..	..
1967	374,446	824,173	..	..
1968	384,939	890,965	..	..
1969	436,413	969,097	..	..
1970	487,557	1,041,600	129,371	..
1971	542,896	1,118,989	144,337	400,532
1972	642,792	1,203,148	150,035	419,386
1973	717,583	1,111,668	170,714	451,655
1974	825,226	1,195,761	183,544	555,909
1975	946,833	1,215,500	200,521	604,759
1976	1,100,463	1,244,439	226,320	603,179
1977	1,250,827	1,379,642	275,312	704,233
1978	1,429,229	1,445,801	384,536	758,896
1979	1,585,678	1,572,630	494,378	841,727
1980	1,680,960	1,666,843,	527,729	881,860
1981	1,873,049	1,797,066	571,754	959,601
1982	2,053,174	1,957,991	646,996	986,736
1983	2,227,130	2,176,585	785,316	1,124,504
1984	2,433,713	2,253,000	948,319	1,201,819
1985	2,887,126	2,536,952	1,113,430	..
1986	3,574,463	2,815,836	1,309,434	1,470,417
1987	4,122,939	3,108,495	1,611,375	..
1988	4,776,352	3,573,725	2,035,448	2,667,832
1989	5,274,663	3,971,154	2,658,598	..

Sources: Motor Vehicle Manufacturers Association, "World Motor Vehicle Data", 1991; International Road Federation, "World Road Statistics" various years.

Table A.9: Energy Consumption in Asia, 1980–90

	Energy Consumption ('000 MTOE)		Average Annual Growth Rate (Percent)	Per Capita Energy Consumption (Kg per capita)		Energy Intensity (KGOE per 1987 US$GDP)	
	1980	1990	1980–90	1980	1990	1980	1990
Asia Region	597,258	1,051,356	5.8	262	383	0.99	0.84
East Asia	483,489	831,744	5.6	350	514	1.26	0.96
South Asia	113,769	219,612	6.8	126	195	0.51	0.57
EA1	73,501	143,441	6.9	301	481	0.44	0.37
Cambodia	99	153	4.4	60	59	..	0.13
Korea, Rep.	35,998	74,095	7.5	1,050	1,898	0.52	0.44
Lao, P.D.R.	77	104	3.1	33	39	..	0.08
Malaysia	7,914	18,867	9.1	616	974	0.34	0.46
Myanmar	1,415	1,758	2.2	60	82	0.16	0.17
Philippines	11,159	13,135	1.6	258	215	0.34	0.34
Thailand	12,119	28,758	9.0	241	352	0.38	0.42
Viet Nam	4,720	6,571	3.4	92	100	..	0.11
EA2	383,719	648,268	5.4	390	571	2.40	1.73
China	381,849	645,528	5.4	428	598	2.42	1.74
Mongolia	1,870	2,740	3.9	1,200	1,277	0.88	0.76
EA3	26,269	40,035	4.3	172	218	0.45	0.41
Fiji	242	264	0.9	526	538	0.21	0.19
Indonesia	25,271	38,795	4.4	190	272	0.47	0.42
Kiribati	9	7	-2.5	159	..	0.35	..
Maldives	14	32	8.6	92	144	..	0.35
Papua New Guinea	631	792	2.3	229	..	0.23	0.26
Solomon Island	34	54	4.7	1,669	..	0.38	0.32
Tonga	13	25	6.8	142	..	..	0.35
Vanuatu	21	22	0.5	339	..	0.22	..
Western Samoa	34	44	2.6	..	423	0.33	0.44
SA1	2,952	6,235	7.8	29	49	0.20	0.27
Bangladesh	2,765	5,914	7.9	34	57	0.22	0.30
Bhutan	8	54	21.0	..	13	0.05	0.18
Nepal	179	267	4.1	15	25	0.09	0.08
SA2							
India	97,490	185,444	6.6	161	231	0.54	0.59
SA3	13,327	27,933	7.7	118	186	0.50	0.59
Afghanistan	545	2,544	16.7	56	90	..	..
Pakistan	11,637	23,828	7.4	166	233	0.54	0.60
Sri Lanka	1,145	1,561	3.1	126	179	0.23	0.21

Note: .. = no available data.
Sources: World Bank data; United Nations, 1992, "1990 Energy Statistics Yearbook."

Table A.10: Fossil Fuel Consumption in Asia, 1990

	Coal		Gas		Oil		Total Fossil Fuel	
	'000 MTOE	Share	'000 MTOE	Share	'000 MTOE	Share	'000 MTOE	Share
EA1	34,131	6.0%	12,089	33.0%	89,444	43.3%	135,664	16.7%
Share /a	25.2%		8.9%		65.9%		100%	
Cambodia	0		0		150		150	
Korea, Rep.	24,760		3,023		41,217		69,000	
Lao, P.D.R.	0		0		77		77	
Malaysia	1,341		3,171		13,749		18,261	
Myanmar	73		1,002		577		1,652	
Philippines	1,476		0		10,666		12,142	
Thailand	3,406		4,893		19,977		28,276	
Viet Nam	3,075		0		3,031		6,106	
EA2	533,567	93.6%	14,187	38.7%	90,874	44.0%	638,628	78.5%
Share /a	83.5%		2.2%		14.2%		100%	
China	531,567		14,187		90,147		635,901	
Mongolia	2,000		0		727		2,727	
EA3	2,488	0.4%	10,399	28.4%	26,292	12.7%	39,179	4.8%
Share /a	6.4%		26.5%		67.1%		100%	
Fiji	10		0		225		235	
Indonesia	2,477		10,396		25,133		38,006	
Kiribati	0		0		7		7	
Maldives	0		0		32		32	
Papua New G.	1		3		752		756	
Solomon Is.	0		0		54		54	
Tongo	0		0		25		25	
Vanuatu	0		0		22		22	
Wn. Samoa	0		0		42		42	
E. Asia Total	570,186	100%	36,675	100%	206,610	100%	813,471	100%
Share /a	70.1%		4.5%		25.4%		100%	
SA1	316	0.2%	3,679	14.8%	2,085	3.5%	6,080	2.9%
Share /a	5.2%		60.5%		34.3%		100%	
Bangladesh	279		3,679		1,880		5,838	
Bhutan	13		0		27		40	
Nepal	24		0		178		202	
SA2: India	124,285	98.2%	9,267	37.2%	45,608	76.2%	179,160	84.8%
Share /a	69.4%		5.2%		25.5%		100%	
SA3	1,977	1.6%	11,955	48.0%	12,183	20.3%	26,115	12.4%
Share /a	7.6%		45.8%		46.7%		100%	
Afghanistan	100		1,760		619		2,479	
Pakistan	1,876		10,195		10,274		22,345	
Sri Lanka	1		0		1,290		1,291	
S. Asia Total	126,578	100%	24,901	100%	59,876	100%	211,355	100%
Share /a	59.9%		11.8%		28.3%		100%	

/a The share of total fossil fuel use.

Source: United Nations, 1992, "1990 Energy Statistics Yearbook."

Table A.11: Power Sector: Projected Installed Capacity (1999) and Average Annual Growth Rate (1989–99)

	Total		Coal		Oil		Gas		Hydro		Geothermal		Nuclear	
	(MW) 1999	Growth Rate (%) 1989–99	(MW) 1999	Growth Rate (%) 1989–99	(MW) 1999	Growth Rate (%) 1989–99	(MW) 1999	Growth Rate (%) 1989–99	(MW) 1999	Growth Rate (%) 1989–99	(MW) 1999	Growth Rate (%) 1989–99	(MW) 1999	Growth Rate (%) 1989–99
Asia Region	490,552	7.7	257,755	7.6	22,104	−1.3	22,476	9.5	143,724	8.2	2,963	11.1	23,530	9.6
East Asia	306,798	6.0	166,605	6.8	20,973	−1.5	15,313	8.8	86,744	6.5	2,963	11.1	14,200	6.4
China	220,000	6.6	136,700	6.6	9,000	0.0	0	0.0	70,400	7.3	0	0.0	3,900	–
Fiji	173	1.6	0	0.0	67	0.0	0	0.0	106	2.9	0	0.0	0	0.0
Indonesia	20,360	8.9	9,740	18.9	3,537	−1.4	2,972	17.8	3,716	5.5	395	10.9	0	0.0
Korea, Rep.	31,931	4.1	12,500	12.9	3,331	−3.6	2,300	−1.0	3,500	2.9	0	0.0	10,300	3.1
Lao, P.D.R.	169	0.0	0	0.0	14	0.0	0	0.0	155	0.0	0	0.0	0	0.0
Malaysia	8,538	5.0	600	0.0	737	−10.5	5,629	19.1	1,572	1.1	0	0.0	0	0.0
Myanmar	1,597	8.4	60	0.0	130	−0.4	610	9.8	797	11.1	0	0.0	0	0.0
Papua N. Guinea	394	6.0	0	0.0	119	2.9	0	0.0	275	7.6	0	0.0	0	0.0
Philippines	9,467	5.0	1,605	14.8	2,621	1.0	0	0.0	2,673	2.3	2,568	11.1	0	0.0
Thailand	14,169	0.6	5,400	−2.9	1,417	−1.3	3,802	5.4	3,550	4.7	0	0.0	0	0.0
South Asia	183,754	11.4	91,150	9.1	1,131	2.9	7,163	11.0	56,980	11.4	0	0.0	9,330	17.9
Bangladesh	4,908	9.6	600	–	436	1.2	3,642	10.5	230	0.0	0	0.0	0	0.0
India	158,766	10.4	90,400	9.1	315	6.5	3,521	11.5	55,200	11.9	0	0.0	9,330	17.9
Nepal	445	5.5	0	–	10	−9.1	0	0.0	435	6.4	0	0.0	0	0.0
Pakistan	18,000	7.0	–	–	–	–	–	–	–	–	–	–	–	–
Sri Lanka	1,635	3.0	150	–	370	3.2	0	0.0	1,115	1.7	0	0.0	0	0.0

Source: E.A. Moore and G. Smith. 1991. "Capital Expenditures for Electric Power in the Developing Countries in the 1990s." Energy Series Paper 21, World Bank, Washington, D.C.

Table A.12: Structure of Manufacturing, 1970 and 1989

	Value Added in manufacturing (millions current US$)		Distribution of manufacturing value added (percent; current prices)							
			Food, beverages and tobacco		Textiles and clothing		Machinery and transport equip.		Chemicals	
	1970	1989	1970	1989	1970	1989	1970	1989	1970	1989
East Asia	34,582	274,680	..	..	..	..	..	..	..	..
EA1										
Cambodia	..	..	..	..	..	..	..	..	..	..
Korea, Rep.	1,880	66,215	26	12	17	14	11	30	11	9
Lao, P.D.R.	..	..	..	..	..	..	..	..	..	..
Malaysia	500	..	26	18	3	7	8	23	9	14
Myanmar	225	1,546	..	..	..	..	..	..	..	..
Philippines	1,665	10,728	39	41	8	8	8	9	13	10
Thailand	1,130	17,635	43	29	13	18	9	13	6	7
Viet Nam	..	..	..	..	..	..	..	..	..	..
EA2										
China	27,555	145,646	..	12	..	14	..	26	..	12
Mongolia	..	..	..	..	..	..	..	..	..	..
EA3										
Fiji	27	111	61	..	2	..	3	..	3	..
Indonesia	994	17,272	65	..	14	..	2	..	6	..
Kiribati	..	..	..	..	..	..	..	..	..	..
Maldives	..	..	..	..	..	..	..	..	..	..
Papua New G.	35	392	23		1		35		4	
Solomon Is.	..	..	..	..	..	..	..	..	..	..
Tonga	..	..	..	..	..	..	..	..	..	..
Vanuatu	..	8	..	..	..	..	..	..	..	..
Wn. Samoa	..	..	..	..	..	..	..	..	..	..
South Asia	10,545	54,788	..	..	..	..	..	..	..	..
SA1										
Bangladesh	527	1,730	30	23	47	36	3	5	11	18
Bhutan	..	19	..	..	..	..	..	..	..	..
Nepal	32	151	..	35	..	25	..	2	..	8
SA2										
India	7,928	44,445	13	11	21	12	20	26	14	17
SA3										
Afghanistan	..	..	..	..	..	..	..	..	..	..
Pakistan	1,462	5,923	24	30	38	19	6	8	9	16
Sri Lanka	369	969	26	52	19	20	10	2	11	3

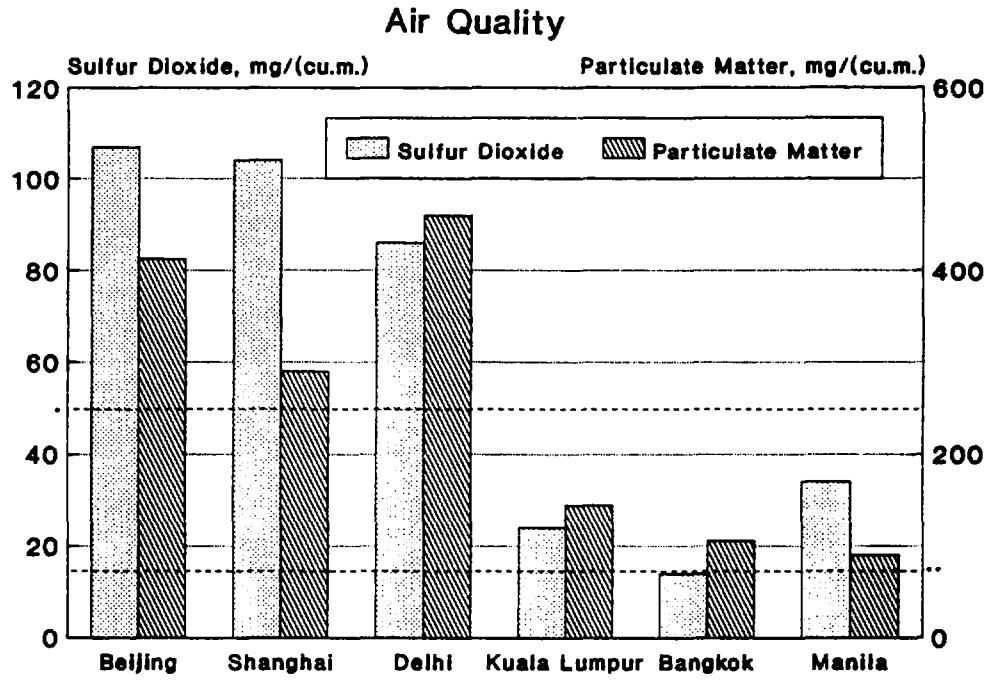
Source: Bank Economic and Social Database

Table A.13: Share and Growth of Some "Dirty" and "Clean" Industrial Sectors in Selected Countries in Asia
(in Constant 1985 Local Currency)

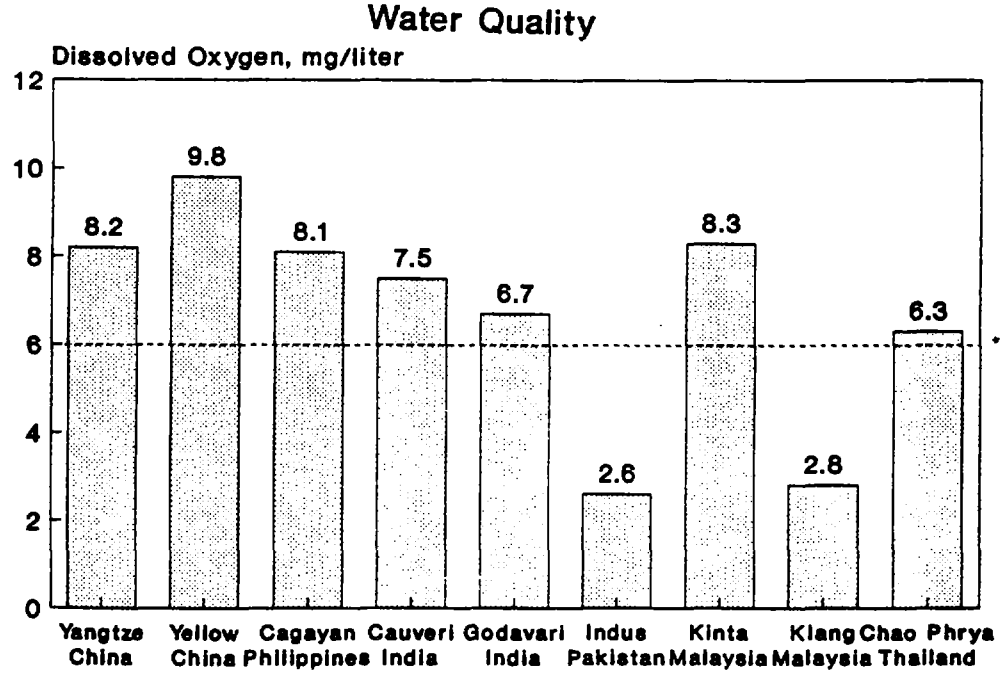
	Bangladesh (Mn. Taka)		China (Bn. Yuan)		India (Bn. Rupees)		Indonesia (Bn. Rupiahs)		Malaysia (Mn. Ringgit)		Philippines (Mn. Pesos)		Thailand (Bn. Bahts)		Korea, Rep. (Bn. Won)		Pakistan (Mn. Rupees)	
		Growth Rate		Growth Rate		Growth Rate		Growth Rate		Growth Rate		Growth Rate		Growth Rate		Growth Rate		Growth Rate
Code "Dirty" Industries	1989	1980–89	1989	1980–89	1989	1980–89	1988	1980–88	1989	1980–89	1989	1980–89	1988	1980–88	1989	1980–89	1988	1980–88
323 Leather Products	3,204	3.7%	7	−7.1%	9	4.7%	83	14.3%	32	2.7%	335	−4.0%	4	14.3%	1,791	17.3%	3,688	8.5%
341 Paper and Products	2,228	3.0%	13	−2.1%	23	3.4%	801	22.0%	804	10.6%	10,037	0.4%	36	4.4%	3,435	11.2%	1,638	8.5%
342 Printing and Publishing	604	4.5%	7	na	15	5.6%	683	21.7%	1,312	4.4%	4,455	−1.3%	7	4.6%	1,947	12.6%	1,498	10.5%
351 Industrial Chemicals	4,642	9.6%	47	−6.2%	106	5.9%	2,058	19.3%	4,110	18.9%	14,553	−0.3%	26	9.3%	6,089	6.6%	9,332	11.0%
352 Other Chemicals	5,657	−0.0%	24	−1.8%	100	5.3%	1,947	16.2%	1,488	6.3%	25,503	−0.7%	48	10.5%	4,442	10.6%	11,262	10.1%
371 Iron and Steel	2,706	−5.9%	32	−9.6%	132	3.4%	2,122	24.1%	2,407	12.3%	14,281	4.1%	29	−0.3%	9,032	9.5%	10,806	12.2%
372 Non–Ferrous Metals	na	na	14	−9.6%	26	7.2%	0	na	878	5.9%	8,548	16.1%	22	−1.1%	2,320	12.9%	35	−16.0%
Subtotal	19,040	1.4%	144	−6.1%	414	4.6%	7,695	19.9%	11,030	11.0%	77,713	1.2%	172	4.6%	29,057	10.0%	38,258	9.3%
Share in total manufacturing	26.9%		23.4%		32.5%		22.0%		15.7%		21.0%		13.4%		23.8%		20.5%	
"Clean" Industries																		
322 Wearing Apparel, Except Footwear	908	71.7%	18	na	15	13.4%	590	37.5%	1,540	13.1%	13,219	4.5%	90	9.7%	4,015	7.7%	1,823	21.7%
324 Footwear, Except Rubber or Plastic	621	10.6%	0	na	5	14.0%	113	10.9%	35	−8.7%	668	−1.0%	6	6.6%	726	12.4%	339	3.6%
382 Machinery, Except Electrical	874	12.0%	75	−15.3%	80	4.0%	271	9.7%	1,474	4.6%	3,258	−3.0%	27	9.6%	7,235	21.1%	5,158	14.7%
383 Machinery Electric	2,310	6.3%	68	na	90	5.4%	1,241	9.2%	14,193	12.9%	25,421	7.4%	40	5.7%	16,030	18.6%	6,112	10.0%
384 Transport Equipment	1,492	2.2%	30	na	81	4.9%	2,243	17.0%	2,103	5.9%	8,000	−7.6%	103	8.3%	10,857	15.6%	5,998	3.6%
385 Prof. and Scientific Equipment	4	1.8%	11	na	7	8.6%	22	20.6%	442	11.0%	378	8.6%	5	17.5%	1,254	12.2%	472	9.2%
Subtotal	6,209	7.9%	201	−5.4%	278	5.3%	4,480	14.6%	19,788	11.0%	50,944	1.6%	271	8.5%	42,117	16.6%	19,902	9.1%
Share in total manufacturing	8.6%		32.6%		21.6%		12.6%		28.2%		13.6%		21.1%		34.5%		10.6%	
300 Total Manufacturing	70,673	1.7%	617	−7.6%	1,273	4.3%	35,030	15.6%	70,225	6.6%	370,118	1.2%	1,285	6.6%	122,131	11.5%	186,964	8.2%

Sources: World Bank data; United Nations, "Industrial Statistics Yearbook", various years.

Table A.14: Selected Air and Water Quality Indicators



Note: * WHO guidelines are that average annual mean levels should not exceed 40-60 mg/(cu.m.).
** WHO guidelines are that average annual mean levels should not exceed 60-90 mg/(cu.m.).



Note: * Most life cannot survive at oxygen levels below 5.5 mg/liter (warm water) and 6.5 mg/liter (cold water).

Table A.15: Land Use in Asia, 1989

	Total Land Area	Arable land		Permanent cropland		Pasture land		Forest & woodland		Other land	
	(km2)	Area (km2)	Share (%)	Area (km2)	Share (%)	Area (km2)	Share (%)	Area (km2)	Share (%)	Area (km2)	Share (%)
Asia Region	20,586.4	3,612.8	17.5	270.5	1.3	5,098.0	24.8	4,946.7	24.0	6,658.5	32.3
East Asia	15,811.6	1,551.0	9.8	214.9	1.4	4,594.5	29.1	4,137.5	26.2	5,313.7	33.6
South Asia	4,774.8	2,061.8	43.2	55.6	1.2	503.5	10.5	809.2	16.9	1,344.7	28.2
EA1	2,626.7	456.0	17.4	120.9	4.6	42.0	1.6	1,187.7	45.2	820.1	31.2
Cambodia	176.5	29.1	16.5	1.5	0.8	5.8	3.3	133.7	75.8	6.4	3.6
Korea, Rep.	98.7	19.8	20.1	1.4	1.4	0.9	0.9	64.9	65.7	11.7	11.9
Lao, P.D.R.	230.8	8.8	3.8	0.2	0.1	8.0	3.5	128.0	55.5	85.8	37.2
Malaysia	328.6	10.4	3.2	38.4	11.7	0.3	0.1	191.0	58.1	88.5	26.9
Myanmar	657.5	95.4	14.5	5.0	0.8	3.6	0.5	324.2	49.3	229.4	34.9
Philippines	298.2	45.5	15.3	34.2	11.5	12.4	4.2	105.5	35.4	100.6	33.7
Thailand	510.9	190.0	37.2	31.3	6.1	7.7	1.5	142.4	27.9	139.5	27.3
Viet Nam	325.5	57.0	17.5	9.0	2.8	3.4	1.0	98.0	30.1	158.1	48.6
EA2	10,857.5	933.7	8.6	32.2	0.3	4,432.4	40.8	1,385.2	12.8	4,074.0	37.5
China	9,291.0	920.0	9.9	32.2	0.3	3,190.8	34.3	1,246.0	13.4	3,902.0	42.0
Mongolia	1,566.5	13.7	0.9	0.0	0.0	1,241.6	79.3	139.2	8.9	172.0	11.0
EA3	2,327.4	161.2	6.9	61.8	2.7	120.1	5.2	1,564.7	67.2	419.6	18.0
Fiji	18.3	1.5	8.3	0.9	4.8	0.6	3.3	11.9	64.9	3.4	18.7
Indonesia	1,811.6	158.0	8.7	54.6	3.0	118.0	6.5	1,134.3	62.6	346.6	19.1
Kiribati	0.7	0.0	0.0	0.4	52.1	0.0	0.0	0.0	2.8	0.3	45.1
Maldives	0.3	0.0	10.0	0.0	0.0	0.0	3.3	0.0	3.3	0.3	83.3
Papua New G.	452.9	0.3	0.1	3.6	0.8	0.8	0.2	382.3	84.4	65.8	14.5
Solomon Is.	28.0	0.4	1.4	0.2	0.6	0.4	1.4	25.6	91.5	1.4	5.1
Tonga	0.7	0.2	23.6	0.3	43.1	0.0	5.6	0.1	11.1	0.1	16.7
Vanuatu	12.2	0.2	1.6	1.2	10.2	0.3	2.1	9.1	75.0	1.4	11.2
Wn. Samoa	2.8	0.6	19.4	0.7	23.7	0.0	0.4	1.3	47.3	0.3	9.2
SA1	314.0	117.4	37.4	3.2	1.0	28.7	9.1	70.4	22.4	94.3	30.0
Bangladesh	130.2	90.2	69.3	2.7	2.1	6.0	4.6	19.5	15.0	11.8	9.0
Bhutan	47.0	1.1	2.4	0.2	0.4	2.7	5.7	26.1	55.4	17.0	36.1
Nepal	136.8	26.1	19.1	0.3	0.2	20.0	14.6	24.8	18.1	65.6	47.9
SA2											
India	2,973.2	1,653.2	55.6	36.8	1.2	120.4	4.0	667.4	22.4	495.5	16.7
SA3	1,487.6	291.2	19.6	15.6	1.1	354.4	23.8	71.5	4.8	754.9	50.7
Afghanistan	652.1	79.1	12.1	1.4	0.2	300.0	46.0	19.0	2.9	252.6	38.7
Pakistan	770.9	202.9	26.3	4.5	0.6	50.0	6.5	35.0	4.5	478.6	62.1
Sri Lanka	64.6	9.3	14.3	9.8	15.1	4.4	6.8	17.5	27.0	23.8	36.8

Source: World Bank data.

Table A.16: Cropland in Asia, 1989

	Total Land Area ('000 ha)	Cropland ('000 ha)	Cropland to Total Land (%)	Irrigated Land ('000 ha)	Irrigated Land to Cropland (%)	Cropland Per Capita (ha)
Asia Region	2,139,599	389,222	18	129,776	33	0.14
East Asia	1,626,280	177,483	11	63,582	36	0.11
South Asia	513,319	211,739	41	66,194	31	0.18
EA1	266,797	57,694	22	10,605	18	0.19
Cambodia	18,104	3,056	17	92	3	0.37
Korea, Rep.	9,902	2,127	21	1,353	64	0.05
Lao, P.D.R.	23,680	901	4	120	13	0.22
Malaysia	32,975	4,880	15	342	7	0.27
Myanmar	67,655	10,034	15	1,018	10	0.24
Philippines	30,000	7,970	27	1,620	20	0.13
Thailand	51,312	22,126	43	4,230	19	0.40
Viet Nam	33,169	6,600	20	1,830	28	0.10
EA2	1,116,346	97,490	9	45,426	47	0.09
China	959,696	96,115	10	45,349	47	0.08
Mongolia	156,650	1,375	1	77	6	0.63
EA3	243,137	22,299	9	7,551	34	0.12
Fiji	1,827	240	13	1	0	0.34
Indonesia	190,457	21,260	11	7,550	36	0.12
Kiribati	71	37	52	..	..	0.05
Maldives	30	3	10	..	..	0.02
Papua New Guinea	46,284	388	1	..	..	0.10
Solomon Island	2,890	57	2	..	..	0.19
Tonga	75	48	64	..	..	0.48
Vanuatu	1,219	144	12	..	..	0.72
Western Samoa	284	122	43	..	..	0.61
SA1	33,180	12,064	36	3,715	31	0.09
Bangladesh	14,400	9,292	65	2,738	29	0.08
Bhutan	4,700	131	3	34	26	0.09
Nepal	14,080	2,641	19	943	36	0.14
SA2						
India	328,759	168,990	51	43,039	25	0.20
SA3	151,380	30,685	20	19,440	63	0.20
Afghanistan	65,209	8,054	12	2,660	33	0.49
Pakistan	79,610	20,730	26	16,220	78	0.17
Sri Lanka	6,561	1,901	29	560	29	0.11

Sources: World Bank data and 1990 FAO Production Yearbook.

Table A.17: Area Expansion and Yield Effects of Cereal Production, 1961-63 and 1988-90

	Production (Million tons)		Harvested Area (Million hectares)		Yield (Tons per hectare)		Contribution to Growth Output (Percent)	
	1961 to 1963	1988 to 1990	1961 to 1963	1988 to 1990	1961 to 1963	1988 to 1990	Area Expansion	Yield
Asia Region	293.69	749.83	239.61	270.56	1.23	2.77	8.3	91.7
East Asia	179.43	502.69	127.09	139.72	1.41	3.60	5.5	94.5
Cambodia	2.52	0.00	2.34	1.82	1.08	0.00	21.9	78.1
China	119.79	367.58	89.66	90.54	1.34	4.06	0.5	99.5
Fiji	0.02	0.03	0.05	0.02	0.45	2.24	−122.2	222.2
Indonesia	14.86	49.97	9.69	13.38	1.53	3.74	16.1	83.9
Korea	5.91	8.65	2.12	1.47	2.78	5.87	−65.8	165.8
Lao, P.D.R.	0.54	1.39	0.61	0.62	0.88	2.25	0.1	99.9
Malaysia	1.15	1.81	0.55	0.67	2.10	2.72	38.3	61.7
Mongolia	0.26	0.72	0.36	0.61	0.71	1.17	38.7	61.3
Myanmar	7.56	13.98	4.92	5.11	1.54	2.74	4.6	95.4
Papua New Guinea	0.00	0.00	0.00	0.00	1.87	1.27	281.9	−181.9
Philippines	5.19	13.78	5.10	7.11	1.02	1.94	23.9	76.1
Thailand	11.90	25.58	6.72	12.03	1.77	2.13	68.7	31.3
Viet Nam	9.74	19.22	4.97	6.35	1.96	3.03	28.4	71.6
South Asia	114.26	247.14	112.52	130.84	1.02	1.89	14.0	86.0
Bangladesh	14.66	27.88	8.89	11.04	1.65	2.53	26.8	73.2
Bhutan	0.10	0.10	0.07	0.09	1.44	1.02	−689.3	789.3
India	88.34	190.68	93.22	104.27	0.95	1.83	10.2	89.8
Nepal	3.17	5.53	1.72	2.98	1.84	1.86	98.3	1.7
Pakistan	6.96	20.67	8.05	11.66	0.86	1.77	22.7	77.3
Sri Lanka	1.03	2.29	0.56	0.80	1.83	2.88	33.8	66.2

Source: World Bank data.

Table A.18: Fertilizer Consumption, 1961–63 and 1987–89

	Average consumption (thousand metric tons)		Consumption per hectare of cropland (kilograms)		Average annual growth rate
	1961–63	1987–89	1961–63	1987–89	(Percent)
Asia Region	1,152	43,791	3.1	112.7	14.8
East Asia	583	30,395	3.5	172.2	16.2
Cambodia	1	0	0.3	0.1	–3.4
China	..	24,479	0.0	255.7	..
Fiji	2	1	9.0	4.2	–2.9
Indonesia	109	2,409	6.4	113.5	11.7
Korea, Rep.	304	874	146.4	409.3	4.0
Malaysia	42	734	10.3	150.3	10.8
Mongolia	..	21	0.0	15.2	..
Myanmar	5	106	0.5	10.6	12.2
Papua New Guinea	..	15	0.0	38.8	..
Philippines	80	509	11.8	63.9	6.7
Thailand	17	725	1.5	33.5	12.8
Viet Nam	23	522	3.8	79.1	12.3
South Asia	569	13,396	2.9	63.2	12.6
Afghanistan	..	63	0.0	7.9	..
Bangladesh	..	800	0.0	86.3	..
India	419	10,502	2.6	62.0	13.0
Nepal	..	60	0.0	22.9	..
Pakistan	84	1,768	4.9	85.1	12.0
Sri Lanka	67	203	40.7	107.0	4.2

n/a = no available data.
Source: FAO Fertilizer Yearbook.

APPENDIX B

ANALYSIS OF THE WORLD BANK PROJECT PIPELINE (FISCAL 1993-95)

This appendix contains the results of a detailed analysis of the Bank's environmental program in Asia, covering the past three years and planned activities for the next three years. First a careful definition was drawn up of what is meant by environmental projects. This definition (box B.1) includes pollution reduction efforts in the urban, industry, and energy sectors; soil, forestry, watershed, and biodiversity conservation in the natural resource sectors; and other environmentally-oriented activities in the policy, institutional, population, education, and health sectors.

Using this definition, estimates were then made of the level of project expenditures being targeted to environmental activities. For all past and present projects with Staff Appraisal Reports, expenditures were assigned to environmental activities on the basis of specific project components. For future projects, in which project design is incomplete, estimates were made using whatever project

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Box B.1: What are Environment Projects?

In this report, the World Bank's environmental activities are divided into the following categories:

(a) Urban and infrastructure projects: project components addressing sewerage and sanitation; solid waste management; pollution monitoring, regulation, and enforcement; urban institutions and strategies for pollution control; and transport-related environmental issues (vehicle standards, fuel efficiency and modification, marine pollution).

(b) Industry and energy projects: project components addressing all forms of industrial pollution abatement, waste reduction, recycling, control of hazardous wastes, reduced energy sector emissions, energy efficiency, demand-side management, and institutional strengthening (standards setting, regulation, monitoring and enforcement).

(c) Agricultural and natural resource projects: project components addressing soil conservation and restoration, forest conservation, watershed areas, and conservation of biodiversity.

(d) Other projects: population programs; environmental health and education; environment-related policy reform; and cross-cutting activities, such as environmental assessment capacity-building, NEAPs, natural resource accounting; and environmental institutional strengthening in general.

Notably absent from this narrow definition of "environmental projects" is lending for urban and municipal water supply, disaster relief/reconstruction, resettlement, and hydro-power. These activities are not considered to be environmental for the following reasons:

(a) Water supply projects, while beneficial for people, do not have unambiguous impacts on the environment (i.e. large water supply systems such as dams, canals, groundwater and transfer schemes may have some adverse environmental impacts). On the other hand, urban and industrial sewage, sanitation, and wastewater treatment projects are included here as environmental, in that they lead to less pollution of surface, ground, and coastal waters.

(b) Disaster relief and reconstruction projects may mitigate the negative effect of the environment on people, but they do not generally mitigate the negative effect of people on the environment. Disaster "prevention" projects, such as the Bangladesh Flood Protection Scheme, similarly are not classified as environmental, since they may have environmentally negative impacts on natural ecological systems.

(c) Resettlement activities are designed to minimize the negative social impacts of certain development projects, but have no direct environmental benefits. The exception to this rule is the case of resettlement activities associated with biodiversity projects.

(d) Hydroelectric projects may have local negative environmental impacts in spite of their regional and global clean energy benefits.

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documentation existed and in consultation with Task Managers.

Two examples show how project expenditures for the environment were estimated.

(a) The Second Jabotabek Urban Development project in the greater Jakarta area, Indonesia, has nine components listed in the staff appraisal report. Three of these components deal directly with drainage, sanitation, and sewerage; three deal with water supply; and three deal with management review, miscellaneous studies, and overall project coordination. The expenditure allocations for this project were: 100 percent of the drainage, sanitation, and sewerage activities were classified as environmental; the water supply components were not classified as environmental; and half of the review, study, and coordination activities were considered to be environmental.

(b) The West Bengal Forestry project in India has eleven components, divided into eight that support commercial agricultural, pastoral, and forestry activities (such as farm forestry, fodder development, plantation forestry, and support to extension), and three that address environmental degradation (mangrove protection, rehabilitation of degraded forests, and support to wildlife and protected areas). Only the latter three components were considered to entail environmental work, as narrowly defined in box B.1.

Another issue that arose during this exercise was that of analyzing total vs. Bank-financed project expenditures. For past and present projects, it was found that regardless of whether total environmental expenditures were expressed as a percent of total project costs, or only Bank-financed environmental expenditures as a percent of total Bank financing, the results were quite similar. In some cases, the Bank share was slightly greater, indicating that it was taking the lead on environmental investments, institutional building, and/or studies. In other cases, the Bank share was slightly less, due to (in most cases) co-financing arrangements for environmental components, often on more concessionary terms for the borrower. Overall, however, the differences were minor.

Asia-wide Trends

Planned Bank expenditures on the environment in Asia over the next three years are more than double those of the past three years. The data shows a rising trend from the fiscal 1990–92 period, at $500 million–$600 million per year (7 percent of total lending), to $0.8 billion–$1.6 billion for fiscal 1993–95 (12 percent of total lending) (see figure B.1 and figures 8.1 and 8.2 in chapter 8, which use lending data as of November 1, 1993). In East Asia, projected environmental lending peaks in fiscal 1994 and drops in fiscal 1995. This may be partially explained by the fact that environmental projects for fiscal 1995 and beyond will depend on the results of analytical work now underway. If so, the lending amounts should increase in fiscal 1995 above current projected levels.

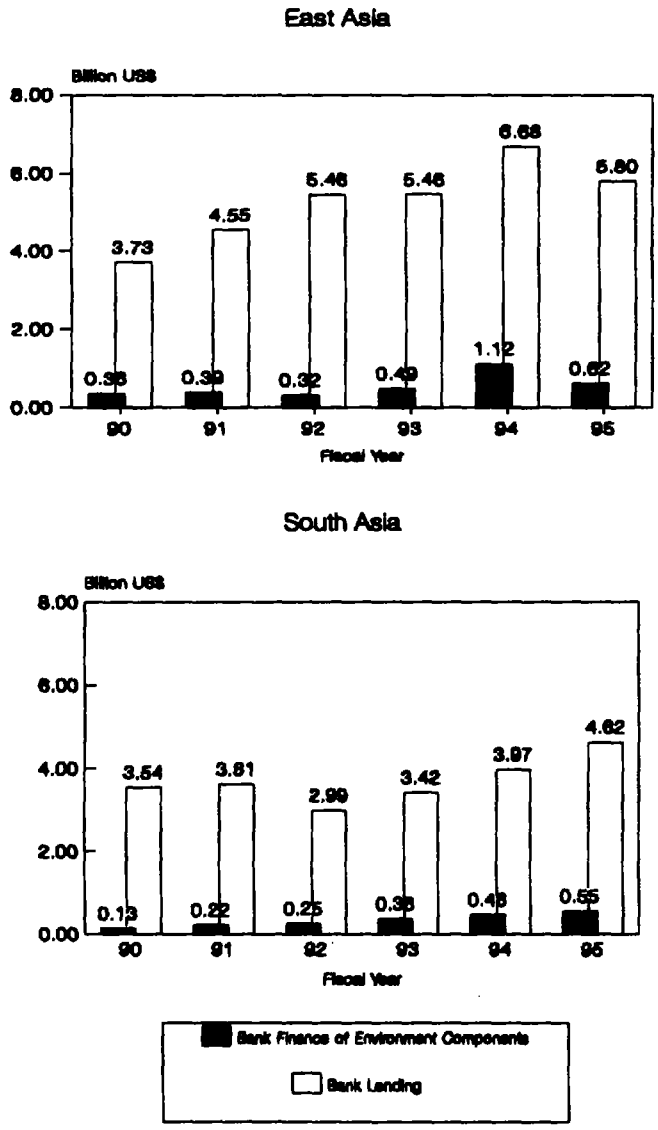
The analysis also distinguished between what may be considered as "traditional" projects with positive environmental impacts, and "newer" approaches dating from the late 1980s (see box B.2). This distinction was made in order to track how the Bank has responded to the newer environmental priorities in the past few years. Projects with "newer" approaches generally have broader activities than traditional projects; are more systematic and institutional in approach; and are more broadly cross-cutting in nature. The increase in the "newer" type project approaches is particularly marked in the urban and industry sectors (see figure B.2). In fiscal 1993–95, the $2.5 billion of Bank finance of "newer" environmental projects is more than double that of the traditional approaches.

Environmental lending for fiscal 1993–95 in East Asia is expected to be $2.23 billion, or 60 percent greater than expected environmental lending in South Asia ($1.39 billion). In East Asia in particular, the project pipeline has already shifted significantly from past trends to reflect many of the newer environmental priorities.

Sectoral Trends

One third of the $3.6 billion planned fiscal 1993–95

Figure B.1: Total Bank Lending and Bank Finance of Environmental Components in the Asian Regions



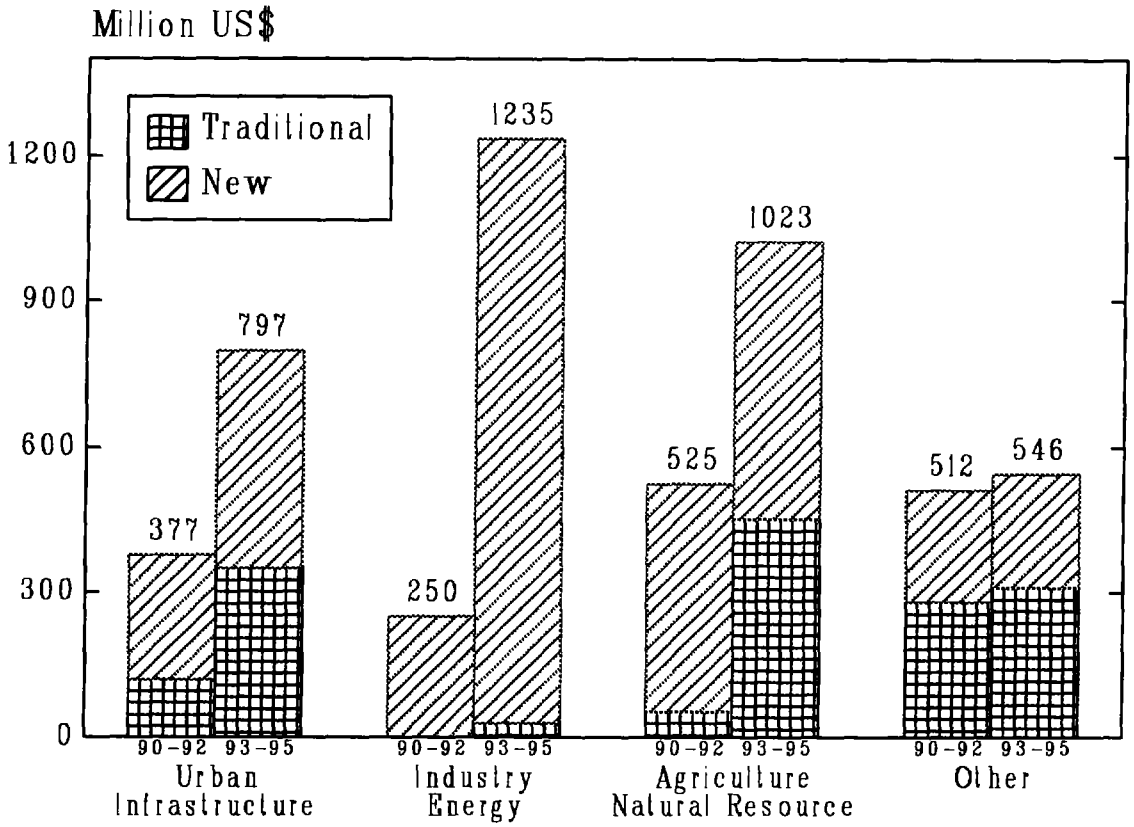
environmental expenditures is expected to be allocated to the industry/energy sector ($1.2 billion), and another 28 percent to the agriculture/natural resource sector ($1 billion). Urban and infrastructure projects will receive approximately $800 million (22 percent), and the remaining $546 million (15 percent) will be allocated to population and human resources projects.

In East Asia, the level of brown-type environmental lending is double that for the green-type, although both are growing rapidly. In South Asia, lending for the brown sector is also much greater than for the green sector. These areas of lending growth reflect, to a certain extent, the development priorities in the two regions (figures B.3 and B.4). When contrasting the sectoral breakdown of environmental lending in East and South Asia during fiscal 1993–95, several points are apparent:

- Infrastructure/urban environment work in East Asia appears to peak in fiscal 1994 and is double that in South Asia, where the trend is stable, except in water sector projects.
- Industry/energy environmental lending in East Asia is nearly double that in South Asia. The trend is upwards in both regions.
- Agriculture/natural resources environment work doubled in East Asia between fiscal 1990–92 and 1993–95, but showed more mild growth in South Asia. Lending in East Asia is much greater than in South Asia.
- Population/human resources environmental lending in South Asia is 2.2 times greater than East Asia.

In East Asian countries, both industrialization and urbanization have been more rapid and concentrated than in South Asia, and hence have created relatively more urgent environmental priorities. The growing "brown" sector environmental lending program in East Asia mirrors this need. Even

Figure B.2: Amount of Bank Finance for Traditional and New Environmental Projects in Asia by Sector, Fiscal 1990–92 and Fiscal 1993–95



though the impacts of rapid urbanization and industrialization may be severe in India and Pakistan, the environmental lending program does not fully reflect this.

In neither region do the lending levels in agriculture fully address the environmental pressures brought by a steadily intensifying agriculture sector trying to feed rapidly growing populations on a degrading resource base. Nevertheless, there is growth in lending in the green sector in both regions.

Trends by Individual Country Departments

Not surprisingly, the environmental lending program in East Asia is dominated by China, and in South Asia by India. The combined environmental lending of EA1 (East and Southeast Asian countries) and EA3 (Indonesia and the Pacific) is slightly less than that for EA2 (China). In South Asia, SA1 (Bangladesh, Nepal, and Bhutan) lags behind in its level of environmental lending, and is only 10 percent of environmental lending in India. As a *share* of total lending, China and India account for 62 percent of the total.

The following trends are noted for each CD in Asia:

- EA1: environmental lending is heavily dominated by the "brown" sectors—infrastructure/urban and industry/energy. Theinfrastructure/urban sector and industry/energy sector are programmed to receive 23 percent and 61 percent, respectively, of the CD's environmental lending. The green sector is budgeted for only 6 percent of the total, which is low. Total environmental funding for fiscal 1993–95 is $675 million.

Box B.2: Traditional Versus Newer Approaches to World Bank Environmental Lending

Project Sector	Traditional Projects with	Newer Project Approaches to Environmental Lending
Urban Infrastructure (Urban projects, water supply and sanitation, and transport)	Sewerage; wastewater collection and disposal; solid waste management. Traffic management and low-cost urban transport options.	Strengthened municipal planning, regulation and enforcement; air and water pollution, including wastewater treatment; monitoring. Mass transit; vehicle fuel efficiency and fuel switching; incentives for higher occupancy vehicles. Regional and multisectoral water quality management; conservation incentives; emphasis on pricing and institutions.
Industry & Energy (Industrial development, power generation and distribution)	End-of-pipe pollution control; project-related pollution control.	Higher plant efficiency and waste reduction; clean technology; recycling; standards setting, regulation and enforcement; reduced ozone depleting substances and greenhouse gases; hazardous waste disposal; supply-side energy efficiency; demand side management; renewable energy technologies; support to financial intermediaries to conduct EAs; lending for pollution abatement.
Agriculture and Natural Resources (Agriculture, forestry, and watershed management; conservation and biodiversity)	Soil conservation and drainage; applied agricultural research for reduced water needs; forest management and reforestation; watershed management for agricultural or water resource purposes.	Land restoration and reclamation; surface and groundwater pollution control; multi-sectoral water allocation; non-commercial afforestation; watershed management for biodiversity; zoning for environmental purposes; biodiversity projects.
Other (Population and human resources, policy-based lending, other)	Population planning.	Environmental health components and awareness campaigns; environmental sector reform lending; national environmental action plans (NEAPs); environmental assessments; natural resource accounting; strengthening of national environmental institutions.

- EA2: the infrastructure/urban and agriculture/natural resources sectors dominate environmental lending, with 38 percent and 34 percent respectively of the total environmental lending for the CD. The apparent gap in the pipeline, therefore, is in the industrial/energy sector, which may be addressed through studies now underway (also, several recent urban projects address industrial issues). Total environmental funding for fiscal 1993–95 is $1.25 billion.
- EA3: Environmental lending for agriculture/natural resources over the next three years has the largest share (75 percent) of environmental lending, followed by infrastructure/urban (19 percent). The upcoming Industrial Efficiency and Pollution Project is not reflected in these numbers, and is scheduled for either fiscal 1995 or 1996. Total environmental funding for fiscal 1993–95 is $303 million.
- SA1: has very low levels of environmental work. Lending in the population/human resources sector is the highest ($63 million over three years), followed by agriculture/natural

Figure B.3: Bank Lending in the Brown Sector
Asian Regions, Fiscal 1990–92 and Fiscal 1993–95

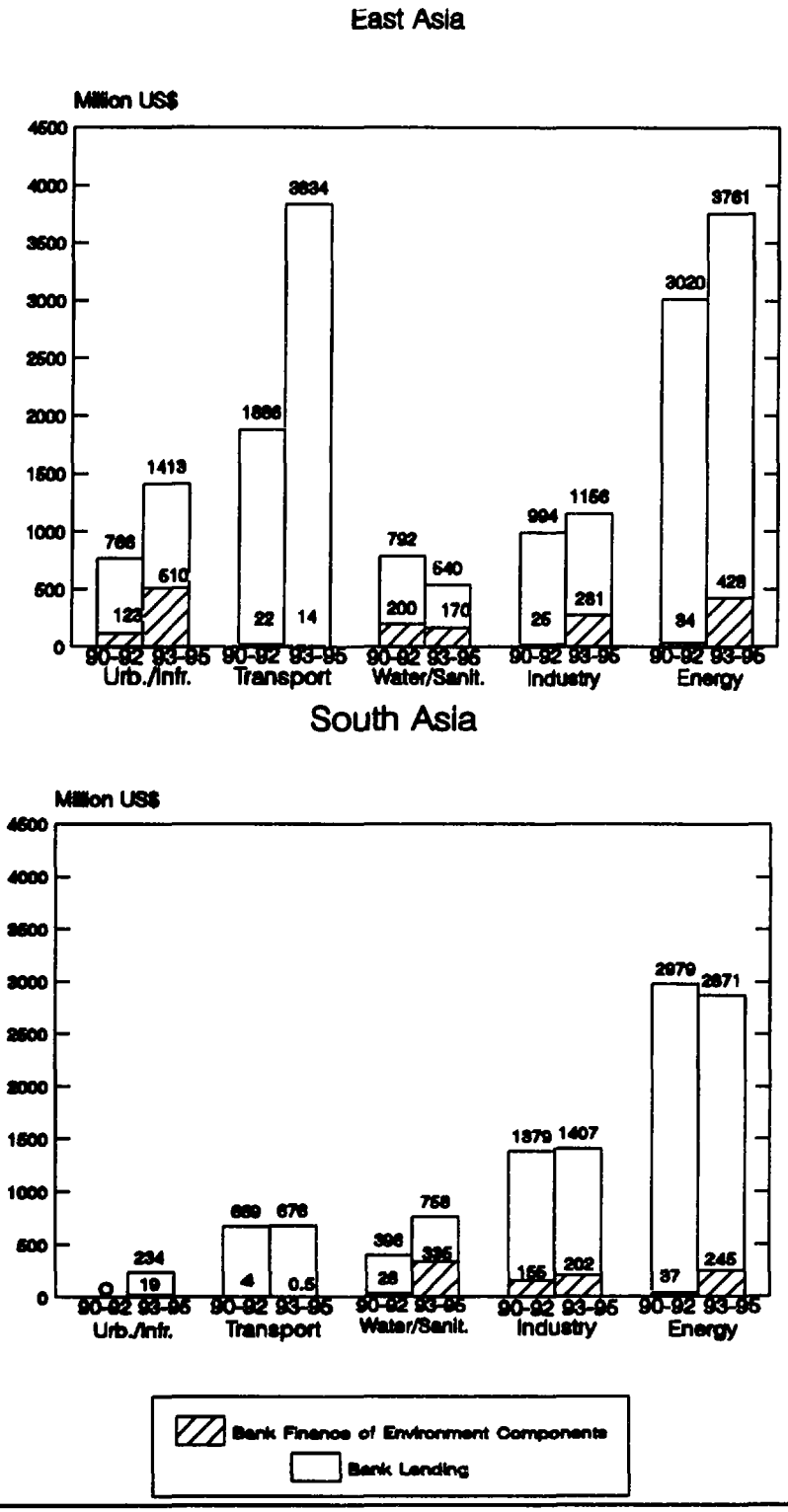
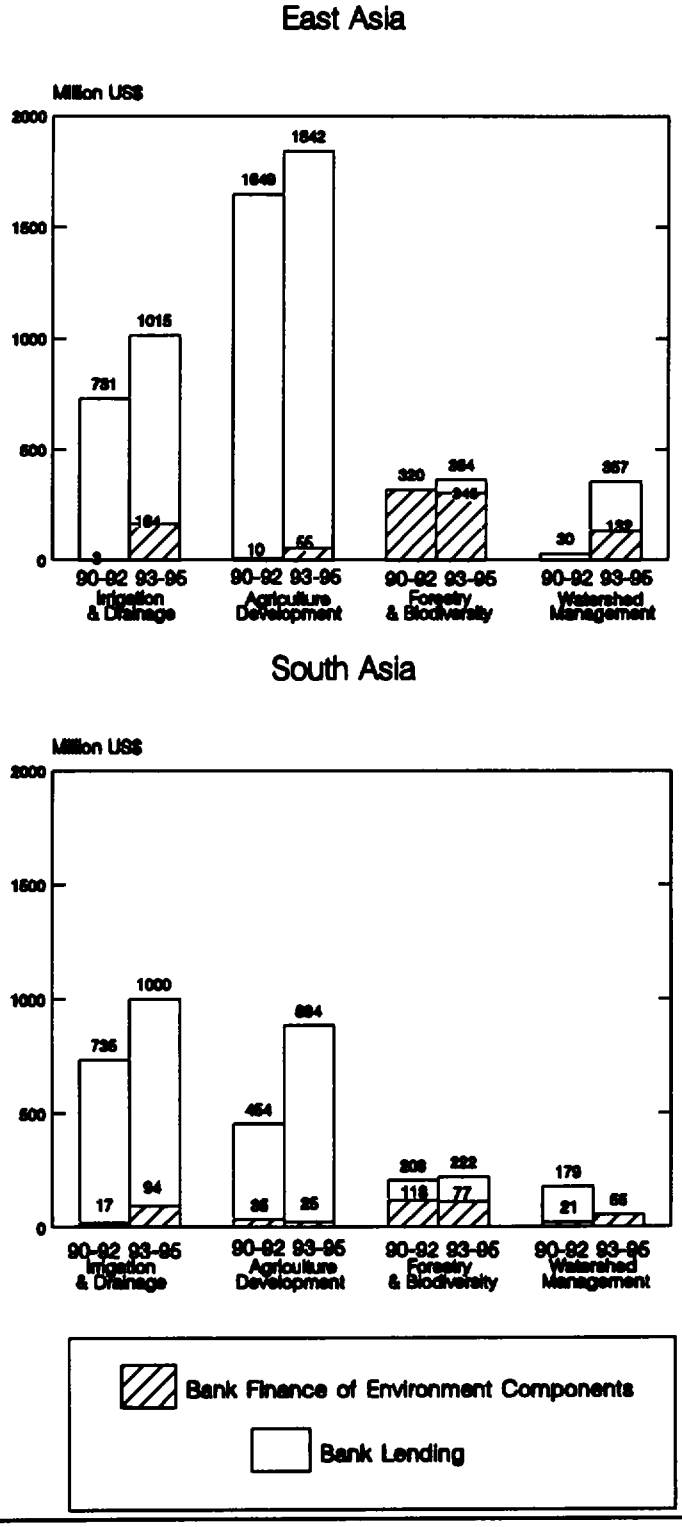


Figure B.4: Bank Lending in the Green (Natural Resources) Sector Asian Regions, Fiscal 1990–92 and Fiscal 1993–95



resources ($38 million). No environmental lending has been planned for the brown sector. Total environmental funding for fiscal 1993–95 is $101 million.

- SA2: this is the only CD in Asia where environmental lending is dominated (44 percent) by industry/energy, due to a large industrial pollution prevention project in FY95. Other important environmental projects are in urban/infrastructure (34 percent) and population/human resources (13 percent). Lending gaps in agriculture and natural resources are apparent. Total environmental funding for fiscal 1993–95 is $1005 million.
- SA3: environmental lending is dominated by the agriculture/natural resources sector (58 percent) and population/human resources (34 percent). The brown sector is projected to receive 8 percent. Total environmental funding for fiscal 1993–95 is $264 million.

Economic and Sector Work Pipeline (Fiscal 1993–95)

Economic and Sector Work (ESW) is the World Bank terminology for analytical studies. The East and South Asia Regions have proposed 206 ESW programs for fiscal 1993–95. Of these, 21 have the environment as a major focus and 22 more have an indirect or small relation to environmental issues. The environmental concerns covered by the two Regions during the next three years will be heavily concentrated in the "brown" sector (urban/infrastructure and industry/energy). A partial list is included in chapter 8 (box 8.5).

APPENDIX C
ENVIRONMENTAL ACTIVITIES BY VARIOUS DONORS IN ASIA

Other donors active in the environment in Asia include the ADB, UNDP, USAID, and Japan's OECF. A review of environmental activities in Asia for fiscal 1991 shows that total environmental lending was about $1.4 billion. Japan is the largest donor, followed by the World Bank. The other three are have much smaller programs (see figure 8.3 in chapter 8 and table C.1).

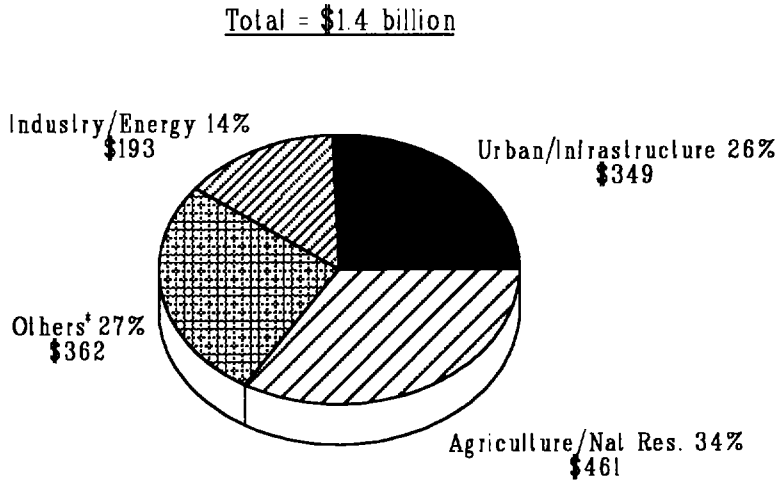
During fiscal 1991, Japan's OECF commitment to the environment totaled $652 million, making up 48 percent of the total lending across all five donors. The World Bank lent $603 million (44 percent). USAID, UNDP, and ADB provided $62 million, $27 million, and $16 million respectively, and their combined lending amounted to 8 percent of the total. The definition of "environmental" projects applied in this analysis is the definition used in Appendix B, which may be more narrow than that used by some of these donors.

The combined allocation of donor resources, including the World Bank's, is fairly well distributed across sectors (see figure C.1 and table C.1 for a more detailed breakdown). These aggregate numbers are, however, heavily dominated by the World Bank and Japan. The smaller donors have focussed on the green sectors (UNDP and USAID) and on cross-sectoral technical assistance (ADB). Only the World Bank is active in the industrial/energy sector, and only the World Bank and Japan have major environmental programs in the urban/infrastructure sector.

The focus of each donor's environmental involvement in Asia differs by sector and country—and even by year. For example, in fiscal 1991, almost all of Japan's environmental loans were in the agriculture/natural resources sector and the urban/infrastructure sector (53 percent and 46 percent of the total, respectively). In fiscal 1990, OECF lending in the urban/infrastructure sector ($200 million) was double that of the agriculture/natural resources. There were no loans to the industry/energy sector in either year. In both years, East Asian countries received over half of OECF lending.

The environmental activities of USAID have been mainly in the agricultural/natural resource

Figure C.1: Amount of Combined Donor Environmental Funding in Asia, 1991 (by sector)
(Millions US$ per year)



Note: "Others" includes population and human resources projects, technical assistance projects, and projects with cross-cutting environmental activities.

Table C.1: Environmental Activities in Asia by Different Donors, 1991
(Millions US$)

Sector	East Asia	South Asia	Regional	Asia Total
The World Bank				
Urban/Infrastructure	29.18	13.35		42.59
Industry/Energy	12.60	156.90		169.50
Agriculture/Nat. Resources	8.58	46.30		54.88
Others	336.40			336.40
TOTAL	386.76	216.55	0.00	603.31
Overseas Economic Cooperation Fund (Japan)				
Urban/Infrastructure	165.44	133.52		298.96
Industry/Energy				0.00
Agriculture/Nat. Resources	223.43	121.19		344.61
Others	8.17			8.17
TOTAL	397.05	254.70	0.00	651.75
U.S. Agency for International Development (USAID)				
Urban/Infrastructure			0.90	0.90
Industry/Energy	5.00	0.60	0.60	6.20
Agriculture/Nat. Resources	37.52	7.11	0.13	44.76
Others	6.71	3.60		10.31
TOTAL	49.23	11.31	1.63	62.17
United Nations Development Programme (UNDP)				
Urban/Infrastructure	0.98		1.41	2.39
Industry/Energy				0.00
Agriculture/Nat. Resources	0.34	8.06	6.06	14.46
Others	1.88	0.39	2.56	4.83
TOTAL	3.20	8.45	10.03	21.68
Asian Development Bank (ADB)				
Urban/Infrastructure	0.47			0.47
Industry/Energy	0.12			0.12
Agriculture/Nat. Resources	0.38	0.13		0.51
Others	3.92	1.45	8.95	14.31
TOTAL	4.89	1.58	8.95	15.41

sector: this sector received 70 percent ($45 million) in fiscal 1990 and 97 percent ($60 million)in fiscal 1991. The bulk of the funding went to the East Asia Region.

Similarly, UNDP has focused on the green sector. It allocated about 70 percent ($15 million) in fiscal 1991 and 100 percent ($27 million) in fiscal 1990 of its environmental funding to the agricultural/natural resource sector. During those years, no funding was directed toward the industry/energy sector. In fiscal 1991 most of UNDP's projects were either regional in scope or in South Asia, although in the previous year they were primarily in East Asia.

Approximately 95 percent of ADB's environmental activities have been in the form of technical assistance (primarily institution building and human resources development). Unlike the other donors, ADB activities were primarily in region-wide activities. In terms of country-specific activities, ADB has been more involved in East Asia than in South Asia.

In summary, the total level of donor lending, $1.4 billion, is only about 5 percent of the total financing required by Asian developing countries to meet their environmental needs. (Total needs in Asia were projected in chapter 2 to be nearly $40 billion per year by the year 2000.) Clearly, donors cannot finance anything even approaching these total amounts. More study is needed to determine how prominent a role the donors should take in terms of these overall financing requirements. Financial mobilization from the private sector, and through more efficient pricing and cost recovery in the public sector, will become ever more important themes in the environmental arena.

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