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Development and the Environment inAsia: A Survey of Recent Literature

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Abstract

Economic growth and environmental damage are associated, but the relationship is neither linear nor even monotonic. This is clearly seen in the diverse experiences of tropical Asian economies over recent decades. The nature of the growth-environment link depends on the changing composition of production and on growth-related changes in techniques and environmental policies; the enforcement of property rights over natural resources and over air and water quality is another important element. Moreover, environmental and economic policies interact: in effect, every economic policy that affects resource allocation is a *de facto* environmental measure. One important implication is that the environmental consequences of major policy shifts, such as the 'globalization' of many tropical Asian economies since about 1980, have been profound. The analytical literature on growth and the environment in Asia tends to agree that environmental damage is costly to regional economies, and has begun to identify and quantify some of the many causal linkages now recognized between economic development and the valuation and use of environmental and natural resource assets.

JEL categories: O1, O2, Q1, Q2

1. Introduction

In recent years a great deal of effort has been invested in documenting, measuring and valuing environmental trends in developing Asian countries. The data indicate that growth rates of energy demand, industrial emissions, and the depletion and degradation of many forms of environmental services and natural resources have matched or even exceeded rates of economic growth. Even in the regions and countries with the brightest records, it seems that high rates of growth and poverty alleviation have apparently come at considerable environmental cost.

Although some economic theories predict that the intensity of environmental damage associated with growth diminishes at higher levels of per capita income, this prediction has not so far received robust empirical support in Asia, especially where natural resource depletion is concerned. In forests, fisheries and agricultural soils, persistent market failures caused by ill-defined property rights may invalidate the theoretical prediction. In these cases, and those of some other environmental services, uncontrolled depletion may create irreversible changes. These concerns place a question mark over the long-term sustainability of current economic development strategies.

In this survey we examine aspects of the interdependence between economic development and the use of environmental and natural resource assets in tropical Asia.[1] The most important environmental problems facing countries in this region are those relating to the use of renewable natural resources, including forests, soils, and water (Jha and Whalley 1999), although problems of urban and industrial pollution are rapidly gaining in importance. Accordingly, to conserve space we restrict our attention for the most part to these resources,[2]

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1 The emphasis on tropical countries is a logical one given constraints on the length of this study. Climate is only one way in which tropical and temperate zone countries differ. Countries in the tropics are generally poorer, more heavily dependent on natural resources, and face other problems, such as disease endemicity, that are not as prominent in temperate zones; see Sachs and Warner (1997). For most purposes the countries covered in this study are the ASEAN economies excluding Singapore and Brunei, plus Sri Lanka, although complete coverage according to the geographical definition would also take in most of continental South Asia and southern China. We include some data and examples from these regions for comparative purposes.

2 We do not attempt coverage of issues relating to fisheries, groundwater, or hydrocarbons and other mineral resources. Two recent surveys in this Journal provide complementary coverage: Tisdell (1997) on minerals and mining, and Rosegrant and Meinzen-Dick 1997 for an excellent survey of water resources.

The paper is structured as follows. In section 2, we review evidence on the nature and physical magnitudes of ENR depletion and degradation in the resource-dependent economies of developing Asia. Section 3 presents a discussion of modern economic growth, industrialization and structural change in tropical Asia, identifying trends and phenomena likely to be associated with changes in the valuation and use of ENR assets. In section 4, we focus on deforestation and the expansion and intensification of agricultural production as environmental problems of particular importance in tropical Asia. We review trends and arguments on agricultural development itself, and on the economy-wide determinants of pressures and incentives for deforestation and land degradation, including those emanating from development policy decisions. Section 5 focuses on recent developments in the era of ‘globalization’, and in section 6 we address several issues of current research and policy concern. Finally, section 7 presents a summary and some key conclusions.

2. Environmental and natural resource trends

The “environment” can only be meaningfully discussed in terms of its component parts. These include natural resource stocks such as forests, minerals, water, biodiversity and soils, as well as air and water quality in specific locations and times. It is convenient to group these as a set of *ecosystems*—forest and uplands, lowland agriculture, urban-industrial, coastal/marine, freshwater—and a set of *resources* (that are components of ecosystems): forests, fisheries, soils, minerals and biodiversity. In this section we present indicative data and some analytical evidence on each of these, with emphasis on the years since 1990. For detailed coverage of earlier environmental data see Brandon and Ramankutty (1992). Recent volumes by ESCAP (2000) and World Bank (2000) cover a much broader ranger of environmental variables than our space permits.

Urban air and water pollution

Industrialization is a central feature of economic growth, and since most industry is concentrated in and around cities, urban population growth rates in Asia far exceed national averages (Table 1). As a consequence of both urbanization and the spatial concentration of industry, air, water and solid waste pollution problems are most acute in cities. Table 2 shows mid-1990s levels of three major air pollutants in the major cities of developing Asian economies; these show levels of total suspended particulates (TSP) to be far in excess of WHO standards. Measures of PM_{10} (particulate matter less than 10 microns) are also considerably higher than WHO standards. The impact of these pollutants on health is potentially large. 1995 estimates for Metro Manila, for example, indicated that PM_{10} alone may cause 1,300 deaths and respiratory diseases costing 4,594 million pesos (equivalent to 0.3% of 1995 GDP) per year (PCSD 1998; and see Shah and Nagpal 1997), and comparable figures have been reported for other Asian cities.

(Table 1)

(Table 2)

Water pollution in urban areas is an equally serious problem, especially in cities where infrastructure, including that for provision of clean water and disposal or treatment of sewage and storm water runoff, has lagged behind growth in demand. In a study filled with disturbing detail Chang et al (2001) catalogue the effects of water pollution in Chongqing, a large inland Chinese city, on agriculture, industrial production, fisheries, and of course human health and morbidity. Using conservative assumptions on unmeasured variables, they estimate the annual cost of water pollution at between 1.2% and 43% of the city's gross product.

These findings are not exceptional (World Bank 2000). In the fastest-growing Asian economies, the rate of increase in the intensity of emissions of industrial pollutants has exceeded the rate of industrial output growth. Indeed, during the period of peak industrial expansion of the 'little tiger' economies of Southeast Asia, the difference between GDP growth and emissions growth increased at almost exponential rates (Brandon and Ramankutty 1992), with weather patterns helping distribute air pollution widely over peri-urban areas (Hordijk et al 1995). However, in an era during which the image of a factory's smokestack and sawtooth roof virtually symbolized modern economic development, such pollution was widely accepted as a necessary price for escaping poverty.

In spite of their evident pervasiveness and severity, air and water pollution and problems of solid waste disposal are typically not the leading forms of environmental damage in developing Asia. The majority of people still live in rural areas and depend on agricultural and natural resource industries for their livelihoods. Accordingly, much larger numbers of people are affected by natural resource depletion in the forms of deforestation, land degradation and diminution of watershed functions. The imputed values of these damages typically exceed estimates of the aggregate costs of urban and industrial pollution.[3]

Forests

Among natural resource problems, deforestation and the conversion of land to agricultural production captures the most media and policy attention. Long-run trends tell a stark story. In Java, a century of agricultural development from the mid-nineteenth century saw the conversion of ten million hectares, or eighty percent of forest area, to agriculture (Smiet 1990). In the Philippines, forest cover diminished from over 70% of land area in the early 20th century to less than 25% by the end of the 1980s (Kummer 1992), and is now below 20% (FAO 2001). Thailand's forest cover has diminished from well over 80% a century ago to barely more than one quarter of land area (Feeny 1982). Less wealthy countries such as Vietnam and Cambodia, now beginning to catch up with the rest of Asia in terms of growth, are presently experiencing similar wholesale rates of removal of natural forest cover. Asian developing countries lost forest cover at average rates of 0.2% in 1980-90 and 0.1% in 1990-2000; however, the average disguise loss rates of more than 1% per year in the largest ASEAN economies (Table 3).

(Table 3).

Although a decadal comparison suggests declining deforestation rates, the total extent of deforestation is not known with accuracy. This is due in part to measurement problems, but also because of changes in the definition of 'forest'. In particular, the FAO data for deforestation in 1990-2000 report a net change in which the loss of *natural* forest in many countries is compensated by an increase in *plantation* forestry. The World Resources Institute has calculated the gross change in natural forest cover in tropical Asia at –1.9% per year, or more than double the average for all tropical developing countries (Table 4). Since the data on plantation forest area are less reliable, these calculations must be treated with caution.[4] Nevertheless, the picture that emerges, both from remote sensing and from on-ground surveys, is one of substantial rates of removal of natural

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3 See Jha and Whalley (1999) for a synthesis of evidence on this point.

4 See FAO 2001, para 25, p.5, and Mathews 2001, footnote 5 p.9.

forest cover in tropical Asia, and its partial replacement in some countries by commercial plantations for agriculture or agroforestry. The consequences of this shift for forest-related environmental phenomena such as biodiversity have yet to be measured with accuracy, yet emerge as a major concern in policy documents everywhere in Asia.

(Table 4)

Water

About three-quarters of all available fresh water in the world is used for agriculture, and a higher ratio prevails in most developing countries (Table 5). The growth of overall agricultural production, as well as investments in irrigation, both contribute to rapid growth in freshwater withdrawal rates. These demands are augmented by increased industrial and household demand.

(Table 5)

At an aggregate level, water stress or shortages[5] do not currently appear to pose serious problems for most developing Asian countries. However, there is a pronounced declining trend in per capita water availability, which has fallen in Asia from 9.6 million cubic metres in 1950 to 3.3 in 2000 (Alexandratos 1995). The aggregate data, moreover, indicate average supply per inhabitant and can only be regarded as providing extreme lower bound measures of water stress or shortage. True availability is contingent on time, place, quality and cost. All Asian countries have regions and/or times of year in which water for specific uses is very scarce (e.g. WRI 1999). Matching the quality of water supplied to the intended use is increasingly a challenge, especially where infrastructural deficiencies make it difficult or impossible to separate flows (e.g. Chang et al 2001). Where mismatches occur, costs to consumers rise. In urban areas, households lacking access to potable water from municipal sources must buy it from private vendors, typically at a much higher price. According to a recent ten-city survey by the Asian Development Bank, the average ratio of private to public water prices in Asian cities is 67:1; figures range from a low of 2 in Jakarta to more than 100 in Vientiane and Delhi (Kataoka 2002).

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[5] *Water stress* is defined as 600 – 1,000 inhabitants per million cubic metres of water availability per year. *Severe shortage* is defined as more than 1,000 inhabitants per million cubic metres (Dasgupta and Mäler 1995).

Soils

Soils are more or less vulnerable to erosion according to combinations of slope and soil type, and the soils of tropical Asia are particularly susceptible in this way (FAO 2000; Doolette and MacGrath 1990).[6] While accurate data on soil quality and propensity for erosion or land degradation are of course difficult to obtain except at a very fine scale, indicative data from the FAO suggest that agricultural land degradation in Asian countries is a serious and pervasive problem (Table 6). Worldwide, many millions of tons of productive topsoil are lost from fields every year. On-site, soil loss from fields carries away nutrients and organic matter and thus diminishes the productivity of agriculture. Some of the soil so transported is of course merely moved to other agricultural locations, but a large fraction is deposited in streams, lakes and coastal waters where it is not only lost to agriculture but becomes a source of pollution.

Nor is the land degradation problem restricted to sloping or upland areas. Lowland and irrigated land, on which the bulk of agricultural production takes place, is susceptible to degradation from two sources: on-site fertility decline attributable to overcropping, and the deleterious effects of upstream erosion. Studies based on time series of data suggest that in spite of several decades of varietal improvements and 'best practices' management, rice yields in intensively farmed irrigated land in Asia are no longer rising, and may even be falling (Cassman and Pingali 1995).[7] Research comparing the planned and actual service area of irrigation systems indicates a close relationship between the removal of forest cover in upper-watershed areas and the decline of irrigation systems and rice yields in lowlands downstream (Pingali 1997).

Other damages associated with intensification in lowland agriculture include nutrient decline, salinization, acidification, groundwater depletion, and the water pollution consequences of agricultural runoff (for a more detailed review, see Rosegrant and Meinzen-Dick 1997).

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[6] The FAO definition of erosion hazard uses information about slopes and soil types. Land classified as having a severe erosion hazard is defined by "predominantly very steep slopes (> 30%) interspersed with areas of steep slope (8-30%) in conjunction with an abrupt textural contrast in the soil profile" (p.20). The Philippines, Malaysia, Cambodia, Laos, Myanmar, Vietnam, and Thailand are all among the top-ranked 15 countries by this measure (FAO 2000, p.20).

[7] According to the International Rice Research Institute: "The irrigated area devoted to rice is declining and yields are stagnating. Evidence is mounting that flooded rice soils are not resilient to intensification

(Table 6)

While the majority of soil studies indicate declining productivity and attribute this to human interventions, there are dissenting voices. Lindert (1999; 2000) has maintained on the basis of very detailed reviews of historical data on China and Indonesia that far from degrading agricultural land, a combination of investments in irrigation and technology have actually improved average soil productivity in lowland delta areas. In China, he argues, the "average quality of agricultural topsoil has probably not declined since the 1930s. In most regions, the expansion of China's agriculture is soil-conserving" (Lindert 1999: 701).

Moreover, part of the soil loss and sediment transport typically attributed to agricultural activities cannot, in Lindert's view, be rigorously traced back to human interventions. For Java also, in a study approvingly cited by Lindert, Diemont et al (1991) question the sources of observed sediment loading in rivers, arguing from field evidence that these are in large part attributable to factors other than agriculture, especially as in their estimate more than 75% of Java's uplands (lands with slope of more than 30%) are terraced (Diemont et al 1991: 218).[8]

Watershed services

Trends in the functioning of developing country watersheds capture the combined effects and interactions of deforestation, water demand and land degradation. The conversion of forests for agriculture contributes to diminished watershed function through loss of water storage capacity both in forests and in the soils they protect. It also contributes a large fraction of atmospheric carbon releases (Table 7). Watershed-level data show that the removal of forest cover and the conversion of cleared land to agriculture are processes strongly associated with increased amplitude of seasonal stream flow fluctuations, diminished overall flow, and increased loadings of sediments as well as pollutants introduced by crop and pastoral activity (e.g. Deutsch *et al.* 2001a). Soil and other pollutants displaced in the course of tillage contribute higher loadings of total suspended

pressures, and that the productivity made possible by current technology may not be sustainable." *Rice Facts,* http://www.irri.org/Facts.htm, accessed March 15, 2002.

[8] These distinctions are arguably semantic, since erosion from non-agricultural sources such as roads, construction, and landscape manipulation themselves are most frequently the indirect outcomes of agricultural development in sloping lands.

sediments and chemical pollution; moreover, soil removal from fields is a component of declining agricultural productivity in uplands, unless compensatory expenditures are made in the establishment of perennial crops, increased use of fertilizer, and/or construction of physical structures such as bunds and hedgerows. Finally, water pollution contributes to sedimentation in dams and canals, accelerated wear on turbines and other hydro power plant, eutrophication of lakes, health costs for downstream human and animal populations, and turbidity and related damage in coastal and estuarine areas normally providing habitat for corals, seagrasses and other flora and fauna as well as incomes for households engaged in fisheries and tourism (Doolette and MacGrath 1990).

(Table 7)

Valuation of ENR losses

It is, for a variety of reasons, very difficult to estimate the economic costs of resource depletion and degradation. Forests, for example, provide a number of market and non-market benefits to populations that live in and around them. Outputs with market values—at least in principle—include timber resources (industrial wood and fuelwood) and many non-timber outputs, such as amenity values, fruits, nuts, forage and animal fodder. But information on the many non-marketed benefits of forests, soils and watersheds (including carbon sequestration, local climatic influences, biodiversity and aesthetic existence values) is not widely available, is highly location-specific, and is subject to considerable measurement error. Hence it is difficult to generalize about the costs of deforestation or the degradation of natural resources without reference to specific circumstances.

Biodiversity and genetic reserves, as well as emissions having transboundary and global climate effects obviously have international value in addition to their local or national impacts. The value of biodiversity and genetic reserves lost due to deforestation is intrinsically difficult to measure. There are no well-functioning markets for these resources, and the development of such markets is inhibited by complications arising from property rights at local, national and international levels. Further, there is no simple relationship between the scale of deforestation and protection of biodiversity. While it is a widely held view that this is a source of potentially very large losses, there is no consensus on the issue.[9] Given the major conceptual and information problems involved in any evaluation of the costs and benefits of biodiversity preservation, it is not surprising that no generally accepted global estimates are available. Similarly, the valuation of deforestation costs in terms of local climate changes as well as contributions to global warming is fraught with difficulty. In all these cases, however, there is a growing acceptance that aggregate costs are potentially so large that remedial steps are urgently needed.

Since the early 1990s it has become increasingly common for countries to augment conventional measures of national income with 'satellite accounts' showing net additions to or reductions in estimated national income due to environmental damage and natural resource depletion. In developing countries, these exercises typically result in estimates of 'adjusted' net domestic product (ANDP) that fall substantially below measured NDP. Even the more conservative ANDP estimates, taking account of depreciation only of a limited range of natural resources (typically forests, soils and hydrocarbons), suggest that the value of their depreciation is large in relation to net income. The first empirical study of this type, the World Resources Institute study of Indonesia, calculated that allowing for natural resource depletion, NDP growth in the 1970s-80s was closer to 4% per annum than the 7% indicated by conventional methods, and that the ratio of net investment to GDP, again adjusted for resource depletion, was about one third below the estimated 26% average of the same period (WRI 1989; and see World Bank 1990). The study suggested that "a substantial portion of Indonesia's rapid growth during the 1970s and 1980s was simply the unsustainable 'cashing in' of the country's natural wealth" (Vincent 2000:13).

Subsequent empirical work elsewhere in Asia tends to corroborate the WRI finding for Indonesia. A detailed review of evidence for Malaysia indicated that financial returns from the conversion of forested land to agriculture were profitable, but that "important non-timber values were sacrificed when forests were converted" (Vincent, Rozali and Associates 1997:142). Other accounting studies for Asian countries indicate proportionally larger losses: over one per cent of GDP in the Philippines (World Bank

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[9] For example, Hyde, Amacher and Magrath (1996), who refer to evidence that 'these values are not large in any aggregate sense' (p.235).

1990; ENRAP 1994[10]); 0.75-1.0 % in Sri Lanka (Somaratne 1998). A World Bank study of India estimated the total cost of environmental degradation at about 4.5% of GDP per year, of which roughly one half is due to water pollution and another one quarter to deforestation and the degradation of soils and rangelands (cited in ESCAP 2000).

Of course, valuations are subject to change as economies develop, as prices and policies change, and as local, national and international valuations assigned to non-marketed environmental goods and services change. Infrastructural development is an important determinant of natural resource values (Coxhead and Jayasuriya 2002a); but market trends and national policies, reflecting both domestic development strategies and responses to international shocks, treaties and other pressures also influence valuations (see section 3). Another important insight from the ecosystems approach is that spatial variation is important. Environmental damages are not equally distributed across households; wealth (implying access to resources as well as capacity to mitigate damages) and location are both important. Thus in an economy in which the natural resource base is being rapidly depleted, most of the adjustment costs fall on rural populations.

Economy-environment linkages

All production, and much consumption, generates environmental side-effects in the form of pollution and/or contributes to the depletion of natural resources. It follows that in growing economies pressures on the environmental and natural resource (ENR) asset base should increase in step with the expansion of the economy, other things equal. It is well known, however, that the environment-economy relationship is non-linear—and indeed, non-monotonic. While environment-economy interactions are complex and multifaceted, a useful conceptual tool for understanding broad trends and their underlying economic determinants is provide by the so-called Environmental Kuznets Curve, or EKC (Grossman and Kreuger 1993). As its name suggests, the EKC is theorised to take an inverse-U shape; as per capita income increases, the intensity of environmental damages first increases, then stabilizes and ultimately declines.

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[10] The ENRAP study of the Philippines purports to find 'no statistical difference' between ANDP and unmodified GNP figures. We have argued elsewhere, however, that this finding embodies a number of assumptions that tend to reduce net valuations of environmental damage, and includes positive valuations of several phenomena inconsistent with the methodology (Coxhead and Jayasuriya 2002a).

The shape of the EKC reflects a multiplicity of influences on the production of ENR damage in the course of economic growth. It is now conventional to group these into three types known as *scale, composition,* and *technique* effects (e.g. Antweiler et al. 2001). The *scale effect* refers to the association between the size of an economy and the provision of environmental services, where 'size' is defined as the value of GDP at base-period world prices (Antweiler *et al.* 2001). Other things equal, economic growth produces increased demand for ENR assets, and when this effect dominates, the EKC rises with per capita income.

The *composition effect* refers to the environmental impact of changes in the structure of production and consumption. This has several components, of which the main ones are the influences of prices and endowment changes on the production mix. A change either induces the reallocation of productive resources among sectors. If sectors differ in their propensity to pollute or to use natural resources, it follows that emissions and/or natural resource depletion will also change. Clearly, aggregate composition effect can be either positive or negative.

Finally, the demand for environmental services associated with any given output level also depends on techniques of production and consumption. Changes in these—the *technique effect*—may be stimulated by relative price changes that cause shifts in the input mix, or by the introduction of new technologies that alter the ratio of emissions to output.[11] The technique effect reflects these supply-side changes and their underlying causes, among which it is conventional to include changes in government policies limiting permissible emissions or intensities, on the grounds that demand for such policies reflects income-elastic demand for a cleaner environment. Accordingly, the technique effect is normally expected to reduce rates of environmental damage.[12]

The EKC hypothesis is aggregative and abstract, and as such has value as a conceptual tool rather than as a guide for policy analysis. It is nevertheless interesting to ask whether Asian data provide support for this hypothesis. A number of time series and cross sectional studies exist, and most provide separate estimates by geographic region.

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[11] The introduction of new, typically cleaner, technologies may itself be a direct function of the liberalization of trade or investment rules (Grossman and Krueger 1993), as well as being indirectly influenced by income-dependent preferences and policies.

While these vary in both methods and findings, and the robustness of results remains in doubt, results for Asia tend to show that as per capita incomes grow, emissions of solid wastes and some other consumer and industrial pollutants increase, and problems related to sanitation and potable water decrease. Air pollutants are sometimes found to follow the EKC pattern, but importantly, no relationship is observed in cross-country data between income growth and deforestation (Cropper and Griffiths 1994; Shafik 1994; Cole et al 1997; Koop and Tole 1999).

An obvious problem confronting empirical EKC studies is the need to pool country data. Very recently, time-series studies have begun to emerge, with that of Malaysia by Vincent, Rozali and Associates (1997) among the first for Asia. Their estimates suggest that cross-country studies over-predict the growth of per capita emissions of industrial and household pollutants such as SO_x, NO_x and CO, but that they underestimate growth of TSP emissions, largely attributable to burning undertaken for land conversion (p. 279). For forests on Peninsular Malaysia, the same study finds a non-linear relationship between deforestation and income consistent with the EKC hypothesis, and concludes that that region's forest area "is indeed on the way to being stabilized by economic development…Peninsular Malaysia could be among the first regions in the tropics to reduce its deforestation rate to zero" (p. 124). This encouraging result remains an outlier for Asia as a whole, however (and notably does not include the states of Sabah and Sarawak, where most of Malaysia's timber resources are located). More definitive results on the EKC, both for Malaysia and for elsewhere in Asia, await the acquisition of longer data series.

3. Economic growth, structural change and industrialization

Growing economies undergo structural changes that imply significant composition effects. Until the 1970s, Asian economies were dominated by agriculture and other primary industries. Since then, most countries in the region have grown very rapidly by developing-country standards (Figure 1). Along with that growth they have experienced a tremendous expansion of industrial activity in general, and manufacturing in particular.

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[12] There may be exceptions however, such as 'smokestack chasing' competition, in which governments relax environmental standards in order to attract employment-creating investment.

The latter has been rapid both in absolute terms and relative to total GDP, and has been matched by a corresponding decline in the relative importance of agriculture (Table 8).[13]

(Table 8)

Within manufacturing sectors, the composition of production and trade has also changed. Processing of primary products—food, fibre and beverages, wood products, and basic metals and minerals—has always been important in the industrial structure of Asian economies. Other types of manufacturing have risen to prominence over time, however; most notably, labor-intensive industries producing garments, footwear, consumer electronics, and semi-conductors. These industries now account for the majority of manufactured exports by value. Trends in the structure of industrial output and employment have in turn had important influences on labor markets and wages and these have in turn affected the growth rates of agricultural and natural resource industries.

These patterns of growth and structural transformation are the products of initial conditions, development policies, and the effects of various 'shocks' emanating from the world economy. In the early postwar era, most tropical Asian economies were richly endowed with land, forests and other natural resources and unskilled labor. Other productive factors, notably human and industrial capital and technology, were very scarce. The more open economies have exploited their comparative advantage, exporting natural resource and agricultural products along with basic manufactures. In such economies, structural change has come from differential rates of factor endowment growth, changes in relative prices, and policies aimed at promoting unbalanced sectoral growth rates—notably industrialization.

The past four decades has also been a period of very high savings and investment rates in most Asian economies. In particular, the decade of very rapid growth of the 'East Asian Miracle' era from the mid-1980s was fuelled by net investment rates in excess of 30% of GDP, resulting from both the mobilization of domestic savings and rapidly rising foreign direct investment (Table 9). Capital accumulation at such unprecedented rates has been the cause of a shift in the factor content of production, accelerating growth by manufacturing industries in general, and in the faster-growing economies by industries

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[13] In oil-rich countries, the intersectoral or 'Dutch disease' effects of booms in world demand for hydrocarbons may also have helped reduce demands on natural resources (Sunderlin and Wunder 2000).

such as electronics and transport equipment, which are capital-intensive relative to traditional manufacturing activities.

(Table 9)

Although capital accumulation primarily fueled industrial growth, however, it also had effects in other sectors. Rising labor demand associated with manufacturing growth helped shift the balance of employment creation away from primary sectors. In Malaysia, for example, manufacturing growth contributed nearly two-thirds of total job creation in the decade 1987-96 (Athukorala 2001:20). Industrialization also fuelled urbanization, further reducing direct dependence on agriculture and natural resources. During the1980s and 1990s, Asian developing economies experienced average rural population growth rates of under 0.6% per year, well below replacement rates. As a consequence, rural population density (persons/sq. km) peaked during the 1970s, whereas in other developing regions it has increased in every decade since 1960.[14]

In addition to changing factor endowments, policies governing trade, investment, exchange rates and other areas of economic activity have exerted significant influence over industrial structure. Among these, import-substituting industrialization (ISI) policies are arguably the most important. ISI in general provided support for heavy industry and other ‘basic’ manufacturing, and thus conferred benefits mainly on capital-intensive industries producing for the home market.

However, the impacts of ISI were not limited to industries at which they were directly aimed, but were transmitted to other sectors through factor and product markets, and through their influences on the aggregate growth rate. In some countries, relatively mild ISI regimes had only minor intersectoral effects. More far-reaching ISI policies, however, promoted the expansion of capital-intensive industries at the expense of more labor-intensive sectors, and thus contributed little to industrial employment growth. Traditional tradables industries (labor-intensive agricultural and natural resource sectors) were penalized by ISI and experienced relative declines in investment and labor productivity. As a consequence, labor force growth was concentrated in urban areas (where new entrants joined the informal services sectors) and at the frontier of agricultural cultivation (see section 4).

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[14] Source of basic data: World Bank, *World Development Indicators 2001*.

After the 1970s Asian economies began to move away from ISI towards growth strategies that placed more stress on manufactured exports. So-called export-oriented industrialization (EOI) policies typically encouraged industries making intensive use of unskilled or semi-skilled labor. Rapid industrialization and growth in the Asian newly industrializing economies (NIEs) are widely attributed to their pursuit of EOI strategies (World Bank 1993).[15] These economies now depend much less, in a relative sense, on the exploitation of environmental and natural resources to generate employment and foreign exchange (Table 10). This in turn should have reduced the social cost of adopting 'sustainable' environmental strategies (at least where natural resources are concerned), as compared with countries where incomes continue to depend on agriculture and resource-intensive primary industries.

(Table 10)

Environmental consequences of industrialization policies

By what means do industrialization and related macroeconomic policies influence the use of environmental and natural resources in Asia's resource-dependent countries? The extent of structural change that has accompanied growth indicates that scale effects must have been substantially modified by changes in the composition of output, whether attributable to rising capital-labor ratios, unequal sectoral rates of technical change, or policy-driven relative price changes. To the extent that early industrialization involved the rise of protected capital-intensive industries, since these are also by and large pollution-intensive (for Thai data see Table 11) it is clear that industrial emissions expanded faster than overall GDP (Brandon and Ramankutty 1992). Subsequent shifts to industries making more intensive use of unskilled labor and human capital have reduced emissions-intensity at the sectoral level. However, the environmental implications of industrial growth under ISI and in more liberal trade policy regimes are hard to measure directly, in part because they interact with growth rates. Lucas et al (1992) found that among low and middle income countries, a faster rate of per capita income growth was associated with greater growth in emissions intensity only in relatively closed economies;

[15] This shift to export promotion was often accompanied by continued protection of selected import-substituting industries. For example, countries such as Thailand and Indonesia adopted policies intended to promote export growth by natural resource and labor-intensive sectors through a variety of means ranging

in relatively open economies, higher growth rates of per capita income were associated with faster *declines* of emissions intensity. Importantly, changes in industrial emissions have been due almost entirely to scale and composition effects; technique effects—the main focus of emissions reduction programs in the OECD— have begun to occur only very recently, and in the most obviously pollution-intensive industries (Hartman et al 1995).

(Table 11)

The effects of industrialization on the natural resource base are more complex, because they are primarily indirect. Labor-intensive forms of industrial growth have tended to diminish pressures on forests and watersheds by raising the opportunity cost of rural labor, as in Malaysia and more recently, Thailand). In contrast, capital-intensive industrialization, when associated with relatively low average GDP growth rates, has tended to reduce the profitability of commercial agriculture and also to drive labor to the agricultural frontier where land could be colonized for subsistence production. In view of the intersectoral effects of capital-intensive growth it is not surprising that in the countries with the most severe and persistent import substitution policies, internal migration to rural areas peaked during the high tide of protectionism, contributing to a doubling and redoubling of the numbers dependent on frontier agriculture, and increasing pressures for deforestation (Roche 1988; Barbier 1990; Southgate 1988; Cruz 2000). Moreover, ISI policies not only reduced growth of the agricultural sector as a whole, they also introduced substantial differences in incentives *within* agriculture.

4. Agricultural development

The tropical Asian landmass was historically heavily forested. The major story of land conversion in the region has been the removal of natural forest cover and its replacement by agricultural crops and plantation forestry. Commercial timber harvesting was once a significant share of GDP and a major export earner for all the large countries of the region, and continues to be so for those economies (Cambodia and Myanmar) that have failed to diversify into other activities. As recently as the late 1980s, three Southeast Asian countries were the world's leading exporters of timber and timber products:

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from "competitive" exchange rate depreciations to export-processing zones while maintaining high levels of protection for ISI sectors such as automobiles.

Malaysia with 48.6% of world exports; Indonesia with 26.7%, and the Philippines with 3.2%.[16] Less than two decades later, the Philippines, like Thailand, has so depleted its forest reserves that it is now a net timber importer. Commercial timber extraction has been estimated to be *directly* responsible for a fairly small percentage of forest loss—about one quarter (Braga 1992). Its indirect effects are clearly greater, however, since commercial logging is known to create access to forests by agriculturalists, whose actions are held responsible for well over half the area deforested (for a survey and discussion, see Angelsen 1995).

Whereas most of Asia was historically a region of food surplus and labor scarcity, twentieth century population growth brought about a fundamental change. In the three decades after World War II, a period during which the region's population more than doubled, pressures on the agricultural resource base began to climb, domestic food production per capita began to decline, and the share of food in the value of imports to rise. Initially, states responded by sponsoring land colonization through internal migration, supported by subsidized or publicly provided services such as land clearing and market and physical infrastructure. Subsequently, investments in irrigation, and in the 1960s and 1970s the introduction of yield-improving technology packages centered on modern cereal varieties (the 'green revolution') partially alleviated land scarcity by enabling production increases on existing land. In countries and sub-national regions with adequate irrigation, and where fertilizer and other complementary inputs were available to farmers, rice yields increased rapidly with adoption of green revolution technologies, and this reduced the pressure on the land resource. In the two decades following the release of modern rice varieties, rice output and yields in most of the region's economies rose rapidly, while the land area devoted to its cultivation increased only slightly (Table 12).

(Table 12)

Governments also enshrined food security—or more strongly, self-sufficiency in cereals at the national or even sub-national scale— as a basic plank of development policy (Barker and Herdt 1985; David and Huang 1996). The key instruments of the self-sufficiency strategy in food-importing countries have been quantitative restrictions on

[16] Braga 1992. The other leading exporters were Cote d'Ivoire (2.4%), Brazil (2.4%) and Gabon (2%).

food trade (recently converted to tariffs to comply with WTO rules) usually with monopoly control over imports assigned to a state agency. These policies, along with overall agriculture sector strategy, have done much to determine resource allocation and investment both to agriculture as a whole, and to industries within the sector.

(Table 12)

Environmental consequences of agricultural development

Trends in food demand, agricultural technology, and food policy have all had very significant environmental consequences. Most obviously, agricultural area expansion has taken place primarily at the expense of forest. The mechanisms for this land use change vary from country to country and over time, with contributions from state-sponsored land clearing for settlement programs, commercial forestry and subsequent land conversion by corporate agribusiness enterprises, and deforestation and land clearing (as well as the intensification of bush fallow rotation systems) by 'subsistence' farmers. All, however, have been driven by a combination of opportunity and necessity, and encouraged by the absence of well-defined and effectively enforced property rights over forest-covered land.

While the direct impacts of infrastructural investments and of green revolution technologies outside of irrigated areas were generally small (David and Otsuka 1994), yield gains in lowland irrigated areas almost certainly diminished pressures for expansion of food production in uplands by driving down relative grain prices. Rising labor productivity and labor demand in lowland agriculture also reduced incentives for labor migration to uplands (Coxhead and Jayasuriya 1994, Hayami and Kikuchi 2001). These indirect impacts of the green revolution conferred environmental benefits in uplands, raising the opportunity cost of deforestation and land conversion. Such gains must be offset against the long-term costs of intensified production in lowland areas—especially soil quality degradation and the water pollution effects of increased use of inorganic inputs. In addition, the human health effects of intensive pesticide use under common rice-farming practices have been shown to be very high, even exceeding the agricultural benefits of their use (Rola and Pingali 1993; Resosudarmo 2001; for further coverage see Pingali 2001).

Alongside the endemic market failure of open access to new lands, agricultural price policies have had the twin effects of promoting the expansion of food cultivation and of de-linking domestic and international cereal prices in the short to medium term. Whatever their benefits in terms of food security, these policy-induced distortions have potentially important implications for the environment. Since the land cultivated to cereals is a very large fraction of total agricultural area (Table 13), it follows that virtually any intervention in cereal markets that affects incentives or the production technology is bound to have environmental impacts through the demands for land, soil nutrients, and water, and through the discharge of agricultural effluents into freshwater and coastal ecosystems. Food policies must be held at least partly responsible for the expansion of area planted to annual cereal crops in the region, especially that into the relatively fragile and easily degraded uplands (Coxhead and Shively 1998; Coxhead 2000).

(Table 13)

Deforestation and agricultural growth in the uplands

The economies of uplands—usually defined officially by slope, but in practice referring also to 'remote' agricultural areas—differ both in structure and level of development by comparison with coastal and river delta zones. They are less densely populated and more dependent on agriculture and other resource-based industries; their populations are poorer, less healthy, and less well educated. Market access is constrained by higher transport and transactions costs. Formal legal and administrative institutions are relatively weaker, although traditional or customary institutions may be stronger than in lowlands. Though an accurate count is impossible, a 1990 study put the population of upper watershed areas in Asia at 128 million, or about ten per cent of the rural population (Doolette and MacGrath 1990).

Whereas upland agricultural systems were traditional based on long-cycle rotations between crops and bush fallow, modern practices are increasingly sedentary. Typically the sector utilizes labor and very limited capital to colonize new lands, or to intensify the use of existing land by means of new crops or technologies. This form of development is constrained by market access. As markets expand they create new economic opportunities, and in so doing, alter the value of immovable resources such as forests and land. In a subsistence economy, such resources (and even labor) have values derived only from the requirements of local households, but in a market economy, resource valuations come to reflect returns obtainable in new uses. The environmental implications of this change are very important when the frontier of cultivation for the market is located within environmentally sensitive forest and upper-watershed areas.

Impacts of development policies in the uplands

Economic development policies—notably, though not exclusively, policies related to trade and the macroeconomy—exert tremendous influence over the allocation of natural resources and the rate of environmental degradation in developing countries (Cruz and Repetto 1992; Repetto and Gillis 1988; Coxhead, Rola and Kim 2001). Through markets and migration, policies directed at specific sectors such as manufacturing or lowland agriculture can also affect upland resource valuations, patterns of land use and production, and thus environmental outcomes.

Food policies have historically had a particularly important role to play, promoting both migration and agricultural intensification (Tongpan and Panayotou 1990; Panayotou and Sungsuwan 1992). In most of tropical Asia, the expansion of corn and coarse grains as well as and temperate climate vegetable production—the spread of which is associated with very high rates of land use change and soil erosion in upland and highland areas (Hefner 1990; Lewis 1992)— has received significant support from policies that both raised and stabilized their prices, thus greatly increasing the area over which they could profitably be grown for the market. But policies directed at other sectors have also mattered: much of the impetus for migration to upland areas has come from very slow growth in real incomes in lowland agriculture and urban areas, thus rendering the expected income to be derived from land colonization and upland farming relatively attractive.[17] Recent empirical work indicates that higher wages in non-agricultural and lowland employment would have significant effects on land use in Philippine uplands (Coxhead, Shively and Shuai 2002), although the short-medium run impact on resource depletion and the environment, which depends on farmers' adoption of soil-conserving technologies, is less clear (Shively 1999; Lapar and Pandey 1999; Rola, Coxhead and Kim 2001).

[17] This was documented in a study by Cruz and Francisco, who concluded that "migrants [to upland areas] are motivated more by lack of other livelihood options than by the attractiveness of destination lands" (1993:26).

5. 'Globalization' and the environment

As noted above, Asian economies began to turn away from the most highly inward-oriented development policies after about 1980.[18] In the region, countries that moved fastest to create a more level sectoral playing field enjoyed faster overall growth and poverty reduction (Herrin 1999). During the peak years of growth from 1986-96, the more export-oriented Asian NIEs experienced booms in labor-intensive manufacturing production. These in turn produced very rapid growth of non-agricultural labor demand, and the effects of this spilled over, through migration, to labor markets in all sectors. In Thailand and Malaysia, the fastest-growing resource-rich economies of tropical Asia, labor productivity growth in manufacturing caused rural wages to rise sharply, and the agricultural labor force to decline in absolute as well as in relative terms (Coxhead and Jiraporn 1999; Athukorala 2001).

The shift in the composition of industrial production, driven in large part by the forces of 'globalization' through trade policy reforms and the opening of economies to foreign capital flows, has been generally in the direction of cleaner industries; in addition, by absorbing more labor, the expansion of labor-intensive manufacturing has reduced pressures on open–access land and forest resources. This is not to say that aggregate industrial emissions have decreased—clearly they have not—but rather that the composition effect of globalization has been generally pro-environment at the margin, a phenomenon observed more generally in the developing world (Birdsall and Wheeler 1992; Lucas et al 1992; for Asian examples see Aldaba and Cororaton 2001, Coxhead 2000). There is, moreover, emerging evidence that income growth and associated changes in political and economic organization, including decentralization, are promoting pro-environment technique effects through popular pressure on polluters and on environmental policy makers (see section 6).

The effects of these aspects of globalization on agriculture have been twofold. Profitability has declined in labor-intensive sub-sectors, as a consequence of the boom in manufacturing sector labor demand, but the consequent relative decline in returns to land

[18] The use of 1980 is merely an approximation. For many purposes it is convenient to date the 'globalization' of developing Asia from the opening of China in 1978. However, this ignores the much earlier opening of economies such as Malaysia (not to mention Singapore and Hong Kong), and does not take account of reforms begun much later, for example in Indochina and India, or not at all, as in Myanmar.

(together with improved access to rural credit) has increased profitability in the production of land-intensive tradables such as plantation crops. In rapidly growing countries with open land frontiers—mainly Thailand, Malaysia and Indonesia—agriculture continues to expand in area; however, growth is heavily biased toward the use of land for perennial crops (Table 14). Their expansion takes place mainly by conversion of forests. In Peninsular Malaysia, for example, agricultural area increased by 46 per cent from 1970-90, with just over 100% of the growth accounted for by a greater than sevenfold expansion of oil palm plantations. Coincidentally, the increased oil palm area (1.4 million hectares) almost exactly matches the reduction in forest area (1.3 m ha) over the same period.[19] In Indonesia, widespread forest burning, primarily for the purpose of establishing oil palm and other industrial crops, has in recent years produced catastrophic environmental side-effects, including the well-publicized 'haze' that envelops large areas of Southeast Asia during the burning season (Schweithelm and Glover 1999).[20]

(Table 14)

In other Asian countries, mainly net food importers, expansion of overall agricultural area has been more tightly constrained. Moreover, in those countries—especially the Philippines and Sri Lanka—agricultural land expansion has been mainly for food crops. These countries exhibit agricultural development patterns associated with inward-looking development policies. Recent deforestation, to an even greater extent than elsewhere in the region, has been mainly to produce land for the expansion of short-term food crops and to replace agricultural land abandoned due to degradation.

Imbalances in the rate of trade liberalization, as already mentioned, are also important. Historically, the net price-increasing effects of food import restrictions and related interventions were insufficient to offset the prevailing anti-agriculture bias of industrial promotion policies (Siamwalla and Setboonsarng 1990; Intal and Power 1990; Krueger et al 1988). In a very significant shift, however, this policy bias has been

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19 These calculations are based on data in Vincent, Rozali and Associates 1997, Tables 5.1 and 5.2. Vincent *et al.* note, however, that the rate of deforestation has diminished sharply in recent years.

20 "The 1990s has seen the rise of tree plantations as the most powerful force behind the conversion of forest lands in [the Indonesian islands of] Sumatra and Kalimantan. The government supported the development of pulp wood and palm oil plantations, using incentives such as free land, subsidized capital, and free use of standing timber. Rising domestic and international demand for palm oil, pulp, and paper…has given additional impetus to the growth of these industries" (Schweithelm and Glover 1999, p.6).

inverted in the 1990s. WTO trade policy rules bind import tariffs for manufactures, but are considerably more lenient where developing country agricultural imports are concerned. As a result, very high levels of protection for cereals have persisted in Asia even after major trade reforms in other sectors and rice, corn, and other staples are now among the region's most heavily protected commodities (WTO 1998-2001). Thus in the Philippines, for example, the effective rate of protection for manufacturing declined from 32% to 15% between 1990 and 2000, whereas that for agriculture fell only from 32% to 24% (Aldaba and Cororaton 2001). In 2000, the Philippines' implicit tariff on rice and corn was 43% while the median value for manufactures other than food processing was under 10% (ibid.). Indonesia, another net food importer, liberalized trade in a very wide range of commodities in the 1990s but excluded rice, imports of which remain under the control of a State trading agency "to guarantee its supply to the population at affordable prices and to ensure food security" (Government of Indonesia, cited in WTO 1998).

Finally, while continuing high protection has done little to reduce production of import-competing crops, globalization and capital-deppening have also fueled expansion in the area and production of industrial plantations. The area planted to exportable crops such as oil palm and coffee has increased tremendously in the era of liberalization. In Southeast Asia, the area planted to coffee has risen by more than 300% since 1980, while for oil palm the increase is more than 500% (Figures 2 and 3), while areas devoted to traditional smallholder crops such as coconut and rubber have remained more or less static (Figures 4 and 5). New land for expanding crops has been obtained primarily through the conversion of forests (Gérard and Ruf 2001; Vincent, Rozali and Associates 1997; Ha 2001).

[Figures 2–5 about here]

<u>Economy-wide analyses</u>

As the foregoing discussion makes clear, empirical assessment of the environmental consequences of the globalization of Asian economies requires an economy-wide approach. A number of applied general equilibrium (AGE) modeling exercises has recently emerged in this field.[21] Most use trade policy reforms as the stimuli for

[21] Kaimowitz and Angelsen (1998) review numerous earlier economic models of tropical deforestation, including a number of economy-wide models for Asian countries.

counterfactual investigations of economy-environment linkages; however, there are as yet no AGE models applied to Asia that take account of all major forms of environmental damage. A common finding is that policy liberalization has mixed environmental effects. Lee and Roland-Holst's 1997 study of the Indonesian economy finds that trade liberalization would raise real purchasing power but, through changes in relative prices, also induce a composition effect that would see increased emissions from a wide range of manufacturing processes as well as increased natural resource demands by primary sectors. Their study, however, does not investigate the implications of trade reforms for the environmental effects of agriculture. Similarly, a CGE analysis of trade liberalization in the Philippines yields mixed results on the environmental composition effect, with a notable shift to relatively clean industries such as garments and electronics. However, the study neglects agricultural and natural resource sectors (Aldaba and Cororaton 2001). A notable contribution of this study is its consideration of the pro-competitive effects of liberalization in heavily concentrated industries such as sugar processing and cement. The authors note that liberalization of trade and foreign ownership restrictions can in general be expected to eliminate the least efficient (and most pollution-intensive) firms within an industry, in addition to providing incentives for other firms to upgrade to newer (and presumably cleaner) technologies.

Other economy-wide analyses concentrate on natural resource problems to the exclusion of industrial emissions. Cruz and Repetto (1992), in a model of the Philippine economy, find that trade liberalization would increase pressures for deforestation and upland agricultural production. Panayotou and Sussangkarn (1992, cited in Kaimowitz and Angelsen 1998) find that reducing export taxes on rubber would result in increased agricultural area expansion in Thailand. Bandara and Coxhead (1999) find that trade liberalization would have generally positive impacts on Sri Lanka’s agriculture and natural resource sectors, given that some of the most highly protected agricultural industries are also the most land-degrading; moreover, there would be positive off-site effects of trade policy induced changes in the uses of upland land. Anderson and Strutt (2000) compute the implications of GATT compliance in Indonesia for the production of on-site and off-site damages due to soil erosion. Coxhead and Jayasuriya (2002a) present a model of the Philippine economy in which industrial emissions and natural resource pressures, including pressures for agricultural intensification and expansion are all endogenous. In this model, trade liberalization results in migration of labor away from the forest margin, with corresponding environmental gains in the form of reduced pressures on land and forest resources.

All these AGE models are static in nature and embody other limiting assumptions made necessary by the scale and complexity of the modeling exercise. As might be expected they yield mixed results on the environmental effects of 'globalization'. In industry sectors, trade liberalization and the effects of increasing international competition tend to shift resources into cleaner sectors and production processes. However, such comparative static models understate the dynamic growth effects of trade liberalization, and thus provide only indicative results on scale effects. Moreover, whether globalization results in more or less pressure on the natural resource base depends very much on the property rights regime (Jayasuriya 2001), something that few AGE models consider in detail.

Effects of the Asian economic crisis

The region-wide economic downturn that began with the collapse of the Thai baht-US dollar exchange rate in July 1997 affected the more open economies of the region in disproportionate fashion— not surprisingly, since an open capital account is an important element of vulnerability to the crisis. Apart from a general (and in most cases short-lived) downturn in industrial pollution as sectoral output collapsed, the crisis appears to have had medium to long term effects on migration and intersectoral resource allocation, with consequences for deforestation, agricultural land use and watershed services. In the worst-hit countries, Indonesia and Thailand, the early months of the crisis saw substantial outmigration from cities back to the countryside as urban jobs (for example in construction) disappeared. An inflow of labor to rural areas should be associated with expanded agricultural production and thus deforestation. Interestingly, however, reverse migration in Thailand appears to have been transitory; recent data show no increase in the agricultural labor force after a small 'spike' in 1997-8, and the long-term declining trend in Thai agricultural land area has continued. In Indonesia, by contrast, many reverse migrants appear to have remained on the land.

Adjustments associated with the crisis have also affected the structure of agricultural production. Real currency depreciations have boosted domestic prices of tradable crops relative to those of non-tradables or crops, like rice, whose prices are subject to domestic market and policy influences. In the outer islands of Indonesia, the early crisis years saw a rush to plant new acreage of plantation crops (notably cocoa, oil palm and others), driven by lower labor costs as well as the expectation of higher profits from increased export competitiveness (Gérard and Ruf 2000). It is no coincidence that the peak expansion of plantation crop area, accompanied by huge forest clearing through fire, came in the years immediately after 1997 (Schweltheim and Glover 1999). That expectations of a bonanza in export crops have only been met for a subset of plantation crops has just begun to emerge (Sunderlin et al. 2001), but it is most unlikely that forest cleared for these purposes will revert in the medium run.

6. Current environmental trends and policy issues

Modern environmental policy in SE Asia faces a very different set of circumstances when compared with those of a half-century ago; moreover, attitudes that provide the impetus for policy formation are also changing, albeit slowly. The traditional approaches to environmental and natural resource management through direct interventions and command-and-control regulation, though arguably appropriate in an earlier era, are steadily becoming less effective, and more costly, with the growth of the private sector and of markets. Sustained growth in per capita incomes has created opportunities for governments to consider policies which explicitly posit a tradeoff between growth and the environment, such as the declaration of parks and protected areas, and to begin to consider environmental goals more or less on a par with other developmental objectives.

One positive side-effect of broad-based income growth in more open economies is the incipient trend for Asian firms to adopt technologies with lower emissions intensity of production. This occurs as a side-effect of the adoption of newer generations of technologies by firms seeking to produce more efficiently for the world market, but also in some cases through pressure for environmental compliance from international buyers, as the current proliferation of announcements of ISO 14001 compliance by Asian firms makes clear.

Pressure on polluters also comes, increasingly, from the domestic economy. All efforts at managing environmental and natural resources face the open access problem. This applies not only to forest, upland soils, and water supplies, but also to the quality and quantity of 'downstream' water and air when firms or farms can dump pollutants without fear of retribution. Direct and regulatory approaches are not well suited to manage the open access problem, since they do not address polluters' incentives. It has become clear, in fact, that any approach to ENR management requires enabling conditions that either allocate property rights, or substitute for them through collective action. In the mid-1990s, Indonesia's Clean River Program (PROPER-PROKASIH) provided one of the clearest and best-documented illustrations of this point (Afsah and Vincent 1997).

At the national level, environmental initiatives are beginning, albeit slowly, to enter the mainstream of policy debate. Following the 1992 Rio Summit on the environment, several Asian countries produced their own adaptations of *Agenda 21* documents (e.g. PCSD 1997; State Council 1994). Measures to limit the use of leaded petrol, clean air acts, and solid waste disposal measures have followed, as have national initiatives to protect forests and watersheds through measures consistent with, rather than in contradiction with, the needs and aspirations of local communities. Such initiatives will undoubtedly help slow the rate of growth of pollution and natural resource depletion in Asia. Given present rates of increase in the demands for environmental services, however, current measures are unlikely to be adequate to maintain approximate equality between marginal social damages and the welfare benefits of polluting or resource-depleting production.

Optimists might respond that the need for an independent environmental policy may be small, since income-elastic demand for a clean environment as well as supply-side technique effects will all help reduce emissions in growing economies. Thus for example Lindert (1999) has argued for one case that:

> Contrary to the usual presumptions about development and soil, China is especially likely to have a soil-conserving agriculture if it industrializes and prospers, allowing Engel effects and international trade to accelerate

> the shift from grains, oils and cotton to non-staple farm products, which happen to tax the soil endowment less (p.702-3).[22]

However, in more general cases, the persistence of market failures in the form of open access to resources and free disposal of pollutants, unless corrected, will inevitably ensure over-use of environmental services and a persistent need for policy correctives. In economies that are growing and undergoing structural change, the argument for market-based policies, which are by nature more adaptable than quantitative rules to changing circumstances, is even stronger than in the textbook case.

Communities and their local government representatives, as the front-line consumers of pollution or losers from natural resource degradation, are not merely more highly motivated than any other group to influence the use of local ENR assets, but when armed with appropriate capacity and tools, can also be more effective in making and implementing policies for this purpose. This has been demonstrated in studies of pollution abatement by paper mills and other polluting industries in Asia (Hartman et al 1997; World Bank 2000), and by the catalytic local policy actions of community-based water quality monitors in the Philippines (Deutsch et al 2001b). Everywhere in the developing world, the involvement of communities is emerging as a critical factor in the success of environmental initiatives, a trend that has assigned concrete meaning and policy import to the much-abused term ‘participation’. The preconditions for community-level collective action are intuitively clear: knowledge of potential gains from the action; some potential for actual gain; and membership in reciprocating organizations (White and Runge 1995). While project approaches generally address the first two of these, the third—the exploration of ‘social capital’ as a possible contributing factor to collective action—is an area in which the need for research is particularly critical.

So too, in the era of increasingly decentralized administration, is an understanding of the function of representative local governments in resource management initiatives. After years of failed attempts at centralized control, the conventional wisdom has now turned decisively in favor of devolved approaches to environmental and natural resource

[22] An implication of China’s impending agricultural trade liberalization—one condition of its accession to the WTO in 2001— is that pressure to expand agricultural land for food production may diminish. At a regional scale the benefits of this move are less clear, however, since some agricultural trade is likely to be diverted to neighboring countries such as Thailand and Vietnam.

management, in which central government agencies act in partnership with, or even under the leadership of, communities and local governments (e.g. World Bank 2000). The trend towards devolved NRM has been welcomed in principle by many development specialists, especially as it coincides with and is reinforced by a general trend towards democratization, especially at the sub-national level. The latter, however, is a critical constraint on the effectiveness of local control: where local administrations are not accountable to their constituents, devolving authority merely results in accelerated degradation, a process now being witnessed in Indonesia.[23] Moreover, the question of optimal policy 'control areas' for local administrations whose resource management activities influence transboundary externalities (both downstream, nationally, and in the cases of biodiversity and atmospheric carbon releases, globally) has yet to be seriously confronted (Coxhead 2002).

Recognizing both the advantages of first-best policies and the impediment posed by weak institutions, the literature on natural resource management policy in Asia is rapidly converging on a synthesis in which communities, local governments and their support agencies such as NGOs and development aid projects are the central actors in the 'sustainable' management of natural resources such as forests, soils, and watersheds. Localizing resource management policy in a market economy is not without challenges, but is nevertheless widely regarded as presenting the best practical opportunity to equate private and social costs.

7. Conclusions

Rapid economic growth has presented countries in tropical Asia with a widening range of environmental and natural resource problems, the costs of which are transparently reducing capacity for future growth. The causes and consequences of ENR damages are both direct and observable and indirect and difficult to identify, operating through spatial externalities as well as through intersectoral economic linkages. Key features and policy components of development strategy are readily seen to have significant environmental

[23] For excellent and up-to-date coverage of decentralization and forest management in Indonesia see Colfer and Resosudarmo (2002). Papers in this volume also provide insightful coverage of the complex issue of the distribution of resource management powers between central and local agencies in the Indonesian context.

side-effects. In spite of widespread rhetoric about sustainable development, however, policy-making in the region has been characterized by a lack of integration of environmental policies with ‘mainstream’ economic policies. The environmental consequences of reforms in essentially non-environmental policies, such as trade and investment policies related to globalization and the decentralization of government functions—raise questions about their broader welfare implications, when environmental externalities and the depletion and degradation of natural resources are taken into account.

In the Asian setting of generally rapid growth and openness to trade and investment flows, it is ironic that the highest import protection rates are now conferred on agricultural industries, and the environmental consequences of this imbalance in the pace of liberalization are significant. Forests, soils, and watershed services, all ‘inputs’ to agricultural production, remain substantially unprotected by effective property rights institutions. Trade policy distortions further accelerate pressures for their depletion. This interaction of a policy distortion with the continuing open access problem diminishes the likelihood that policies or projects addressing these important ENR areas will achieve measurable and lasting results.

In spite of continuing high rates of resource degradation, there are some grounds for optimism about future development-environment interactions. Among these (and the present Indonesian case notwithstanding), the empowerment of communities and local governments as natural resource managers, a consequence of ongoing decentralization, seems to present one of the best hopes that future development paths will be more consistent with appropriate use of the environmental and natural resource assets that support them.

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Table 1: Population and urbanization in developing Asia

	Total Population (millions)		Urban population (%)		Average annual growth rate (%)	
Country	1970	2000	1970	2000	Total Pop.	Urban Pop.
Bangladesh	66.48	131.05	7.6	24.5	2.27	6.17
Cambodia	6.94	12.02	11.7	15.9	1.85	2.89
India	547.57	1015.92	19.8	28.4	2.07	3.26
Indonesia	117.54	210.42	17.1	40.9	1.96	4.82
Lao PDR	2.71	5.28	9.6	23.5	2.22	5.20
Malaysia	10.85	23.27	33.5	57.4	2.54	4.35
Myanmar	26.85	47.75	22.8	27.7	1.93	2.61
Nepal	11.88	23.04	3.9	11.9	2.20	5.87
Pakistan	60.61	138.08	24.9	37.0	2.75	4.07
Philippines	36.55	75.58	33.0	58.6	2.44	4.32
Sri Lanka	12.51	19.36	21.9	23.6	1.48	1.78
Thailand	35.75	60.73	13.3	21.6	1.81	3.39
Vietnam	42.73	78.52	18.3	24.0	2.04	2.98

Source: World Bank, *World Development Indicators 2001* (www.worldbank,org/WDI, accessed 19 June 2002).

Table 2: Air pollution indicators in major Asian cities, 1995

Country	City	Total Suspended Particulates (TSP) (μ/m^3)	Sulfur Dioxide (μ/m^3)	Nitrogen Dioxide (μ/m^3)
China	Beijing	377	90	122
	Chongqing	320	340	70
	Guangzhu	295	57	36
	Shanghai	246	53	73
	Shenyang	374	99	73
	Tianjin	306	82	50
	Wuhan	211	40	43
India	Bombay	240	..	..
	Calcutta	375	49	34
	Delhi	415	24	41
	Hyderabad	152	12	12
	Mumbai	240	33	39
Indonesia	Jakarta	271	..	..
Japan	Osaka	43	19	63
	Tokyo	49	18	68
	Yokohama	..	100	13
Korea, Rep	Pusan	94	60	51
	Seol	84	44	60
	Taegu	72	81	62
Malaysia	K. Lumpur	85	24	..
Philippines	Manila	200	33	..
Singapore	Singapore	..	20	30
Thailand	Bangkok	223	11	23

Source: *World Development Indicators 1998*.
Note: WHO guidelines for acceptable levels of pollutants are:

TSP < 90 μ/m^3
SOX < 50 μ/m^3
NOX < 50 μ/m^3.

.. = Data not available

Table 3: Forest cover and deforestation, Asian developing countries

Country	Forest area ('000 km^2)				Forest area (% total area)	Average annual deforestation (km^2)		Average change (per cent per year)	
	1980[1]	1990[1]	1990[2]	2000[2]	2000[3]	1980-90	1990-2000	1980-90[1]	1990-2000[2]
China	126,398	133,756	145,417	163,480	17.50	-735.80	-1806.30	0.60	1.20
South Asia			-	-					
Bangladesh	1,258	1,054	1,169	1,334	10.20	20.40	-16.50	-1.80	1.30
Bhutan	2,975	2,803	3,016	3,016	n.s.	17.20	n.s.	-0.60	n.s.
India	58,259	64,969	63,732	64,113	21.60	-671.00	-38.10	1.10	0.10
Nepal	5,580	5,096	4,683	3,900	27.30	48.40	78.30	-0.90	-1.80
Pakistan	2,749	2,023	2,755	2,361	3.20	72.60	39.40	-3.10	-1.50
Sri Lanka	2,094	1,897	2,288	1,940	30.00	19.70	34.80	-1.00	-1.60
SE Asia			-	-					
Cambodia	13,484	10,649	9,896	9,335	52.90	283.50	56.10	-2.40	-0.60
Indonesia	124,476	115,213	118,110	104,986	58.00	926.30	1312.40	-0.80	-1.20
Lao PDR	14,470	13,177	13,088	12,561	54.40	129.30	52.70	-0.90	-0.40
Malaysia	21,564	17,472	21,661	19,292	58.70	409.20	236.90	-2.10	-1.20
Myanmar	32,901	29,088	39,588	34,419	52.30	381.30	516.90	-1.20	-1.40
Philippines	11,194	8,078	6,676	5,789	19.40	311.60	88.70	-3.30	-1.40
Thailand	18,123	13,277	15,886	14,762	28.90	484.60	112.40	-3.10	-0.70
Vietnam	10,663	9,793	9,303	9,819	30.20	87.00	-51.60	-0.90	0.50

Sources:

[1]Source: WRI, *World Resources 1998-99*

[2]Source: FAO 2000a (measurement method different to [1]Source; see Mathews 2001)

[3]Source: World Bank, 2001 *World Development Indicators*

n.s. not significant, indicates a very small value.

Table 4: WRI estimates of changes in natural forest and plantation cover

Region	1990 (‘000 ha)		2000 (‘000 ha)		Average annual change of natural forest	
	Nat. forest	Plantation	Nat. forest	Plantation	‘000 ha	Per cent
Africa	697,882	4,415	641,828	8,038	-5,589	-0.8
Oceania	36,201	149	34,869	263	-133	-0.4
S. America	903,199	7,279	863,739	10,455	-3,946	-0.4
Asia	495,340	56,117	431,422	115,873	-6,392	-1.3
—Tropical	289,820	22,486	233,448	54,624	-5,637	-1.9
—Temperate	05,520	33,631	197,974	61,249	-755	-0.4

Source: Calculations based on FAO data by Matthews 2001, Table 2.

Table 5: Freshwater withdrawals and availability, Asian developing countries

	Year	Annual Withdrawals	Withdrawals by sector (per cent share)			Annual per capita withdrawal	Renewable water availability
		million m^3	Agric-ulture	Dom-estic	Industry	m^3, 1996	'000 m^3 per inhab. 1996
China	1993	525,489	77	5	18	424	2.2
South Asia							
Bangladesh	1990	14,636	86	12	2	122	10
Bhutan	1987	20	54	36	10	11	52
India	1990	500,000	82	5	3	529	2
Nepal	1994	28,953	99	1	0	1,315	10
Pakistan	1991	155,600	97	2	2	1,277	3
Sri Lanka	1990	9,770	96	2	2	540	3
SE Asia							
Cambodia	1987	520	94	5	1	51	46
Indonesia	1990	74,346	93	6	1	371	14
Lao PDR	1987	990	82	8	10	196	66
Malaysia	1995	12,733	77	10	13	619	28
Myanmar	1987	3,960	90	7	3	86	23
Philippines	1995	55,422	88	8	4	780	7
Thailand	1990	33,132	91	5	4	564	7
Vietnam	1990	54,330	86	4	10	723	12

Source: FAO: AQUASTAT Database

Table 6: Human-induced land degradation rates, Asian developing countries

Country	Total Land Area	Severity of human-induced land degradation (per cent of total area)				
		None	Light	Moderate	Severe	V. Severe
China	9550	28	8	30	25	10
South Asia	4716	33	3	15	38	13
Bangladesh	144	5	0	68	27	0
Bhutan	47	2	67	24	0	7
India	3517	37	1	4	43	16
Nepal	141	23	29	30	27	0
Pakistan	802	25	2	49	22	2
Sri Lanka	65	0	17	29	22	32
South East Asia	4485	1	17	33	32	13
Cambodia	181	13	2	36	27	22
Indonesia	1916	1	36	26	32	6
Lao PDR	237	0	16	83	0	1
Malaysia	333	0	0	17	83	0
Myanmar	677	1	0	63	35	1
Philippines	299	3	0	76	3	3
Thailand	513	0	2	20	28	50
Vietnam	329	0	0	21	29	49

Source: FAO. For definitions see FAO 2000.

Table 7: CO2 emissions by sectoral source, selected developing countries (thousand metric tons, 1991).

Country	From industrial processes	From land use change	% From land use change
Bangladesh	15,444	6,800	30
Indonesia	170,466	330,000	70
Malaysia	61,196	110,000	65
Philippines	44,587	110,000	71
Thailand	100,896	91,000	47
Vietnam	20,573	33,000	62

Source: Estimates reported in WRI: *World Resources 1994-95*.

Table 8: GDP shares (%) major sectors, developing Asian countries

Country	GDP growth[a]	Years	Agric.	Industry	(*Mfg*)	Services
China	6.42	1960-80	35	40	*31*	25
		1981-90	29	44	*36*	27
		1991-00	20	48	*37*	32
Indonesia	3.97	1960-80	42	23	*10*	35
		1981-90	22	37	*16*	40
		1991-00	18	43	*24*	40
Malaysia	4.12	1960-80	29	30	*14*	41
		1981-90	20	39	*21*	41
		1991-00	13	42	*27*	45
Philippines	1.04	1960-80	28	31	*23*	41
		1981-90	24	36	*25*	40
		1991-00	20	32	*23*	48
Thailand	4.34	1960-80	29	25	*17*	46
		1981-90	17	33	*24*	50
		1991-00	11	39	*29*	50
Myanmar	..	1960-80	40	13	*10*	47
		1981-90	52	12	*9*	37
		1991-00	60	10	*7*	30
Vietnam[b]	5.37	1960-80	..	..	..	..
		1981-90	40	29	*26*	32
		1991-00	29	30	*20*	41
Bangladesh	1.35	1960-80	44	14	*11*	42
		1981-90	32	21	*15*	47
		1991-00	26	23	*15*	51
India	2.59	1960-80	43	21	*15*	36
		1981-90	34	26	*17*	40
		1991-00	29	27	*16*	44
Pakistan	2.02	1960-80	37	21	*15*	42
		1981-90	28	23	*16*	49
		1991-00	26	24	*17*	50
Sri Lanka	2.99	1960-80	30	24	*17*	47
		1981-90	27	27	*15*	46
		1991-00	23	26	*16*	50

a. Real per capita income (1995 US$), annual average 1970-2000. b. 1991-2000.
.. = not available. Source: World Bank: *World Development Indicators 2001*

Table 9: Gross fixed capital formation (per cent of GDP) and foreign direct investment (per cent of GFCF), developing Asian countries

Country	Item	1961-80	1981-90	1991-00
China	GFCF	29	29	34
	FDI	0	2	11
Indonesia	GFCF	22	25	26
	FDI	3	1	2
Lao PDR	GFCF	..	9	27
	FDI	..	0	21
Malaysia	GFCF	20	30	36
	FDI	13	11	15
Myanmar	GFCF	12	15	13
	FDI	..	..	..
Philippines	GFCF	20	22	22
	FDI	1	4	8
Thailand	GFCF	22	30	34
	FDI	2	4	10
Vietnam	GFCF	..	12	25
	FDI	..	1	32
Bangladesh	GFCF	20	18	20
	FDI	0	0	1
India	GFCF	16	21	23
	FDI	0	0	2
Pakistan	GFCF	16	17	17
	FDI	1	2	5
Sri Lanka	GFCF	18	25	25
	FDI	1	3	5

.. = not available.
Source: World Bank: *World Development Indicators 2001*

Table 10: Total exports (X, % of GDP), manufactured exports (MFG, % of exports), and trade/GDP ratio (per cent), developing Asian countries

Country	Item	1961-70	1971-80	1981-90	1991-00	Trade as % of GDP, 2000)
China	X	2	4	11	22	44.5
	MFG	..	..	*62*	*83*	
Indonesia	X	10	24	25	31	67.0
	MFG	*2*	*2*	*18*	*49*	
Lao PDR	X	..	..	8	23	45.2
	MFG	*7*	*2*	*34*	..	
Malaysia	X	42	46	59	97	219.7
	MFG	*5*	*14*	*34*	*73*	
Myanmar	X	13	6	5	1	1.1
	MFG	*1*	*6*	*6*	*10*	
Philippines	X	16	22	25	42	91.0
	MFG	*6*	*14*	*29*	*60*	
Thailand	X	16	20	27	46	108.8
	MFG	*3*	*16*	*42*	*71*	
Vietnam	X	..	..	14	36	94.1
	MFG	*1*	*11*	*5*	..	
Bangladesh	X	7	4	5	11	28.9
	MFG	..	*63*	*68*	*85*	
India	X	4	5	6	11	19.3
	MFG	*48*	*54*	*61*	*74*	
Pakistan	X	9	11	12	16	31.3
	MFG	*41*	*56*	*65*	*83*	

.. = not available.
Source: World Bank: *World Development Indicators 2001*

Table 11: Protection, factor intensity and emissions in Thai manufacturing industries

Weighted Average[a] (standard deviations in parentheses)	Import-competing (n=45)	Exporting (n=29)	Non-Traded (n=19)
Protection and factor intensity indicators			
Domestic resource cost (DRC)	2.07	0.65	—
	(0.131)	(0.024)	
Effective rate of protection (ERP)	139.39	-12.01	—
	(12.359)	(1.126)	
Nominal rate of protection (NRP)	44.06	1.22	—
	(2.685)	(0.168)	
Labor-intensity (labor cost as a fraction of total cost)	0.42	0.61	0.43
	(0.015)	(0.033)	(0.033)
Emissions indicators (see Note):			
AHTI score (linear index)	6.47	2.92	2.68
	(0.201)	(0.153)	(0.220)
IPPS rank	33.20	36.34	55.04
	(1.611)	(1.806)	(3.908)

Sources: Coxhead (2000), with data from Bank of Thailand and Hettige et al. 1994.

[a] Calculated using within-group weights based on value of domestic production.

[b] AHTI = Acute Human Toxicity Index

Table 12: Indices of rice production, area and yield (1970 = 100)

	Production		Yield		Harvested Area	
	1980	1990	1980	1990	1980	1990
Cambodia	39	63	68	84	57	75
Indonesia	153	227	139	185	111	123
Laos	117	177	106	193	110	92
Malaysia	122	107	153	120	80	89
Myanmar	163	167	163	172	100	97
Philippines	138	172	128	156	108	110
Thailand	125	147	93	99	134	149
Vietnam	115	188	97	151	119	125

Source: IRRI (1991)

Table 13: Area planted to cereals, 1980-98 average

Country	Cereal area planted ('000 ha)	Per cent of arable land
China	91,525	78
SE Asia		
Indonesia	13,422	72
Lao PDR	653	84
Malaysia	695	48
Philippines	6,676	123
Thailand	10,984	64
Vietnam	6,635	118
South Asia		
Bangladesh	10,946	128
India	102,044	63
Pakistan	11,649	57
Sri Lanka	835	96

Note: Due to double-cropping, area may exceed 100% of arable (cultivated) land.
Source: World Bank, *World Development Indicators 2001*

Table 14: Agricultural land use trends in developing Asian economies

	Percent of total land area:					
Country/Region	Arable land[a]		Permanent crops[b]		Agricultural Area[c]	
	1980	1997	1980	1997	1980	1997
Sri Lanka	13.2	13.4	15.9	15.8	29.1	29.2
Philippines	14.5	17.2	14.8	14.8	29.3	32
Lao PDR	2.9	3.5	0.1	0.2	3	3.7
Cambodia	11.3	21	0.4	0.6	11.7	21.6
India	54.8	54.5	1.8	2.7	56.6	57.2
Indonesia	9.9	9.9	4.4	7.2	14.3	17.1
Vietnam	18.2	17.4	1.9	4.7	20.1	22.1
Thailand	32.3	33.4	3.5	6.6	35.8	40
Malaysia	3	5.5	11.6	17.6	14.6	23.1

Source: World Bank, *World Development Indicators 2000.*

[a] Arable area is defined as land under temporary crops, temporary pastures, and short-term fallow. Excludes land abandoned as the result of shifting cultivation.

[b] Permanent crops area is defined as land cultivated with crops that occupy the land for long periods and need not be replanted after each harvest (flowering shrubs, fruit trees, nuts trees, vines, etc). Excludes areas of trees grown for wood or timber.

[c] Sum of arable area and permanent crops

Figure 1: Real per capita growth rates, developing regions (Source: World Bank)

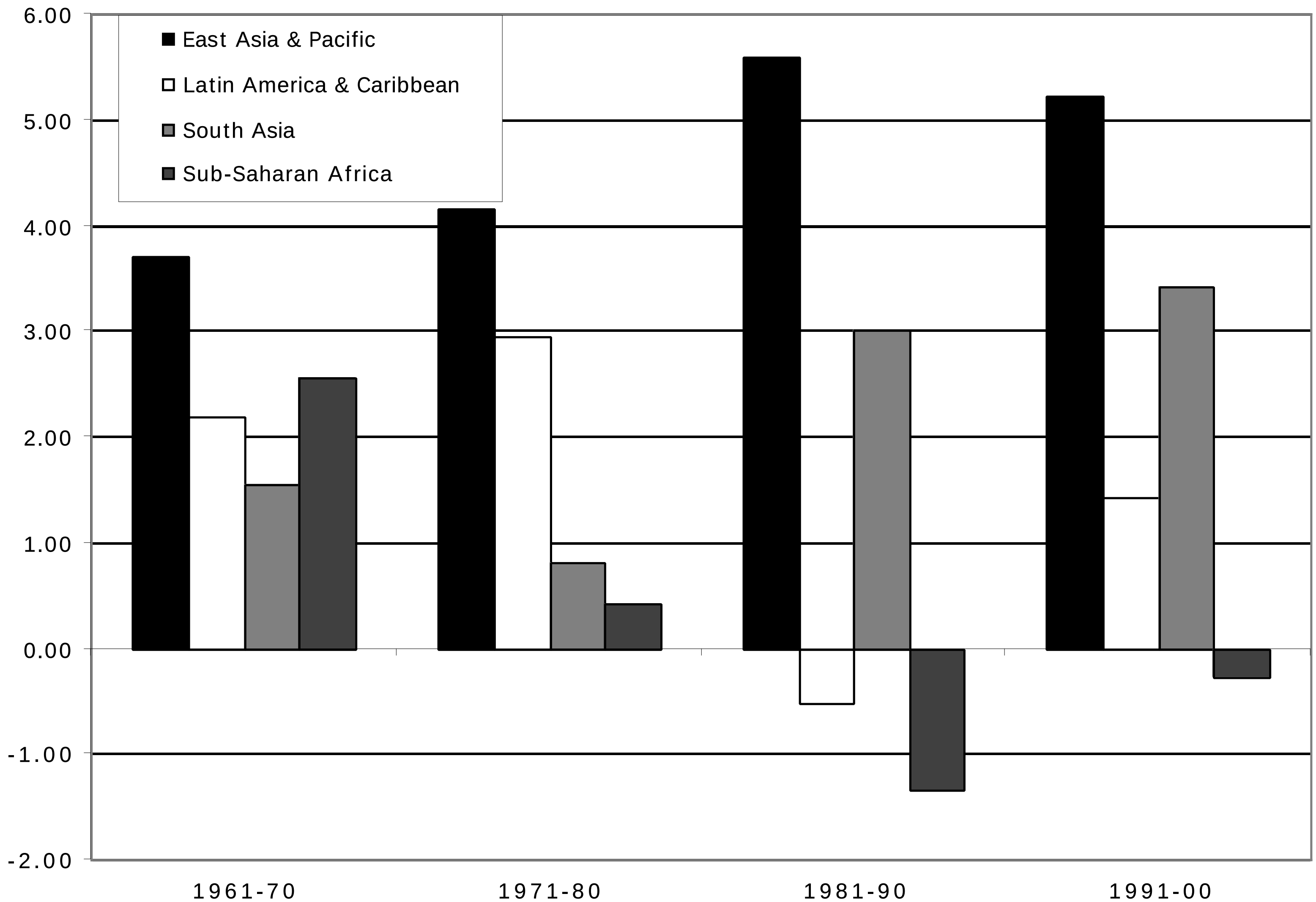
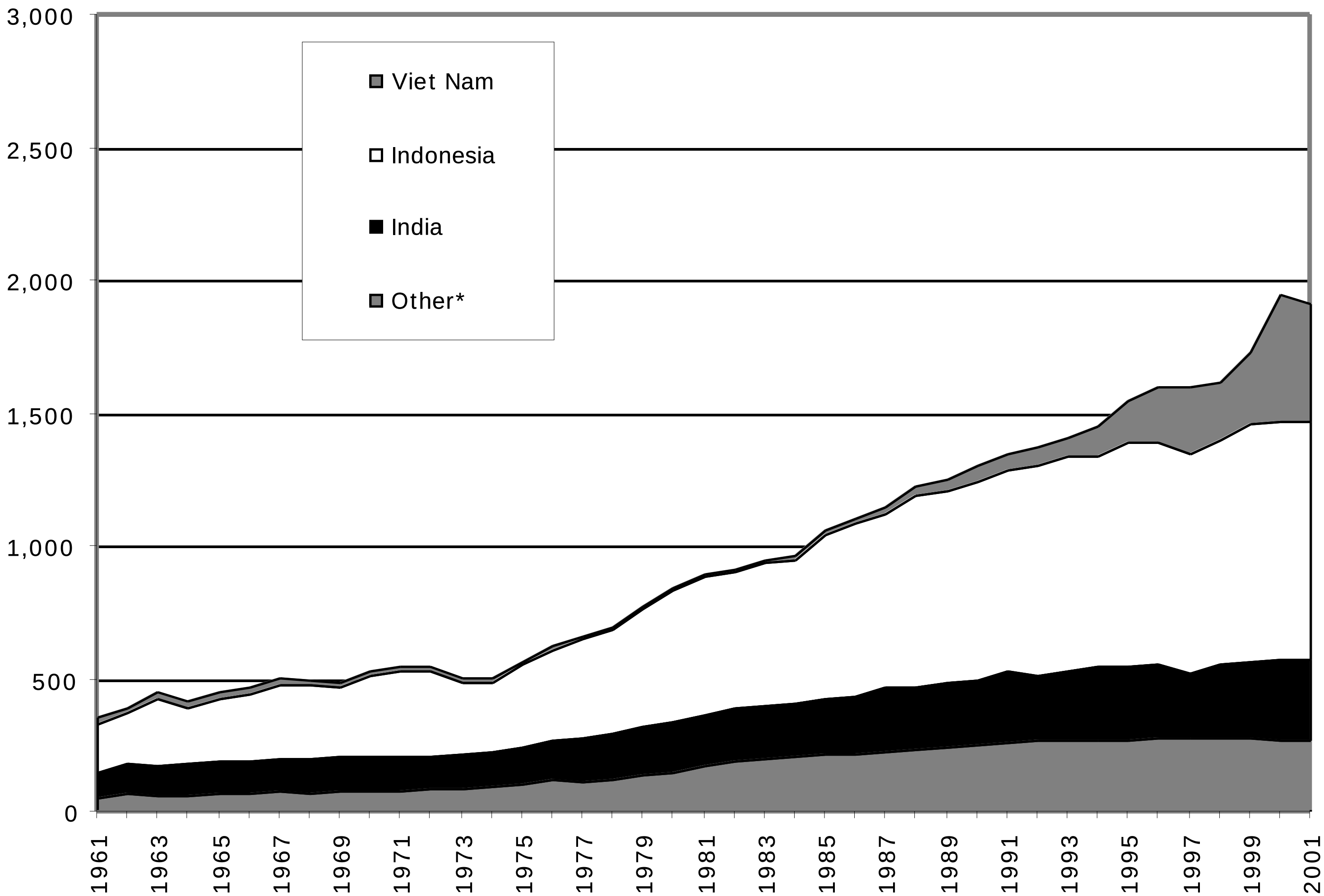
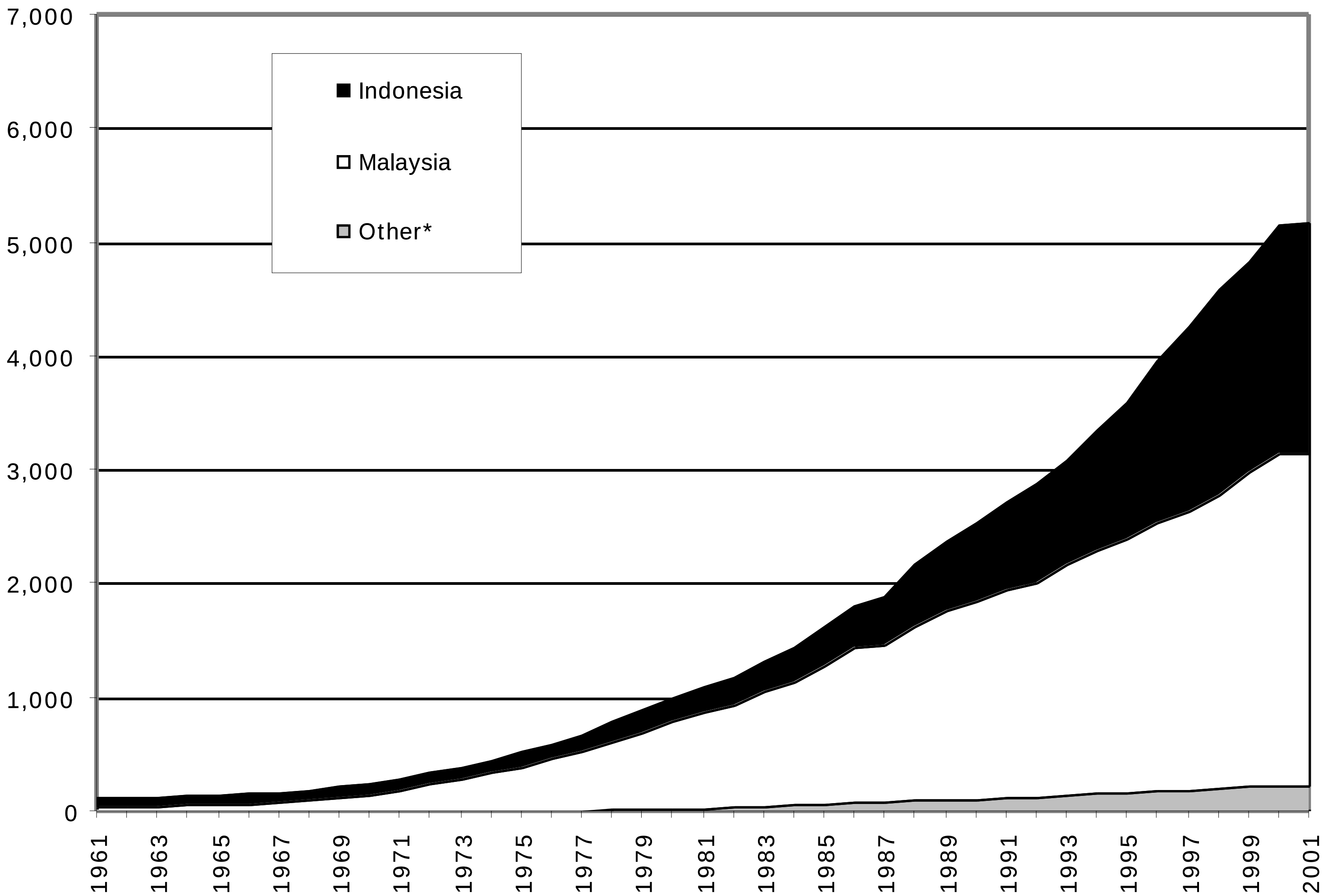


Figure 2: Area harvested, coffee (thousand ha)



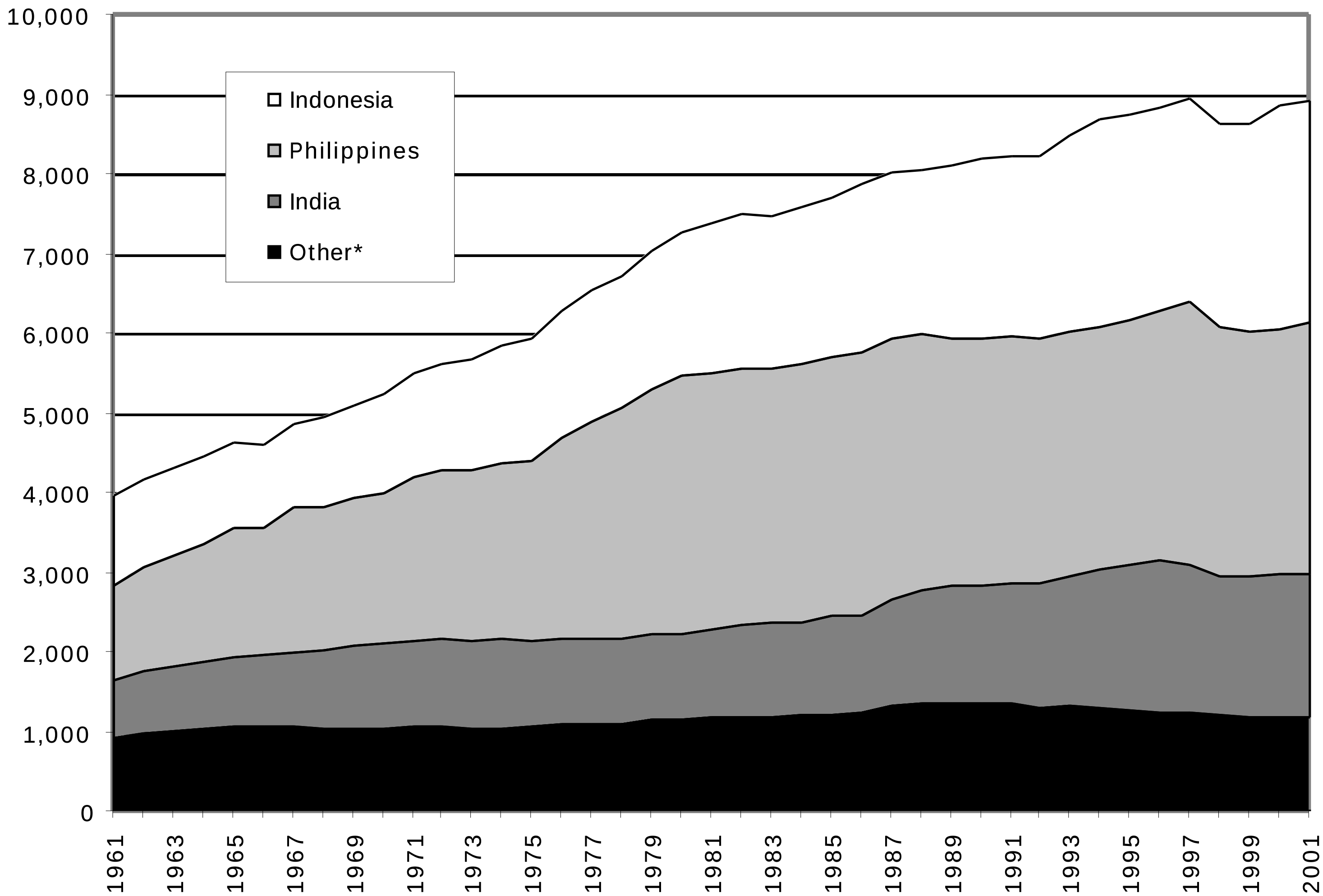
* Bangladesh, Cambodia, Malaysia, Myanmar, Philippines Thailand, Sri Lanka. Source: FAOSTAT

Figure 3: Area harvested: oil palm (thousand ha)



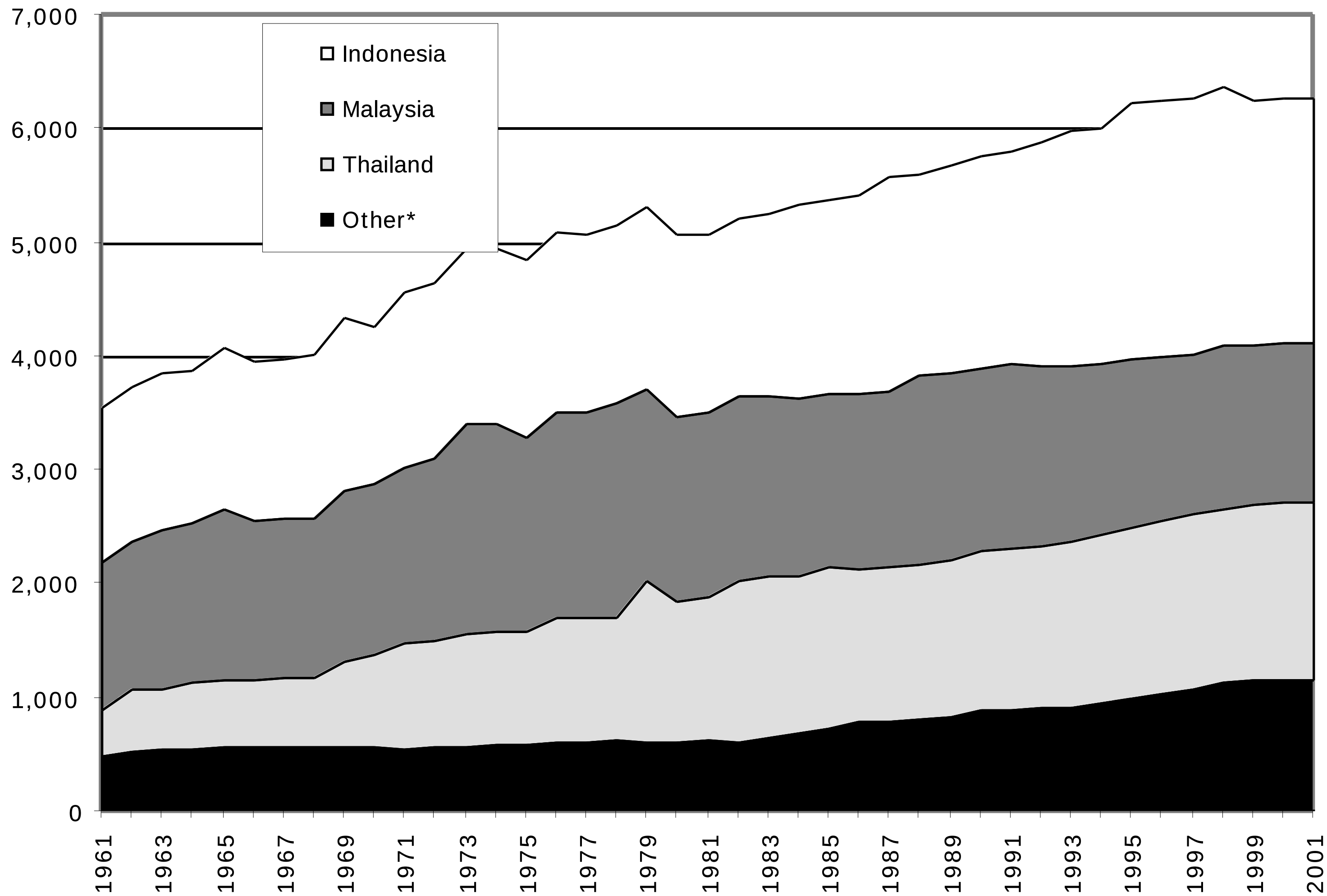
* Bangladesh, Cambodia, India, Myanmar, Philippines, Sri Lanka, Thailand, Viet Nam. Source: FAOSTAT

Figure 4: Area harvested: coconut (thousand ha)



* Bangladesh, Cambodia, Malaysia, Myanmar, Thailand, Sri Lanka, Viet Nam. Source: FAOSTAT

Figure 5: Area harvested: rubber (thousand ha)



* Bangladesh, Cambodia, India, Myanmar, Philippines, Sri Lanka, Viet Nam. Source: FAOSTAT