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COAL MINING IN INDONESIA: ENVIRONMENTAL IMPACTS, SUSTAINABILITY, AND ECONOMIC DEVELOPMENT

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Table of Contents

1	Introduction	1
2	Institutional aspects of coal mining	4
3	Coal mining in Kalimantan Timur	7
4	Economic benefits of coal mining	10
5	Environmental impacts of coal mining	15
6	Competing land uses and the decision whether to mine	18
7	Environmental impact assessment	24
8	Water pollution	26
9	Reclamation	33
10	Ensuring compliance with environmental regulations	38
11	Resource rents	42
12	Conclusions	46
Bibliography		49

1 Introduction

Indonesia is endowed with abundant, commercially valuable natural resources. Timber harvests in its rainforests make it one of the world's leading producers of tropical hardwood products. Its soils, particularly in volcanic areas, are fertile and support one of the most intensive rice cultivation systems in the world. It has great mineral wealth, exemplified by petroleum and natural gas (it is the world's largest exporter of liquefied natural gas).

But other countries' experience indicates that natural resources are no guarantee of development success. In terms of physical resource endowments, Africa is one of the most resource-rich continents. Yet, economic development has stagnated in much of Africa during the last 30 years, and non-African countries that have grown the most rapidly during this period include resource-poor Asian nations such as Japan, South Korea, Taiwan, Hong Kong, and Singapore. In light of this experience, some development experts have concluded that natural resources are in fact a curse, not a blessing. This conclusion may be too strong, but in any event one clearly cannot assume that a country's economy will automatically benefit in the long run from the exploitation of natural resources.

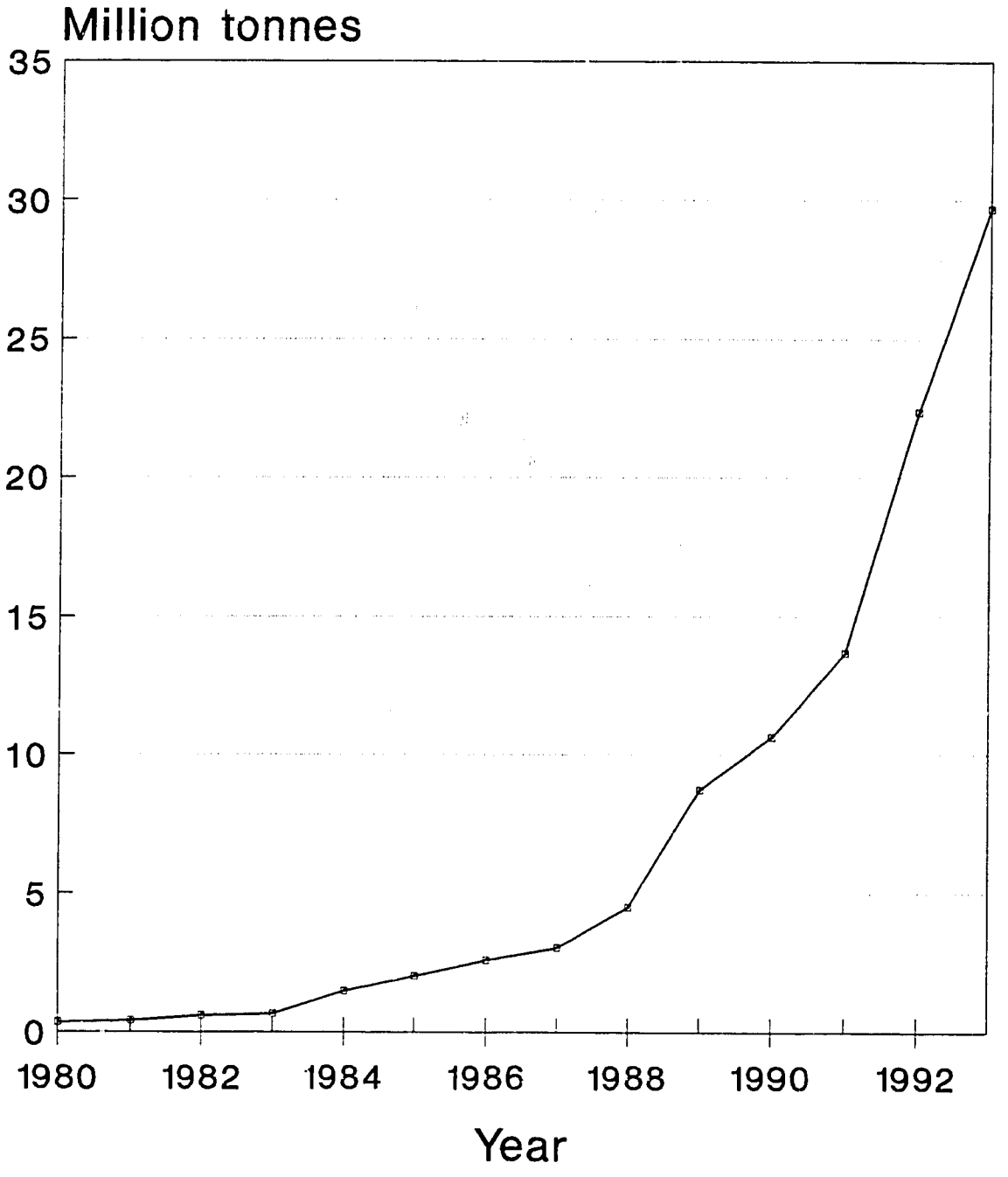
Coal is rapidly emerging as a significant natural resource in Indonesia. Coal mining is not new to the nation, but Indonesia's role as an important supplier in the world market is a very recent development. Commercial mining began in 1849 in the province of Kalimantan Timur (East Kalimantan) on the island of Borneo, and expanded with the opening of the Ombilin and Bukit Asam mines on the island of Sumatra in the late 1800s and early 1900s. The onset of World War II marked the beginning of a prolonged decline that lasted into the 1970s. The industry's resurgence was signaled by a 1976 Presidential Decree that called for the country to make maximum use of its coal resources.

Figure 1 illustrates the exponential growth in coal production from 1980-93. Projections of future output vary, but all indicate that production will continue to grow rapidly. Projections for the year 2000 range from 65 million tons to more than 100 million tons. Even the lowest estimate is six times the 1990 production level.

Rising sales in both domestic and, especially, export markets have led the production boom. During 1989-92, the export share of production rose from 40 percent to 70 percent, as exports rose from 3.5 million tonnes to 16.1 million tonnes and domestic sales rose from 5.2 million tonnes to 6.8 million tonnes. Indonesia now exports coal to many countries, with about a third going to Japan, a third to Western Europe, and the rest mainly to other Asian nations and the United States. It is favorably situated in the most rapidly growing region in the world, where energy consumption and fossil-fuel imports are rising fast.

Coal mining generates employment, export earnings, and other tangible benefits for the Indonesian economy. These benefits should increase rapidly in the medium term, as some relatively new mines expand production and more mines open. However, mining also degrades

Figure 1
Coal Production in Indonesia



environmental quality. It can drastically alter the landscape, destroying natural habitat in the process. In Indonesia, the ecosystems affected include tropical rainforests, which are the most biologically diverse terrestrial ecosystems in the world. Apart from altering the landscape, mining operations contribute to local air pollution through the generation of dust, and increase sediment loads in streams that drain the site. At present, experience with land reclamation following coal mining in the humid tropics is extremely limited, so the ultimate consequences of surface coal mining in Indonesia are highly uncertain.

In response to concerns about these impacts, the Indonesian Ministry of Mines and Energy has established a series of decrees and guidelines to protect the environment. Current environmental policies for mining are based on regulations first enacted by the Ministry in 1977, preceding national policies on the environment by five years. National environmental policy, which also applies to coal mining, was laid out in 1982 in the Provisions for the Management of the Living Environment Act. In early 1993, the Ministry established a Bureau of Environment and Technology to oversee regulatory processes related to this Act, to monitor environmental impacts, and to provide technical support and policy analysis on matters related to the environment. The Bureau has sponsored conferences on coal mining and has worked together with UNCTAD and the U.S. Office of Surface Mining.

The Ministry of Environment has also taken a particular interest in the coal sector. In 1993, the two ministries participated in a study tour of coal mining operations in the western United States. This tour included meetings with regulatory agencies in Washington, D.C. In August, 1994, they jointly sponsored a workshop on mining and the environment in Bandung. This workshop brought together Indonesian and international experts from industry, government agencies, and academia. These last two activities were supported by funding from the U.S. Agency for International Development and were organized with the assistance of the World Environment Center. In recent years, the annual meeting of the Indonesian Mining Association has included special sessions on management of environmental impacts.

The commercial benefits of mining are economically important, but so are the less obvious losses caused by mining-related environmental damage. The challenge facing Indonesia is to ensure that mining benefits not only mining companies, but also the country as a whole. This paper provides an economic perspective on how to meet this challenge. Its purpose is two-fold: to provide a framework for understanding the relationships among mining, environmental impacts, and sustainable economic development, and to recommend policies to ensure that Indonesia benefits to the maximum extent from the development of its coal resources.

The paper is divided into two parts. The first part (sections 2-5) provides a profile of coal mining in the country, with emphasis upon Kalimantan Timur. Coal mining has expanded most rapidly in this province. This part of the paper begins by describing institutional features of the industry and the development of mining in Kalimantan Timur. It closes by discussing the benefits and costs, at national and provincial levels, of coal mining. Readers who are already familiar with coal mining in Indonesia can skim these sections.

The second part of the paper (sections 6-11) addresses six specific policy issues: competing land uses and the decision whether to mine, the environmental assessment process, water pollution during mining, land reclamation, compliance with environmental regulations, and rent capture and utilization. For each, we assess the current situation and offer policy recommendations for improved management. A final section (section 12) summarizes the broad themes emerging from the study.

2 Institutional aspects of coal mining

2.1 Production

Under Article 33 of the 1945 Constitution of the Republic of Indonesia, coal and other natural resources are owned by the State, and are to be "utilized for the greatest welfare of the people." Coal mining is conducted by a large state-owned enterprise, PT Tambang Batubara Bukit Asam (PTBA), and foreign and domestic mining companies. PTBA operates the Ombilin and Bukit Asam mines in Sumatra. In 1993, it accounted for 25 percent of the country's coal production.

Foreign mining companies are involved through cooperation contracts with PTBA. The first international tender was held in 1978. In 1981, Presidential Decree No. 49 established the contractual arrangements for foreign participation. Foreign firms operate under coal cooperation contracts that require production sharing. During the first five years of a contract, contractors give PTBA 13.5 percent of their coal output. This in-kind payment is made on a "delivered" F.O.B. basis, which means that PTBA must pay for transshipment, freight, and marketing, or reimburse the contractor if the latter handles the sale of the coal. The 13.5 percent figure was established in long negotiations with the first coal cooperation contractors, and it was based in part on government estimates of their costs of production. PTBA pays royalties due on the contractor's share of production as well as its own. Each year from the commencement of construction, contractors also give a lump sum payment of $100,000 to PTBA to cover land rent, land and building tax, and some other local taxes.

In theory, PTBA could always undercut the price of coal sold by its contractors, as it does not bear any of the mining costs. In practice, this possibility is avoided by PTBA selling primarily to the domestic market and the contractor to the international market. When PTBA sells internationally, the contractor sells the coal for it under a joint-marketing agreement. PTBA pays royalties, corporate income tax, and dividends (35 percent of after-tax profits) to the government, but it is allowed to accumulate reserves and to pay a bonus to management.

One attractive aspect of coal cooperation contracts from the standpoint of the government and PTBA is that the contractors provide all the capital and bear all the business risk of the ventures. Cooperation contracts in other sectors are less favorable. For example, agribusiness and pulp and paper companies that establish forest plantations can get interest-free loans from the state-owned forestry company, which takes an equity stake in the venture but receives no guarantee of returns.

The first production by a foreign contractor commenced in 1987. In the same year, the government closed the coal sector to new foreign investment in an effort to encourage joint ventures between PTBA and domestic investors. By the end of 1991, 11 coal cooperation contracts had been signed, and all but one were with foreign firms. In early 1993, the government again invited foreign firms to apply for coal cooperation contracts. The policy

reversal was motivated, in part, by government concerns that domestic investment resources were insufficient for developing the full potential of the sector and for meeting future energy and foreign-exchange needs. Nevertheless, the government announced approvals of 19 new coal cooperation contracts with domestic firms in late 1993. In 1993, contractors accounted for 67 percent of Indonesia's coal production.

Domestic firms can also operate so-called "private" mines under Mining Authorizations (*Kuasa Pertambangan*, or KP) issued by the Ministry of Mines and Energy. These amount to concession agreements under which the government grants a mining company the exclusive right to exploit coal in a specified area. The company pays royalties to the government, but otherwise it operates as a purely private venture. This is the traditional arrangement for private-sector involvement in coal mining. KP mines tend to be smaller than contractors' mines, and they accounted for only 8 percent of the country's coal production in 1993.

2.2 Revenue

The central government receives mining-related revenue from three principal sources: royalties, corporate income tax payments (for all companies, including PTBA), and dividends (from PTBA only). Royalties are based on the type of mining, volume produced annually, and calorific value of the coal. For open-pit mining, the royalty ranges from $0.30 per ton for coal with a calorific value below 5,000 kcal/kg and total production below 400,000 tons, to $0.60 for a calorific value in excess of 6,000 kcal/kg and volume in excess of 400,000 tons. Royalties for underground mining are lower, in recognition of higher unit costs of production; they range from $0.15 to $0.30 per ton.

The Ministry of Finance receives 10 percent of royalty revenue, the Ministry of Mines and Energy 10 percent, and the province where mining occurs 80 percent. The latter allocates one-fifth (16 percent of the total) to the provincial government (*Daerah Tingkat* I), and four-fifths (64 percent) to secondary levels of government in the provinces (*Daerah Tingkat* II, or Dati II). The central government therefore receives little of the royalty revenue. On the other hand, it receives all of the corporate income tax payments and dividends.

Apart from royalties, income tax, and, in the case of PTBA, dividends, mining companies also pay land rent, land and building tax, value-added tax on purchases and sales of most goods, withholding tax on dividends and interest, and some provincial and local taxes and fees (described later in the report).

2.3 Environmental impact assessment

Government Act No. 4 of 1982 mandated an environmental impact assessment process for large industrial projects as part of the licensing and approval process for proposed investments. The intention is to force industries to consider the environmental consequences of their actions and to take appropriate preventive and remedial steps. Details of the process were

established by Government Regulation No. 29/1986. More recently, Regulation 51/1993 simplified the process as part of a package of reforms designed to streamline investment procedures.

The overall process is usually referred to by its acronym, AMDAL (*Analisis Mengenai Dampak Lingkungan*). It requires investors to prepare a series of documents, including:

(i) a Terms of Reference (*Kerangka Acuan*), which is intended as a screening device to establish the need for more detailed analysis;

(ii) an Environmental Impact Analysis (*Analasis Dampak Lingkungan*, or ANDAL), which presents baseline (pre-project) information on local environmental conditions and a detailed analysis of a project's impacts;

(iii) an Environmental Management Plan (*Rencana Pengelolaan Lingungkan*, or RKL), which describes how anticipated environmental impacts will be managed; and

(iv) an Environmental Monitoring Plan (*Rencana Pemantauan Lingkungan*, or RPL), which describes how actual environmental impacts will be monitored.

According to Government Regulation No. 51, the AMDAL should assess, among other things, the number of people affected by the project, the extent of environmental and socioeconomic impacts (in terms of physical area), the duration and intensity of the impacts, the environmental components affected, and the potential for reversing these impacts. AMDALs are reviewed by special AMDAL commissions at both the ministerial and provincial levels.

Ministerial Decree No. 0185K/008/M.PE of 1988 established guidelines for implementing the AMDAL process in the mining sector. It did not standardize the monitoring process. For example, in the case of water pollution, the frequency of sampling, the parameters analyzed, and the analytical methods employed are determined on a case-by-case basis in the Environmental Monitoring Plans. AMDALs for mining projects are usually prepared by consultants and not by the mining company employees who actually implement the RKL and RPL.

3 Coal mining in Kalimantan Timur

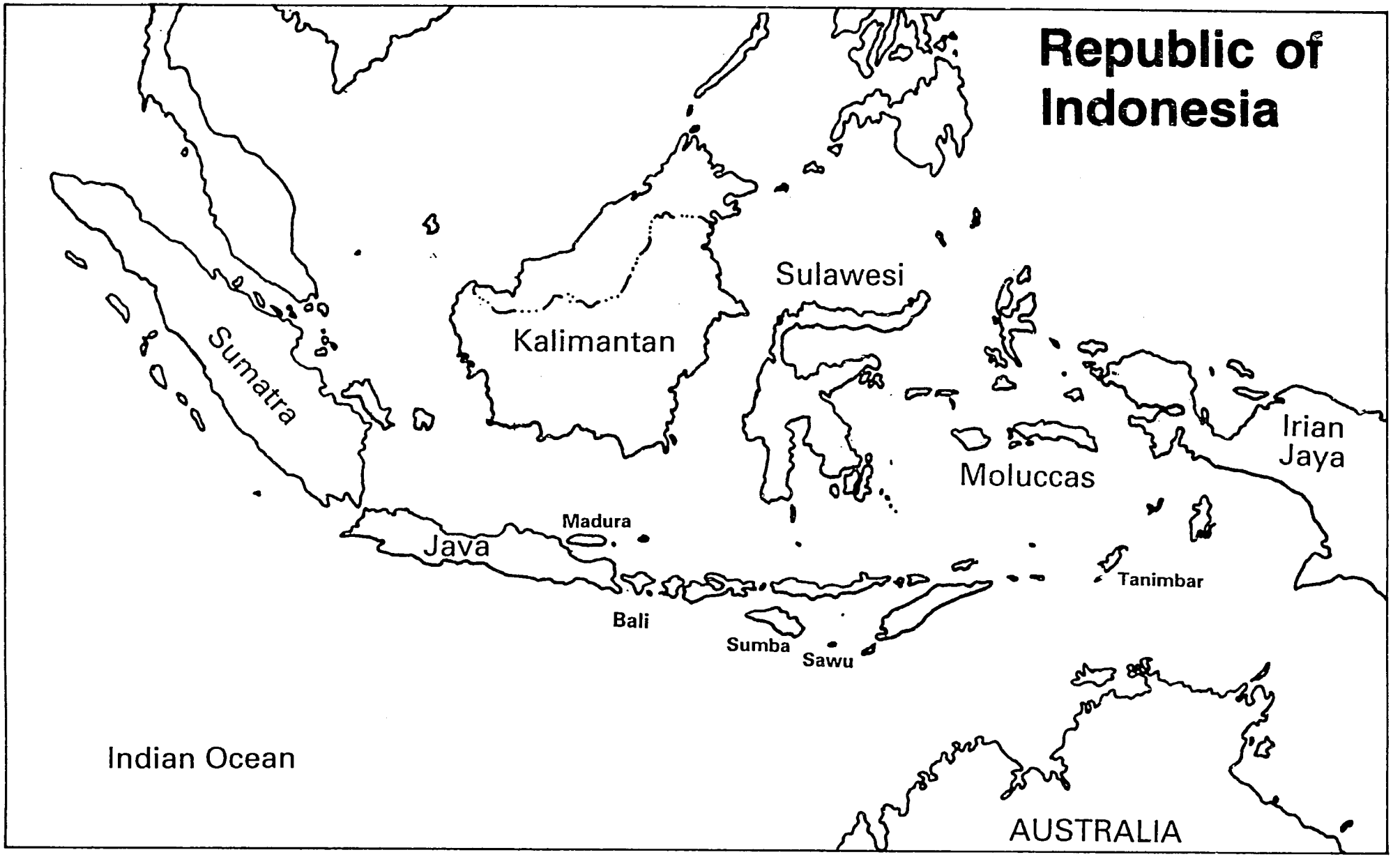
3.1 Key features of Kalimantan

Indonesia's coal resources are located primarily in the "outer islands," that is, islands other than Java. Mining is expanding most rapidly in Kalimantan. Coal production in Kalimantan increased from 3.6 million tonnes in 1990 to 12.9 million tonnes in 1992. Kalimantan is one of the least densely populated parts of the Indonesian archipelago. It accounts for 30 percent of the country's land area but only 5 percent of its population. A few large towns are scattered along the coast, typically at the mouths of rivers serving as highways into the interior. These towns by and large grew up as trading centers for natural resources extracted in the interior and transported down-river to be exported.

Spidery mountain ranges divide Kalimantan into four provinces: east, west, central, and south. Most economic development has occurred near the coast, where the land is flat or gently rolling. The original lowland rainforests have been extensively cleared by various combinations of commercial logging, shifting cultivation, agricultural development, and seasonal fires. Transmigration schemes, intended simultaneously to promote outer-island development and to relieve population pressure in Java, have been established in many areas. Much of the deforested area, however, is not in active use but instead has been overtaken by the aggressive grass, *Imperata cylindrica* (*alang-alang*). Where forests remain, they are generally heavily degraded as a consequence of logging operations that failed to comply fully with forestry regulations, and by slash-and-burn farming. In response to deforestation and degradation, the Ministry of Forestry and the timber industry have established considerable areas of timber plantations, for the most part using exotic tree species.

Preliminary results of the latest survey by the Ministry of Forestry indicate that 73 percent of Kalimantan was forested in 1991. Most of the forests are in the more rugged, less populated interior. It is there that the largest commercial timber stocks remain, as well as the largest reservoirs of biological diversity. The livelihoods of indigenous people living in the interior are closely tied to the forest.

Coal is fossil peat, formed as land plants decay under waterlogged conditions. The decaying vegetation initially forms peat, which changes to coal as the layers sink and are compressed. Coal is classified according to rank (calorific or heat value). High-rank coals include the black coals, anthracite (hard coal) and bituminous (soft) coal. Low-rank coals include sub-bituminous (brown) coal and lignite, which differs little from dried peat. Asia and Australia have the world's biggest reserves of black coal. Because Kalimantan was not glaciated during the Ice Age, coal has been forming there, uninterrupted, for millions of years. Hence, coal seams in Kalimantan are often unusually thick — tens of meters — which makes them especially attractive from a commercial standpoint. Kalimantan has smaller identified coal resources than Sumatera — 7.3 billion tonnes vs. 16.3 billion tonnes — but a much higher proportion of its coal is black — 36 percent vs. only 9 percent.


Republic of Indonesia
Sulawesi
Kalimantan
Sumatra
Irian Jaya
Moluccas
Madura
Java
Tanimbar
Bali
Sumba
Sawu
Indian Ocean
AUSTRALIA

Kalimantan coal also has unusually low sulfur and ash contents. This makes it among the least polluting coals in the world. When coal is burned, the sulfur in it forms sulfur dioxide, which causes acid rain and contributes to respiratory disorders through the formation of sulfate particulates. One mine in Kalimantan Selatan (South Kalimantan), PT Adaro, markets its coal under the trademark "Envirocoal." An industrial estate in Hawaii has signed a long-term purchase agreement with a mine in Kalimantan Timur, PT Kaltim Prima Coal, as use of low-sulfur coal from this mine enables it to avoid the high cost of desulfurization equipment at its co-generation plant. Some mines in the U.S. mix Indonesian coal into their own coal to make a "sweeter" blend that satisfies U.S. emissions regulations. Former centrally planned economies, such as Bulgaria, have experimented with increased use of Indonesian coal as an affordable means of reducing their severe air pollution problems. In the international market, the positive environmental qualities of Indonesian coal help offset its high moisture content, which reduces its heat value. Heat value is the most important determinant of coal price.

3.2 Kalimantan Timur

Most of the increase in coal production in Kalimantan has occurred in Kalimantan Timur. The province's coal output rose from 2.3 million tonnes in 1990 to 8.6 million tonnes in 1992, making it the country's leading province in terms of coal production. Seven of the eleven coal cooperation contracts signed by the end of 1991, and seven of the nineteen new ones approved in late 1993, are in Kalimantan Timur.

Existing mines in Kalimantan Timur are located primarily near the coast. Coastal plains and low hills with elevations below 150 meters extend about halfway into the province. The 1990 "Coal & Peat Resources Map of Indonesia," prepared and published by the Coal & Peat Exploration Division of the Directorate Sumber Daya Mineral (Directorate of Mineral Resources), shows a north-south band of coal basins underlying virtually all of this area. Only the mountain spur that divides the province into northern and southern halves appears to lack resources.

Mining in Kalimantan Timur began along the Mahakam River in the southern half of the province. During the last decade, a number of new, large mines began exploiting other deposits both north and south of the Mahakam. The largest is the Kaltim Prima Coal mine north of the Mahakam, which accounted for more than half of coal output in Kalimantan Timur in 1992. This is now the largest coal mine in the country.

At the end of 1991, coal leases covered approximately 2.7 million hectares in Kalimantan Timur. This represented about 13 percent of the area of the province. Not all of this area will ultimately be cleared for mining and associated activities. Areas lacking commercial coal deposits are removed from coal leases as exploration proceeds.

As with any mineral, total coal resources are not known with certainty. The Directorate of Mineral Resources classifies the country's resources into five categories: measured, indicated,

and inferred, which together comprise identified resources, and hypothetical and speculative, which comprise unidentified resources. The "Coal & Peat Resources Map of Indonesia" indicates that coal deposits underlie proportionately less of the interior of Kalimantan Timur than the coastal lowlands. Moreover, all of the resources in the interior are in the unidentified category. But the Directorate and the industry are confident that commercial coal deposits are present in the interior. Blank spaces on the map simply indicate incomplete geological information. The Kalimantan Timur Regional Office of the Ministry of Mines and Energy expects coal mining to begin expanding into the interior in the near future, and coal seams near the surface in the lowlands to be largely exhausted in 20-30 years. Coal in the interior is expected to be older than that near the coast. This might make its heat value higher and therefore make it more valuable. On the other hand, the seams might be deeper, which would raise extraction costs and possibly require underground mining.

4 Economic benefits of coal mining

4.1 Benefits at the national level

The expanding coal sector contributes to the Indonesian economy in several ways: through GDP growth, government revenue, employment and income, export earnings, regional development, and energy security. These benefits are of course interrelated, but for policy reasons it is useful to consider them separately.

GDP GROWTH — At the most general level, coal mining raises gross domestic product (GDP), which is the sum of value-added in the economy. Value-added is the difference between a sector's revenue and the cost of material inputs it purchases from other sectors. In the case of coal mining, value-added indicates the earnings that are available to pay workers for their labor, owners of capital (i.e., mining companies and their shareholders) for equipment and structures used in mining, and the owner of the resource — in this case, the Indonesian government — for the right to mine coal deposits. The earnings may be used to finance current consumption or saved and invested, in which case they contribute to raising the standard of living of future generations. During 1983-91, value-added in mining and quarrying, excluding oil and natural gas, rose 72 percent after adjusting for inflation. Most of the increase was due to the increase in coal production.

INCOME AND EMPLOYMENT — Payments to labor and capital utilized in coal mining contribute toward raising the income of Indonesian workers and investors. Although per capita income has risen impressively in Indonesia in recent decades (recording an average annual growth rate of 3.9 percent during 1980-91), the country remains a low-income developing country. Per capita GNP was only US$650 in 1993, making Indonesia the 36th lowest among the 127 countries listed in The World Bank's *1993 World Development Report*. Coal mining is not labor-intensive, but it does generate additional jobs. In a country with a rapidly growing population, job creation is a must to maintain social stability. During 1980-91, the country's population grew at an average annual rate of 1.8 percent.

Obviously, the magnitude of income and employment benefits depends on the domestic and foreign shares of labor and capital involved in mining and the degree of repatriation of payments by foreign workers and investors. Foreign involvement is most apparent in mines operated under coal cooperation contracts, but even in KP mines management and technical positions are frequently filled by expatriates. Recognition of the contribution that foreign capital and managerial and technical expertise can make toward developing the sector exists in constant tension with a desire to ensure that Indonesia retains maximum value from coal development

EXPORT EARNINGS — With an increasing share of production going to foreign buyers, coal is a small but rapidly growing component of Indonesia's export basket. Coal's share of Indonesia's export earnings rose from less than 0.1 percent in 1983 to 1.7 percent in 1993 (6.1 percent of energy exports). The value of coal exports increased at an average annual rate of

nearly 70 percent during 1989-93, from less than $77 million to $639 million. Export volumes are projected to increase at an average annual rate of more than 15 percent through 1999 (Mangunwidjaja 1993).

Greater foreign exchange earnings enable the country to finance more imports of capital goods, which are necessary for building the economy, and consumption goods, which raise current well-being. They also enable it to continue servicing its rising debt: the country's total debt service as a percentage of its total exports rose from 13.9 percent in 1980 to 32.7 percent in 1991. Gross export revenues for coal do not, however, translate directly into foreign exchange available to the economy. Most exports come from foreign-operated mines, which repatriate most of their profits. Only revenues that these companies spend on wages, domestic goods and services, and investment in permanent or transferable infrastructure represent real foreign exchange earnings to the economy. A large component of foreign exchange earnings comes from the 13.5-percent production shares. These payments are made in kind, that is, in coal, which can be used domestically for power generation, freeing up more oil for exports and reducing the need for fuel imports.

Foreign exchange savings will become increasingly important to the country as coal production expands and replaces oil for domestic use. Petroleum has been the country's leading export since the early 1970s. But by 1992, crude petroleum production had fallen by 10 percent from its 1977 peak. The country has not discovered substantial new oil deposits since the early 1980s. Enhanced coal production might not be able to pick up all the slack, but it will help cushion the economic blow as the country evolves from a net exporter of oil to a net importer.

GOVERNMENT REVENUE — As discussed in section 2.2, central and provincial governments capture a share of value-added from coal mining through royalties, corporate income taxes, and dividends. This revenue supports federal, provincial, and local public-sector programs. Royalty payments from all coal mining companies totaled $15 million in 1993. This was roughly 4.5 percent of all non-tax revenues (including royalties from forestry and fishing) in the 1992/93 budget. Royalties from contractors with PTBA are expected to reach $12.5 million in 1994, but no estimates are available for KP mining companies.

OUTER-ISLAND DEVELOPMENT — The government has long promoted development of the outer islands as a means of integrating the far-flung archipelago.[1] As most of Indonesia's coal is located in Sumatra and Kalimantan, mining may serve as a catalyst for growth through direct and indirect job creation and infrastructure development.

ENERGY SECURITY — Development of the coal sector helps to ensure that Indonesia will be able to meet the energy demands of its rapidly growing population and economy. Per capita energy consumption, in oil-equivalents, nearly tripled from 99 kg in 1970 to 279 kg in

[1]Indonesia consists of more than 13,000 islands stretching more than 5,000 km from east to west.

1991. Coal's share of energy generation, after remaining nearly constant at 7-8 percent of total megawatt output from 1989 to 1993, jumped to 16 percent in fiscal year 1993/94.

The major barrier to a larger contribution from coal is a lack of coal-fired generation capacity. The government expects to remedy this over the next decade: its Power Generation Plan calls for a 15-percent increase per annum in electricity generation capacity through 2000, and much of this will come from new coal-fired power plants (Millseed 1993). The Plan calls for the capacity of coal-fired power plants to rise to 18,000 megawatts by the year 2000, up from only 1,732 megawatts in 1993. The additional plants will require approximately 50 million tonnes of coal annually. This is twice the entire 1992 production level. Figure 2 shows projections by the Directorate-General of Mines of domestic coal consumption during the next decade. By 2021, coal is expected to provide almost 40 percent of domestic energy needs.

As Table 1 shows, coal's usefulness as a source of energy is not limited to conventional power generation. Coal is used directly in cement kilns and for other industries. Cement plants used 2 million tons of coal in 1992 and are expected to need more than 3 million tons by 1998. The government also hopes to replace kerosene with coal briquettes for home energy needs such as cooking fuel, enabling it to phase out kerosene subsidies. The government currently fixes the kerosene price far below its true economic cost, forgoing as much as $400 million in revenue in 1992/93. But several obstacles remain to this use of coal, including problems with high moisture content and excessive smoke from impurities and sulfur. It is unclear whether ready solutions exist for these problems, and more important, whether coal briquettes can be provided at an acceptable price to consumers without a new subsidy scheme.

4.1 Benefits at the provincial level

The benefits discussed above accrue in varying degrees to the provinces where coal is mined. Three are of particular importance to policymakers concerned with economic development in Kalimantan Timur: employment and income, government revenue, and regional development.

EMPLOYMENT AND INCOME — According to the Central Bureau of Statistics, some 22,584 people in Kalimantan Timur worked in mining and quarrying industries in 1992, out of a workforce of roughly 800,000 people. Today, an estimated 14,000 people work for coal mining companies in the province. Employment in the coal sector may double in the next five to ten years as new leases evolve from the exploration phase to construction and production. Average national hourly wages for direct or semi-skilled labor in all types of mining were estimated at Rp 6,239 at the end of 1991, substantially higher than the regional minimum wage (Biro Pusat Statistik 1993). Wages for coal mining are probably above the mining average because coal mining is more capital- and technology-intensive, and thus requires better skilled equipment handlers, than mining for many basic industrial minerals. Over time, more managerial and high-skilled jobs will become available to Indonesians. Foreign investors are required to use Indonesian labor to the greatest extent possible, according to a schedule based

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Figure 2
Coal Consumption in Indonesia

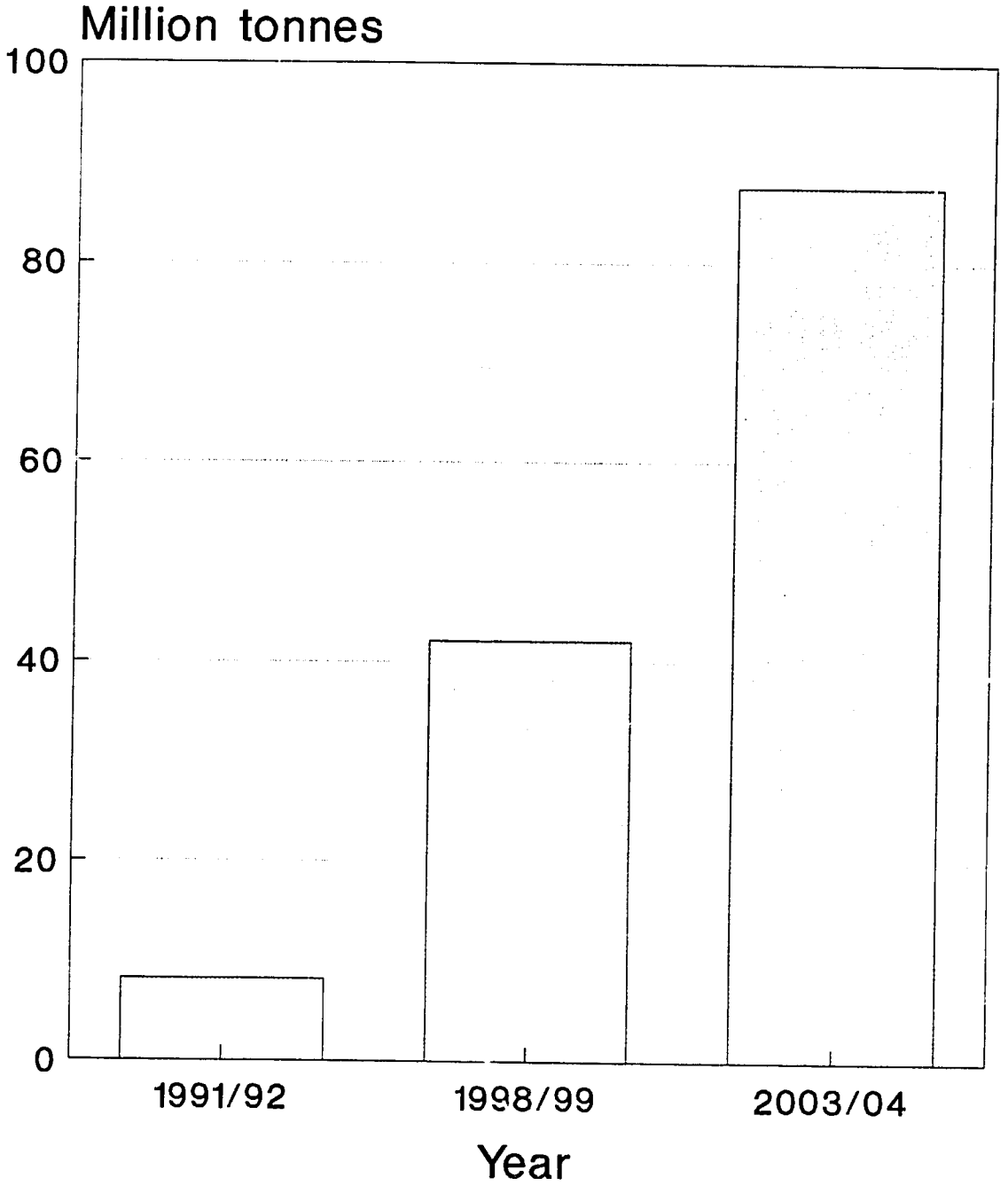

Table 1

Domestic Uses of Coal in Indonesia

Sector	Repelita V[a]	Repelita VI[b]	Increase
	Million barrels of oil equivalent		
Power generation	27.3	68.1	149%
Industry	17.7	33.6	90%
Household briquette	3.8	18.1	376%

a. Five-year developrnent plan for 1989/90 to 1993/94. Figures indicate estimated actual consumption (five-year totals, not annual amounts).

b. Five-year development plan for 1994/95 to 1998/99. Figures indicate projected consumption (five-year totals, not annual amounts).

Source: Departemen Pertambangan dan Energi; Repelita VI.

on job description. If there is a shortage of skilled labor and engineers, mining companies are expected to train local staff to assume those jobs in the long run.

In a tight labor market, the benefit of new coal mining jobs could come at the expense of other industries. But although Kalimantan Timur has a small population relative to most provinces in Indonesia, coal mining has not drawn significant amounts of labor away from other activities. Most of the mines are located in the southeast part of the province, an area with the highest population density and several transmigration sites. The exception is Kaltim Prima Coal, which is mining in a very low population area and has imported labor from outside the province. In general labor is very mobile in Indonesia, with some 42 percent of all workers in Kalimantan Timur coming from other provinces.

GOVERNMENT REVENUE — Provinces (including secondary levels of government) receive the lion's share of the small pool of royalties, and most of the land and building tax. In 1993, the total value of royalty payments to them was about $12 million. Money earmarked for the Dati II is distributed by the provincial government. It is not known whether the money is distributed evenly or in proportion to revenue collection. Provinces may also levy their own fees and taxes to cover services such as vehicle registration and transfer of title, subject to the approval of the central government.

Contractors also make lump-sum payments of $100,000 to PTBA to cover their provincial tax liabilities. Provincial officials complain that this sometimes does not cover the full liability, but since the amount is written into the contract, PTBA is unable to make major adjustments until the contract is renegotiated every five years. The sum can, however, be adjusted every two years for inflation. A lump sum tax payment system would make sense if all mining operations in the province were of the same size, used the same equipment, and required the same services. But in light of the actual variation between companies, the chief advantage of the arrangement is administrative simplicity. In this respect the lump sum system is consistent with recent central government efforts to reduce bureaucratic layers for investors.

Although the exact contribution of coal to provincial tax revenues is not known, the contribution can be expected to rise as the industry expands. Own-source revenues and land and building taxes collected by Samarinda municipality increased at an average annual rate of 6.2 percent from FY89 to FY92, a period when local investments in other large sectors, such as sawmilling and plywood, were beginning to slow down.

REGIONAL DEVELOPMENT — The Secretary-General of Mines remarked in 1977 that the opening of new centers of development outside Java is foremost among the contributions expected from foreign companies engaged in mineral development (Otto 1993). It is perhaps too soon to judge whether coal mining has made such a contribution in Kalimantan Timur, whose economy is dominated by oil, gas, and forest product industries. According to data compiled by the Regional Investment Coordinating Board, mining (excluding oil and gas) will contribute only 2 percent to the formation of gross regional domestic product (GRDP) in 1994,

rising to 2 ? percent by the end of Repelita VI in 1998.

To the extent that coal mining directly or indirectly creates new jobs, raises wages, and increases local spending, the industry provides a stimulus to local growth. Local construction and engineering firms, as well as machinery and vehicle repair, receive a boost from mining activities. Several more specialized companies are now established in the province for surveying, assaying, and water-quality testing. The bulk of mine company investments, however, are for goods and services from outside the province and, for heavy equipment in particular, from overseas.

A study of the socioeconomic impact of coal mining in the U.S. found that increased local revenues were partially offset by increased expenditures for services and infrastructure to meet the needs of the mining industry and an expanding population (U.S. Department of Interior, Bureau of Mines, 1985). In Kalimantan Timur, this burden is shared with mine operators, who generally pay for and complete road improvements in their lease area, provide their own power and water, and provide some services to the communities that supply their labor.

5 Environmental impacts of coal mining

There is a great deal of uncertainty about the environmental impacts of coal mining in Indonesia, due to: (i) the relatively recent expansion of coal mining to a significant scale; (ii) the recent implementation of the AMDAL process; (iii) the lack of standardization of the environmental monitoring process; (iv) the lack of a computerized database for environmental information within the Ministry of Mines and Energy; and (v) the lack of long-term experience anywhere in the world with large-scale coal mining under humid tropical conditions. The comments below are therefore necessarily sketchy.

5.1 General considerations

Coal mining has impacts on land, air, and water quality. Through these environmental externalities, it can cause economic losses in other sectors.

IMPACTS ON LAND USE — Most coal mining in Indonesia is by open-pit or strip-mining techniques, because the country's coal seams are typically at or near the surface. Underground techniques are either technically impossible or much more expensive. In the process of removing overburden to expose the coal seams, human activities such as agriculture are displaced, and the natural environment is severely disrupted by the loss of forest cover and the removal of soil and overburden. The area affected is greater than just the area mined, as the overburden is often dumped into nearby valleys and depressions.

In theory, mining is a temporary land use. Once mining is finished, the land's capability to support other economic activities can be restored through reclamation efforts. But reclaiming mine sites is a difficult, expensive, and uncertain process. Success depends on the care taken in retaining top soil and contouring the site. Experience in the U.S. and Australia indicates that even if the best practices are followed, reclaimed sites may not be as productive for agriculture or timber production as the original land. Uncertainty about the ultimate success of reclamation efforts is particularly great in the humid tropics, where there is virtually no long-term experience with reclamation of surface coal mines.

One thing that is certain in Indonesia is that sites that were originally covered by natural forest will harbor a drastically reduced number of species following reclamation. Indonesia's rainforests are among the most biologically diverse ecosystems in the world. The precise number of species in them is unknown; new species are discovered continually. The reduced biological diversity might make reclaimed sites less valuable as sources of nontimber forest products and recreation, and certainly less valuable as repositories for genetic resources.

The impacts of mining on land use extend beyond the mine site. Large mining projects attract job-seekers from the outside and industries to support them. Mine operators inadvertently open up new lands to farmers and informal loggers by constructing roads through and around the lease area. Pressure on land outside the mining lease increases, and some amount of forest

clearing inevitably ensues.

IMPACTS ON AIR AND WATER QUALITY — Blasting, excavation, and transport of overburden and coal generate substantial amounts of dust, which can damage vehicles, vegetation, and human health. It is in the mining company's interest to control dust problems that affect vehicle maintenance and workers' health, to the extent that the company recognizes these problems and incurs the costs they generate (which they may not in the case of workers' health, if they do not provide health insurance). Some mining companies regularly water roads in their lease areas to reduce damage to vehicles. Only the desire to be viewed as a "good neighbor," however, can be expected to motivate a company to mitigate off-site impacts of dust.

In the absence of adequate buffer strips along streams and adequate erosion-control measures (contours, settling ponds, and sediment dams), mining can cause heavy siltation of rivers. This is particularly a problem in the humid tropics, where rainfall is high and storms powerful. Siltation kills fish, eliminating a locally important protein source, and makes water unfit for drinking, washing, and other household purposes. Runoff from mine sites can also affect pH, sulfate, and nitrate levels in streams.

5.2 Impacts in Kalimantan Timur

Most mining in Kalimantan Timur is open pit, which is unavoidably more disruptive to the landscape than many other industries in the province, including oil and gas. Mine sites that are not properly restored suffer from erosion and loss of top soil, loss of vegetation, degraded water that pollutes natural water courses, and disrupted water flows, which can turn some streams into dry beds and flood others. Underground mining, which is found in only one lease in Kalimantan Timur, but which is expected to expand in the future, can lead to surface subsidence, loss of surface and underground water, and discharge of acid mine drainage. Experience in the U.S. indicates that the impact of underground mining on water quality can be as severe as that from open pit mining (McElfish and Beier 1990).

Water quality and water flow problems are quite different in Kalimantan Timur than in large mining sites in Australia and the U.S. because of the annual cycle of wet and dry seasons in the province. Although coal in the province is low in sulfates, chemical concentrations can build up in stagnant pools and streams during the dry season, which lasts five months of the year. Operators may be able to neglect contouring and draining mine pits and stockpiling overburden and topsoil properly with little fear of erosion during the dry season. But in the wet season, with an average annual rainfall approaching two meters, poorly designed stockpiles and incorrectly contoured slopes lead to sudden and dramatic erosion and heavy sediment buildup in streams and rivers near the mines.

Teluk Dalam, a village located within a coal lease along the Mahakam River, provides an interesting example of the local environmental impacts of the industry. On the positive side, about 2,500 people, or half of the village's total population, earn their living by working at the

mine. In the past ten years the village's population has nearly doubled, due to both newcomers and births. From the perspective of the transmigrant program, the village is a success; often such villages experience a rapid decline in population as transmigrants search for better economic opportunities. The company also repairs roads around the village, provides some housing, and has drilled several wells for drinking water.

On the negative side, the village is subject to a great deal of dust from the mine site during the dry season, and rice paddy fields have been contaminated with turbid water during the wet season. The village also suffers from severe water shortages, which may be due in part to 75 kilometers of underground tunnels near, and possibly under, the village. The swelling population also presents problems because there is not enough land for newcomers. In the first part of 1994 the company had to stop more than 100 families from building houses within the lease area, beyond the boundaries of the village. The proximity of the burgeoning community to the mine site threatens rehabilitation efforts because fragile lands come under use before they have recovered from mining.

Since existing coal mines in Kalimantan Timur are located primarily near the coast, where land is generally of low productivity for agriculture and forestry and extensive land conversion has already occurred, impacts on productive forests and prime agricultural land have been minimal. But as mining moves inland, it will threaten valuable forests, watersheds, and habitats for a large variety of flora and fauna.

6 Competing land uses and the decision whether to mine

Mining is just one of a range of possible uses of land. Even in relatively lightly populated parts of Indonesia like Kalimantan Timur, it usually disrupts existing human activities. Whenever a new coal deposit is discovered, Indonesia must decide whether it should be mined.

6.1 GIS analysis of potential land-use conflicts

All land in Kalimantan Timur is under the jurisdiction of some agency or ministry, and many of the jurisdictions overlap. For example, Pertamina, the state-owned oil company, has exploration rights over 75 percent of the province, yet some 73 percent of the province is covered with forest (according to Ministry of Forestry estimates). There are 102 logging concessions in the province, including 48 in Kutai regency, where much of the measured and indicated coal reserves lie. Add to this transmigration sites, plantations, and gold mining leases, and it becomes clear that coal mining will come in conflict with many other land uses, especially in the future.

To evaluate potential land-use conflicts between coal mining and forestry, we conducted a simple GIS (geographic information system) analysis to determine the overlap between coal deposits and forest areas.[2] Two maps showing estimated surface areas of coal deposits in Kalimantan Timur were available, and both were at a very small scale: a 1991, 1:2,000,000 map from *Geologi Batubara Indonesia* (*Geology of Coal in Indonesia)*, an M.Sc. thesis by Theo Matasak; and a 1993, 1:5,000,000 map, titled "Peta Potensi Bahan Galian Batubara, Propinsi Kalimantan Timur" ("Map of Potential Coal Resources in Kalimantan Timur"), which was prepared by the regional Mines and Energy office and was obtained from a publication of Badan Koordinasi Penaaman Modal Daerah (BKPMD, the Regional Investment Coordination Board). The former is similar to the published "Coal & Peat Resources Map of Indonesia" mentioned earlier, but it is somewhat updated and at a larger scale. Both maps include both identified and unidentified resources. Neither should be viewed as complete, however, as geological surveys have yet to be conducted in much of the province, particularly the interior. Both therefore probably underestimate the area of actual coal deposits. The maps provide no information on the commercial viability of the deposits. Map 1 shows the BKPMD map.

The map of forest areas was obtained, in partially digitized form, from the Regional Physical Planning Program for Transmigration (RePPProT). It was prepared by the Directorate of Forest Conservation and Nature Protection in the Ministry of Forestry. The map shows the Ministry of Forestry's classification of areas it administers, according to designations and boundaries established by the Ministry's Directorate of Inventorisasi Tata Guna (INTAG, the Land Use Inventory Directorate). It does not indicate ecological types or actual forest cover.

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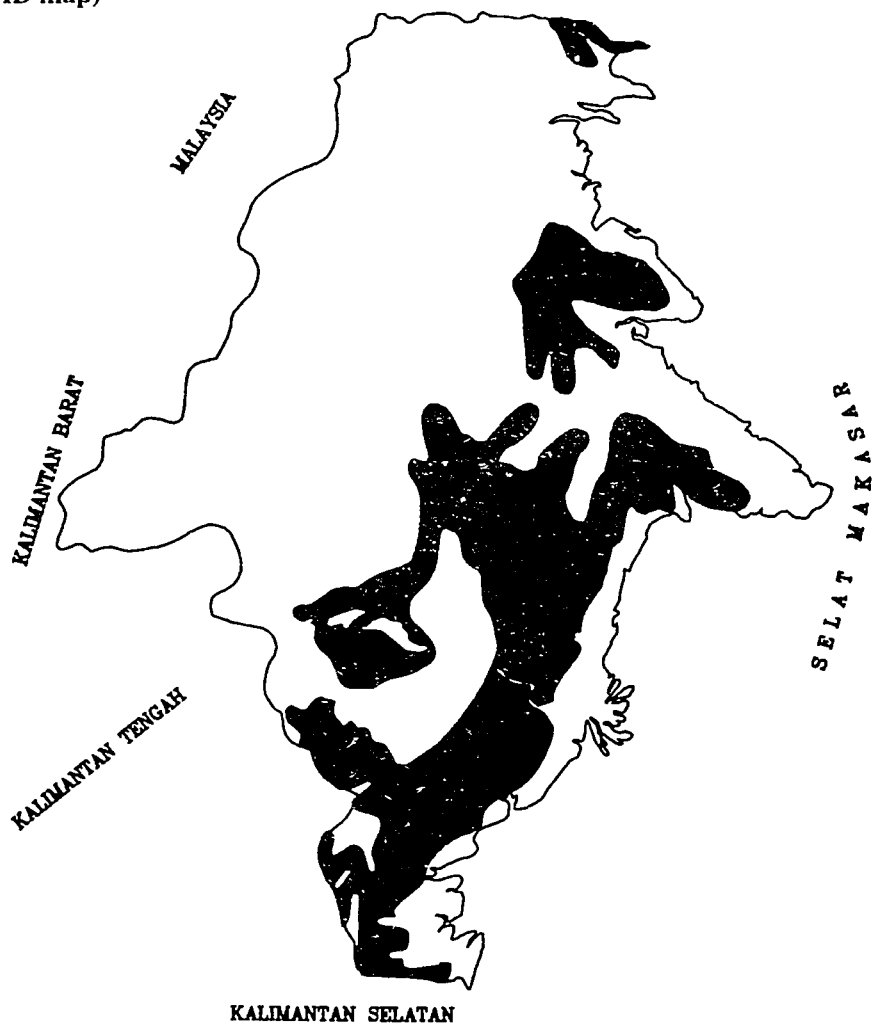
[2] A Jakarta-based company, PADCO, conducted the GIS analysis using the PC-based ARC/INFO package. Much of the initial digitizing was done by BPN and the BPN/GTZ Land Use Planning and Mapping Project (LUPAM). The authors express their appreciation to these organizations for the work done.

Map 1. Coal Resources in Kalimantan Timur
(based on BKPMD map)



PROPINSI
KALIMANTAN TIMUR

PETA
PENYEBARAN TAMBANG
BATU BARA
SEKALA 1 : 5.000.000

KETERANGAN :

TAMBANG BATU BARA.

SUMBER :
Peta Potensi Bahan Galian di Prop. Kaltim Badan Koordinasi Penanaman Modal Daerah Kalimanatan Timur Tahun 1993

Prepared for :
Harvard Institut for International Development

INTAG classifies forests into five categories. From most to least protected, they are:

Nature protection forest (*Hutan suaka alam*): forest reserved for wildlife habitat, biodiversity protection, and recreation

Watershed protection forest (*Hutan lindung*): forest on steep slopes with high risk of erosion

Limited production forest (*Hutan produksi terbatas*): forest where limited logging is allowed, insofar as it is compatible with watershed protection

Production forest (*Hutan produksi*): forest where logging is dominant use

Convertible production forest (*Hutan produksi yg. dapat konversi*): forest intended for conversion to nonforest uses, after commercial timber has been removed.

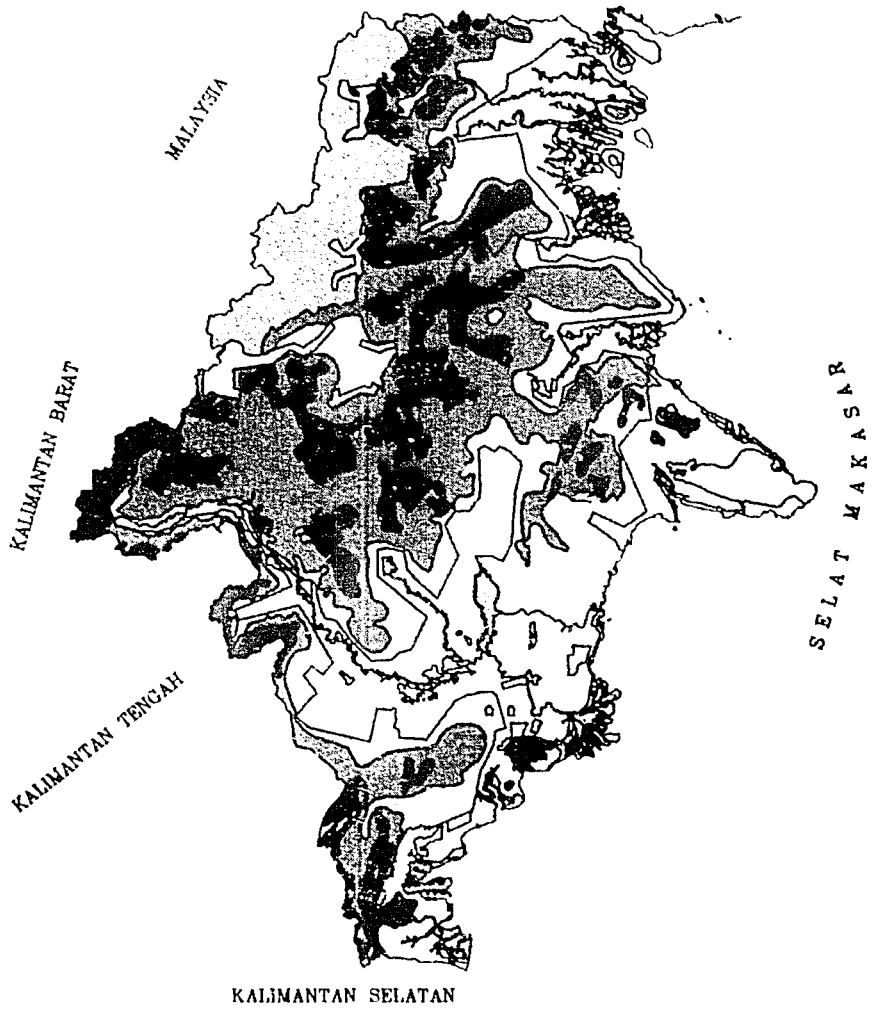
Individual map sheets were based on 1993 data and had a scale of 1:250,000, significantly larger (and therefore more precise) than that of the coal maps. Map 2 shows forest areas by type.

The total surface area of coal deposits is 29 percent of the province according to the BKPMD coal map and 47 percent according to the map from Matasak's thesis. The reason for the discrepancy is not clear; the most straightforward explanation is that all estimates of coal resources are based more on inference than on field surveys and are therefore prone to differ substantially. To be on the conservative side, we used the BKPMD map, which is moreover somewhat more "official," for the overlay analysis. Results are summarized in Tables 2 and 3.

Table 2 shows the area of coal deposits by forest category. Limited production forests, production forests, and convertible production forests each contain one-fourth to one-third of estimated coal deposits; remaining categorie includes much smaller amounts. The potential for conflicts is greatest for limited production forests and production forests, which are intended to be part of the province's permanent forest estate. Many of these forests are in as pristine condition as nature protection forests and watershed protection forests. If surface coal mining occurs in production and limited production forests, environmental impacts are likely to be greater in limited production forests, as they fall between watershed protection forests and production forests in terms of their importance for watershed protection. If we broadly define protected forests as encompassing nature protection forests, watershed protection forests, and limited production forests, protected forests contain just over a third of coal deposits.

Table 3 shows the area of coal deposits relative to the total area of the forest categories where they are found. To begin, note that permanent forest categories (nature protection forests, watershed protection forests, limited production forests, and production forests) cover three-fourths of the province. Coal deposits occur in just over a quarter (27 percent) of this area. Limited production forests, production forests, and convertible production forests all have coal

Map 2. Forest areas in Kalimantan Timur



PROPINSI
KALIMANTAN TIMUR

PETA
TATA GUNA HUTAN
KESEPAKATAN
SEKALA 1 : 5.000.000

KETERANGAN :

- HL
- HPT
- HP
- HSA-W
- HPK
- APL

HL : HUTAN LINDUNG
HPT : HUTAN PRODUKSI TERBATAS
HP : HUTAN PRODUKSI
HSA-W : HUTAN SUAKA ALAM
HPK : HUTAN PRODUKSI DAPAT DIKONVERSI
APL : AREAL PENGGUNAAN LAIN

SUMBER :
Peta RePPProT Sekala 1 : 250.000 & NFI

Prepared for :
Harvard Institut for International Development

Table 2

Location of Coal Resources in Kalimantan Timur

Administrative classification	Area of coal resources (km^2)	Share of coal area (%)
Nature protection forest (*Hutan suaka alam*)	284	0.5
Watershed protection forest (*Hutan lindung*)	4,337	7.6
Limited production forest (*Hutan produksi terbatas*)	15,224	26.8
Production forest (*Hutan produksi*)	19,067	33.6
Convertible production forest (*Hutan produksi yg. dapat konversi*)	16,913	29.8
Other land use (*Areal penggunaan lain*)	587	1.1
Unclassified (discrepancy)	321	0.6
Total	56,733	100.0

Source: RePPProT (1987)
Peta Potensi Bahan Galian Batubara, Propinsi Kalimantan Timur

Table 3

Rela.ive Area of Coal Resources in Kalimantan Timur

Administrative classification	Area of land use (km^2)	Portion with coal (%)
Nature protection forest (*Hutan suaka alam*)	15,763	2
Watershed protection forest (*Hutan lindung*)	30,191	14
Limited production forest (*Hutan produksi terbatas*)	56,190	27
Production forest (*Hutan produksi*)	43,532	44
Convertible production forest (*Hutan produksi yg. dapat konversi*)	47,239	36
Other land use (*Areal penggunaan lain*)	1,693	35
Unclassified (discrepancy)	321	100
Total	194,929	29

Source: RePPProT (1987)
Peta Potensi Bahan Galian Batubara, Propinsi Kalimantan Timur

under more than a quarter of their area. The percentages for nature protection forests and watershed protection forests are low, just 2 percent and 14 percent, respectively. These reassuringly low amounts may be deceptive, however: these forest categories are found primarily in the interior, where only limited exploration for coal has been carried out.

6.2 Land-use planning

Some administrative structure exists for resolving land-use conflicts in Indonesia. Although a long-standing Presidential Decree gives mining priority over all other land uses, in reality some compromises are made between competing land uses. For example, two joint decisions between the Ministries of Forestry and Mines and Energy in 1989 and 1991 set guidelines for mining in forest areas. The decisions forbid mining in parks, but they apparently allow it in protective forests subject to review by the Ministry of Environment and the Board of Science and Knowledge (Harahap 1992). The government also prohibits mining in cemeteries and near public roads or population areas.

U.S. federal and state laws include similar but broader provisions for designating land as unsuitable for coal mining. Included are lands that cannot be restored to a level of usefulness comparable to their undisturbed state, lands that are critical watersheds, and areas where it would be impossible to prevent negative impacts on water quality and flow outside the mine area (Leathers 1977, McElfish and Beier 1990). This is a fairly sweeping definition of unsuitability, and it would disqualify many, if not all, existing mine sites in Kalimantan Timur. Few states in the U.S. have actually applied this definition.

The main body officially entrusted with land-use planning is *Badan Pertanahan Nasional* (BPN). Its regional office (*kanwil*) in Kalimantan Timur has directorates for land ownership, land use, and land measurement. BPN is responsible for collecting information on current land use, assessing potential for future uses, determining compensation for land appropriation and dispute settlement, and mapping. BPN is also supposed to work with several land-use planning bodies in the province, including the Inter-Departmental Committee on Location Permits and the Provincial Spatial Planning Team. These two groups include representatives from the Regional Planning Office (*Bappeda*), the governor's office, and various ministries.

Discussions in Kalimantan Timur reveal a less structured situation in practice. The land-use planning process could be improved. Each agency has different maps, many of which are outdated, and land-use information is guarded more often than shared. The problem was illustrated by officials from the provincial investment coordinating board, who lose many potential investors because of the bureaucracy involved in granting land-use rights, and the uncertainty of those rights. Despite restrictions on the location of mining, at least one mine lease in Kalimantan Timur overlaps completely with a transmigration site. Many roads have had to be rerouted to make way for mining pits.

6.3 Economic principles for land-use decisions

From an economic perspective, displacement of existing land uses is not a problem as long as two conditions hold:

(i) the net present value of all current and future benefits from the land if it is mined is greater than the net present from all alternative uses; and

(ii) all current owners or users of the land who are displaced by mining are fully compensated for the forgone current and future benefits they lose.

The compensation required by condition (ii) is possible as long as condition (i) holds. If condition (i) does not hold, then mining makes the country worse off and should not be allowed.

The calculation indicated in (i) should include nonmarket as well as market values, and it should cover the post-mining period as well as the life of the mine. If this is not the case, in general the calculation will be unfairly biased in favor of mining. Many of the economic costs of mining are nonmarket ones related to air and water pollution, habitat destruction, and other environmental impacts. Despite reclamation programs, some of these impacts will be irreversible, and any permanent losses of productive capacity must be factored into the land-use decision.

Faced with a similar challenge, the Ministry of Forestry has developed a simple system for designating land that should not be logged due to the likelihood of severe erosion. The erosion hazard rating is based on the slope of the terrain, erodibility of the soil, and rainfall intensity. Although this system does not calculate the economic costs of logging on land with a high hazard rating, it implicitly recognizes that these costs exceed the benefits of timber production.

The AMDAL and permitting processes as applied to coal mining require simply a description of current land use, not an explicit calculation of land values in proposed lease areas. Unofficially, the government seems to link mitigation of social and environmental impacts more to a mining company's ability to pay than to the magnitude of potential social and environmental costs. One paper proposes that social and environmental obligations should be scaled to a project's size and "cost structure" and to the investors' financial condition (Simatupang 1992). This implies that companies that develop less profitable (in a private sense) coal deposits should bear a smaller social and environmental burden. Following this approach would inevitably result in a certain amount of mining that fails to provide economic benefits larger than the economic costs it generates.

6.4 Compensation in practice

Mining companies are legally required to pay compensation to government agencies that administer or individuals who hold rights to land that will be mined. Once a mining company has paid compensation, land rent, and land and building taxes, it is not obligated to make any

other payments for use of the land. The government publishes detailed compensation schedules according to current land use. For example, the Ministry of Forestry publishes a compensation schedule that determines the payment according to the number and species of trees to be removed. If the payments in such schedules are calculated accurately (based on the present value of forgone net economic benefits) and enforced, then companies face the social costs of mining, and their choice of lease areas will reflect social as well as private interests.

In practice, compensation levels are usually set through negotiation. Sometimes compensation is settled informally, particularly on degraded land with no current use. Despite these arrangements, competing land uses remain an issue in the Mahakam basin. Mines along the Mahakam have acquired just enough land to establish coal washing and loading facilities, but not enough to establish necessary environmental safeguards. More land is available, but companies to date are unwilling to pay the level of compensation demanded by landowners. Even if negotiations bid the level of compensation up to the land's market value, the payment may not fully represent the value to society if land markets are inefficient or nonmarket values are important. But as a starting point, market value provides the best available guide to compensation.

At least one coal mine in Kalimantan Timur has pursued innovative means of compensating for habitat destruction due to its mining operations. Kaltim Prima Coal helps fund Kutai National Park, which is on the opposite side of the Sangatta River from its lease area. The park, which includes 200,000 ha of relatively intact lowland rainforest, is the only protected area in Kalimantan Timur that includes part of the province's coastline. It is the largest gazetted reserve within the home range of the orangutan, and it provides habitat for 12 endangered species of mammals and 17 endangered species of birds. By actively contributing to efforts to protect the park, the company also reduces encroachment by the many new people the mine has attracted to the area.

6.5 Recommendations

- **Require that the ANDAL include at least rough net present value calculations comparing mining to principal alternative land uses** — The government should consider taking steps toward institutionalizing social benefit-cost analysis in the evaluation of proposed mining projects. Initially, net present value calculations could include just values related to market impacts. That is, they would be standard financial and economic appraisals of the sort routinely prepared for development projects. These appraisals would, as a byproduct, generate information on resource rents that would be useful in determining royalties and production shares. As in-country capacity in environmental economics is built up, the appraisals could be extended to include nonmarket impacts. Even before this happens, the appraisals should include a full description of nonmarket impacts, including as much quantitative information as is available (e.g., on projected changes in water quality, potential population affected, impacts on habitat for particular species, etc.).

- **Provide training opportunities (workshops, short courses, etc.) in project appraisal and environmental economics** — Greater use of social benefit-cost analysis in the AMDAL process will require upgrading of skills in project appraisal and environmental economics (in particular, nonmarket valuation) for government officials involved in the AMDAL prccess and local environmental consultants and consulting firms that prepare ANDALs.

- **In determining compensation levels, move toward greater use of information generated by economic analyses in the ANDAL** — The present value of forgone net benefits from alternative uses provides the conceptually correct basis for determining compensation. Linking actual compensation levels to ANDAL estimates of net present values for alternative land uses would encourage demand for more rigorous and defensible ANDALs.

7 Environmental impact assessment

To a degree, negative environmental impacts of mining are unavoidable: no amount of mitigation can completely prevent on-site and off-site degradation when a large area is dug up and rebuilt from scratch. Environmental impact assessment provides information necessary for anticipating these impacts and addressing the most serious ones through cost-effective preventive and remedial measures. The proverb, that an ounce of prevention is worth a pound of cure, is perhaps nowhere more relevant than in the management of environmental impacts of mining.

The last section suggested additional, economics-related information that AMDALs should contain. This section focuses not on the content of the AMDAL, but rather on the process. Specific issues related to water pollution and reclamation are covered in detail in subsequent sections.

7.1 Shortcomings in practice

Interviews with mining companies indicate that company managers are quite removed from the impact assessment process and often find the recommendations inappropriate or infeasible. At one extreme, the plans can be too detailed. Mine inspectors, lacking expertise in some aspects of mitigation and reclamation, often must rely on a strict reading of the RKL and RPL to evaluate the company's performance. But the company may have found some parts of the RKL and RPL unworkable, particularly as conditions at the mine site evolve. At the other extreme, some recommendations and plans are too vague, simply stating that negative impacts will be controlled or minimized. A review of several RKLs confirmed this "boilerplate" tendency, particularly in their recommendations and plans for mitigation.

Although the AMDAL review commissions reject some ANDALs and RKLs for insufficient information or inadequate abatement plans, it seems that approval hinges more on meeting content requirements than on substance. While ANDALs contain much useful data, the information is not consistent from company to company, and it is often insufficient for designing detailed RKLs and RPLs. Companies typically need to put in considerable additional effort to design implementable RKLs and RPLs. A proper evaluation of these plans would require on-site inspections of the proposed mining area after an initial review of the reports, but the Ministry of Mines and Energy currently does not have the manpower, in terms of expertise and numbers, to do so.

Recent changes in AMDAL requirements may exacerbate these problems. For example, mining companies now are required to submit their environmental monitoring and management plans at the same time as the ANDAL, i.e. during the feasibility stage, although it is impossible to specify exactly how to monitor and manage environmental impacts at that stage. One internal review of these changes recommended that the government allow amendments and changes to the RKL and RPL as the mine enters the design and construction phase, to incorporate new information from the site.

Officials in the Ministry of Mines and Energy are well aware of the problem, and they have initiated programs to clarify assessment procedures for companies and to improve the human and technical resources in the Bureau of Environment and Technology. The Bureau is understaffed and underfunded. It has had to look to multilateral lending agencies to support expansion and improvement. It expects to get funding as part of a larger World Bank loan to the state-owned power company.

7.2 Recommendations

- **Include mining companies in the AMDAL review process** — Company managers and spokesmen are often poorly informed about the environmental impacts of coal mining, and consultants who prepare AMDALs often have limited knowledge of difficulties that arise in implementing proposed RKLs and RPLs. Greater involvement by representatives of mining companies would help overcome these two problems.

- **Make provisions for environmental management and monitoring plans to be adjusted and refined as conditions at the mine site evolve** — If companies find part of their RKL or RPL unworkable, they should report problems to the AMDAL Commission with suggestions for changes or improvements. As long as the AMDAL process lacks the direct and ongoing participation of mine operators and contractors, and is subject to little reconsideration after mining commences, it will remain largely a paper exercise.

- **Require mining companies to submit annual action or working plans identifying specific environmental problem areas and proposing strategies for addressing them** — Through these plans, companies would formally commit to improving "hotspots" identified by mining inspectors. Currently, companies can delay action for months, and sometimes for several years, without fear of closure.

- **Introduce a one-year probation period from the start of mine construction, during which the Ministry of Mines and Energy would monitor implementation of the RKL and RPL** — This would encourage companies to be aware of their environmental responsibilities from the outset.

- **Increase budgetary resources allocated to the Bureau of Environment and Technology** — The importance of the Bureau's work justifies direct and increased funding from the government. One possible source of funds is from in-kind payments made to PTBA by contractors. According to Presidential Decree No. 21, part of the proceeds from the sale of this coal is to be used to supervise the living environment in mining areas and to ensure that contractors meet their environmental obligations. Investments made to clarify those obligations and improve the government's ability to monitor companies seem well within PTBA's writ.

8 Water pollution

Controlling the quality of water discharged to natural streams and rivers has proven to be the biggest environmental challenge to mine operators. The main pollutants are suspended and dissolved solids. Acid mine drainage appears to be less of a problem, because coal and overburden in mine sites in Kalimantan Timur are generally low in sulfates.

8.1 Water-quality standards and sources of pollution

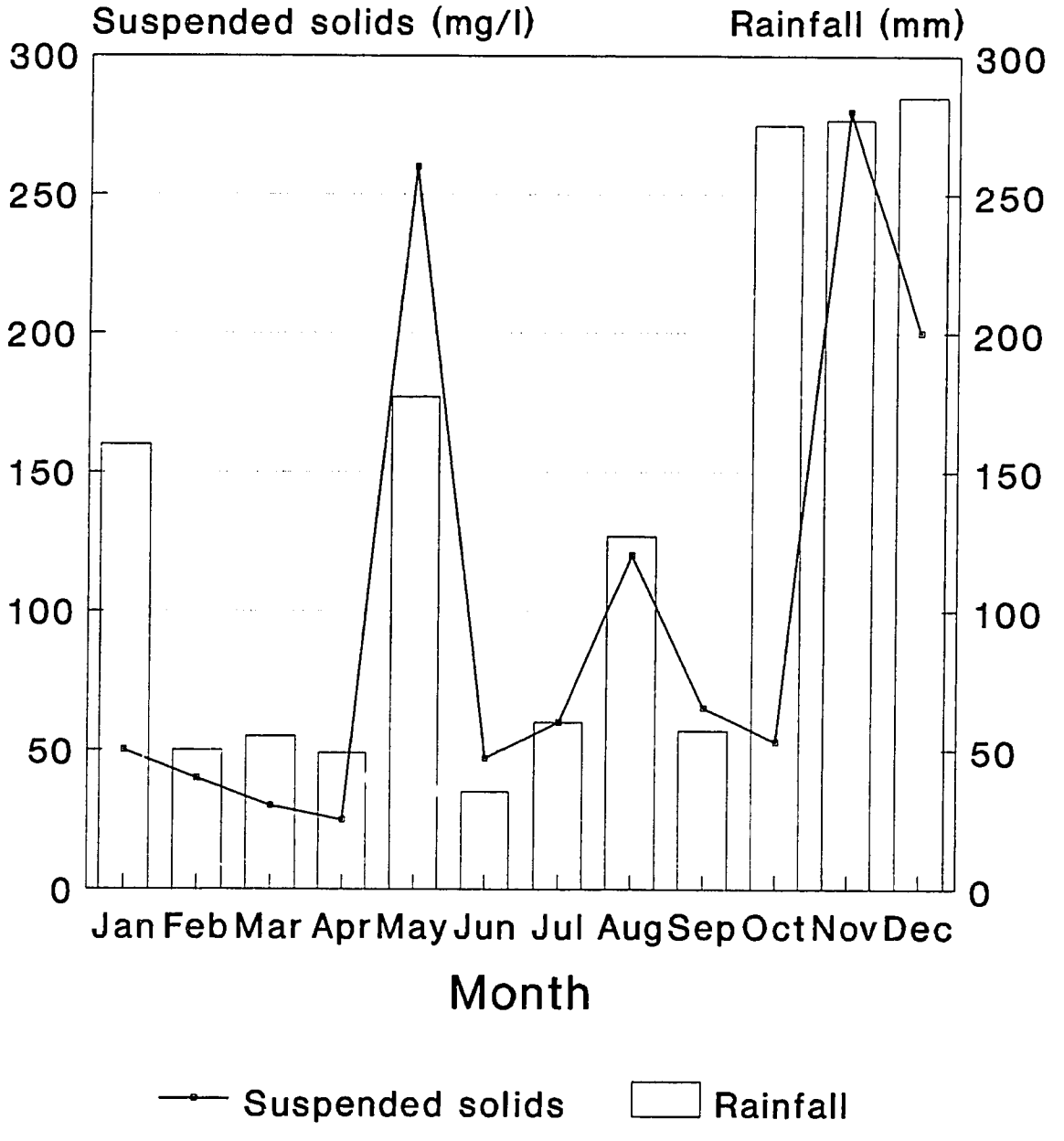
Water-quality standards in Indonesia are established by the Ministry of Environment. The Ministry classifies rivers into three categories. "A" class rivers are the cleanest, capable of providing water for household use without further treatment. "B" class rivers require treatment for drinking, but not for washing, bathing, or industrial use. The Mahakam is a "B" class river. "C" class rivers are the most polluted.

The acceptable pollution concentrations for "B" class rivers are much less stringent than comparable ambient standards in the U.S. For example, the daily maximum concentration of suspended solids in "B" class rivers is 400 mg/l. In contrast, the daily maximum in the U.S. is 70 mg/l, and the 30-day average is even lower, 35 mg/l.

Implicit in the Indonesian system is the notion that rivers should at least be maintained at the quality found when classified. It is difficult to assess the actual level of compliance in Kalimantan Timur, because mining companies measure and report water quality with little consistency in terms of pollutants measured and location of measuring sites. A review of water-quality reports filed with the regional Mines and Energy office revealed an almost random variation among companies in terms of measurements made and locations of sampling points. Figure 3 shows 1993 data on suspended solids for one mine site in Kalimantan Timur. Predictably, the level of suspended solids was correlated with rainfall. Although it was within the "B" class standard in all months, in nearly all it exceeded the U.S. standard several times over.

Turbidity problems due to erosion are less severe in smaller mines and in mines with deeper pits, where there is less drainage from areas of exposed soil. But larger mines that cut across and alter waterways require systems of sediment dams and settling ponds to reduce turbidity before water enters streams outside the mine. In the rainy season these systems must be repaired and dredged constantly to remain effective. One mine was discharging enough sediment-filled water to alter the color of a medium-sized river, despite an extensive network of sediment dams. Drainage problems literally evaporate during the dry season, at least in the mining areas, but this can be deceptive. Although it was impossible to detect sediment discharge from mine areas visited during the dry season, it was clear at some of the smaller mines that little attention had been given to planning or constructing proper drainage for exposed areas in preparation for heavy rains.

Figure 3
Suspended Solids and Rainfall at One Mine Site



A more constant water-quality problem is discharge from coal-processing lines. With the exception of Kaltim Prima Coal, which has its own deep-water loading facility, mines in Kalimantan Timur are located very close to major rivers like the Mahakam. This is not an accident: with a lack of infrastructure, investors have concentrated on deposits that will be less costly to transport. By this same logic it makes sense to process coal — including crushing, washing, sorting by size, and mixing by quality — as close to the riverbank as possible to reduce the expense of pumping water and conveying the final product to river barges. The millions of gallons of water used and discharged each day by washing and sorting operations contain heavy concentrations of clay sediment, fine coal, and other suspended and dissolved particles. Water samples taken at one washing plant contained more than 30 g/l (*not* mg/l) of dissolved solids and 9 g/l of suspended solids. The company is supposed to reduce suspended solids to 0.4 g/l or less, and dissolved solids to 4 g/l or less, before it discharges this water into a stream or river.

No effort has been made to estimate the cumulative or combined impacts of coal mining on water quality in the Mahakam River. Such an undertaking would require accurate pre-mining baseline data, and careful analysis to identify pollutants that come from mines and not from other industries along the river. For some types of pollutants, such as oil and non-coal sediment, it may be impossible to identify the source of the pollutants. There are at least ten sawmills and a large plywood mill along the same stretch of river as the coal mines, and there are agricultural and logging activities upriver. Mills contribute oil, chemicals, and solids to the water, and both agriculture and logging result in sedimentation.

8.2 Abatement measures

Reducing the concentration of suspended and dissolved particles in the waste water from coal washing plants requires a series of settling ponds before the discharge point. To work effectively, settling ponds must be large and easy to dredge, and they should not be located directly adjacent to the river. Unfortunately, settling ponds are inadequate to handle the volume of water at almost every mine in Kalimantan Timur. Hence, their discharge regularly exceeds pollution standards. In many cases, the companies have not acquired enough land to build a proper washing plant, because land along the banks of rivers is generally more densely populated and comes at a premium. Companies must dredge fine coal and sediment from the ponds constantly and truck this material to dumping sites, where it is eroded by rainfall. This problem is exacerbated in the rainy season, when ponds overflow directly into the river.

AMDALs reviewed for this study contained only sketchy details on plans to control discharge from coal washing operations. Yet, the problem is by no means an insurmountable one, even for land-short companies. Some companies have achieved a much better record of compliance through better planning and design of their washing plants and through simple, inexpensive innovations. One company, recognizing that fine coal particles are usually high quality coal, uses two bucket elevators to continuously dredge this material from discharge water and then mixes it with its lumpy and medium product. The two elevators cost only $17,000, and they recover 11.2 tons of fine coal per day. Assuming an average local coal price of

$25/ton, this system paid for itself in only 61 days. The actual pay-back period is probably shorter, because less effort is needed to settle remaining solids.

Another company is examining the possibility of pumping waste water into mined-out areas some 6 kilometers from the washing plant. Currently, it has created an enormous dump of fine coal and sediment adjacent to the Mahakam River. This dump is constantly eroding back into its drainage system. Another solution is to use a series of cyclone tanks to separate commercial-sized particles down to 1 mm in diameter. This strategy has been used with some success by one of the companies visited for this study.

A method of removing fine coal from discharge water that has yet to be tried by any company in Kalimantan Timur is a belt press filter, which uses water jets and suction to remove fine coal in a cake-like form. Although this system is considerably more expensive than a bucket elevator system, it recovers more coal. Hence, its costs should be weighed against not only the costs of dredging and rebuilding sediment ponds, but also the benefits from the coal recovered. Dredging and transporting tailings are by no means cheap. One mining company said it takes 1,200 truck loads to clean out its six sediment ponds. Another company spent almost $70,000 in 1993 to dredge its ponds, without making a noticeable impact on the turbidity of water discharged into a nearby river.

8.3 Monitoring and enforcement

The government's enforcement efforts appear to be spasmodic, due in part to limited monitoring data and constraints in terms of number and training of mining inspectors. Mining companies provide data on water quality in streams inside lease areas to the Regional Office of the Ministry of Mines and Energy, which forwards a copy to the Jakarta office. The company often attaches a cover letter explaining unusual readings, such as high suspended solids levels resulting from collapse of a dam at a settling pond. The Ministry reviews the data and decides whether further action, such as a site visit, a warning letter, or ultimately suspension of a company's mining permit, is warranted. In reviewing the data, the Ministry officials are aware of the possibility that companies might not report the data truthfully. In some cases, they require companies to provide water samples for the Ministry to analyze independently. Mine inspectors also conduct site visits to collect samples if they doubt the validity of the data or samples provided by the companies.

For a variety of reasons, it is difficult for the Ministry to use these data to assess short-run and long-run changes in water quality. Filing problems and lack of computerization make it difficult to track performance over time. The data have been collected only since the late 1980s, which is obviously inadequate for analyzing environmental impacts over the life of a mine. There is a lack of baseline data, in terms of readings before mining started and upstream of the mine site after mining commences. ANDALs usually do not contain pre-mining data covering the entire year, not to mention several years (which is necessary to get reliable estimates of means and standard deviations). Water quality varies between the wet and dry

seasons due to natural factors; hence, a "baseline" ANDAL value derived from data collected during the wet-season cannot be meaningfully compared to the mean value of annual monitoring data. Companies tend to collect data above the mine site infrequently, because of the time and expense involved in traveling upstream. Additional data on water quality are sometimes available from the Ministry of Environment, but only if it has established monitoring stations in the vicinity of the mine site.

There is some evidence that the government has intensified enforcement efforts in recent years. In 1992, for example, persistent complaints from communities on the Mahakam River about flagrant environmental violations by three mines led the Ministry to suspend the mines' operating permits for three days. This action was taken after the mines were warned three times to improve their practices.

8.4 Economic principles for pollution control

Establishing ambient water-quality standards and designing policies to achieve them is not easy under any circumstances, but the limited data on pollution levels and pollution impacts makes the situation particularly difficult in Indonesia. Even in the absence of data, however, the government needs to follow some principles in determining standards and setting policies to encourage abatement. Environmental economics offers the following principles.

Pollution abatement costs money, but it also provides benefits, in the form of reduced damage to the ecosystem and downstream human activities. Hence, there is a trade-off between private costs and social benefits. Just as the decision whether to mine must take into account opportunity costs related to alternative land uses, so the decision about pollution abatement must take into account opportunity costs related to impacts of pollution on downstream activities. For Indonesia to benefit the most from pollution control, it should neither tolerate zero abatement nor mandate zero pollution. Rather, it should set ambient standards at the point where the net benefits of abatement — the difference between the value of environmental damage prevented and the costs of abatement — are as great as possible. Zero abatement is intolerable, because it ignores the damage that pollution causes. Zero pollution is undesirable, because it ignores the costs of pollution control.

Following this line of reasoning, Indonesia should not necessarily strive to achieve the same standard of water quality in all rivers, as indeed it does not. However, it should base standards not on existing water quality, as is the case with the current river classification system, but rather on the benefits and costs of improving water quality through pollution control activities. For example, a river running through a heavily populated basin should not remain heavily polluted just because it is currently heavily polluted. If the population drawing water from the river is high, then the benefits of pollution abatement are also likely to be high, and so expenditure on pollution reduction is probably justified. On the other hand, a lightly polluted river without significant human activities or unique ecosystems downstream should not necessarily remain lightly polluted, as the social costs of permitting additional pollution may not

be very significant.

In setting standards for rivers affected by mining, then, the government needs to look carefully at downstream activities, pollution's impacts on them, and the costs to mining companies of reducing pollution. Once a standard is chosen, the government then faces the challenge of promulgating regulations to ensure that water quality is maintained at that level. This is not an easy task, particularly when there are several mines in the same river basin (as in the case of the Mahakam), not to mention other pollution sources. For simplicity, the following hypothetical discussion assumes that mines are the only significant source of pollutants in a given river basin.

In general, two regulatory approaches are possible in the basin. One is the command-and-control approach: the government can specify water-quality standards for streams draining each mine site at the point where they enter the main river (e.g., at the boundary of each mine site), dictate the pollution-control practices that mines must follow, and fine or otherwise punish mines if they violate the stream standard. The stream standard is chosen so that, in the aggregate, pollution from the various mines yields the desired river standard. The regulatory approach followed by Indonesia is essentially of this type.

The second approach is the economic-instruments approach. Under this approach, the government still wants to maintain a ceiling on the total pollution load in the river, but it is less concerned about pollution concentrations in individual streams draining the mine sites. Nor does it specify pollution-control activities. Instead, it charges each mine an effluent fee on the quantity of pollution discharged by streams draining the mine site into the river.[3] Each mine faces the same fee, and the fee is chosen so that total pollution equals the desired value. Effluent fees are an example of a policy based on the "polluter pays principle." They communicate to mining companies the social costs of water pollution, and they generate revenue that can pay for downstream remediation and compensation.

The economic-instruments approach is results-oriented: it allow mines to determine how to reduce pollution, instead of dictating the practices to follow and the equipment to purchase. It offers two principal advantages over the command-and-control approach. First, it creates an incentive for mines to reduce pollution below the targeted level. A mine that reduces its pollution load reduces the effluent fees it must pay. Second, in theory anyway, the mines that are able to reduce pollution at the lowest cost end up bearing most of the burden of pollution abatement. When instead mines face the same stream standard, they bear the same pollution-control responsibility, in spite of inherent differences in their pollution-control costs (which

[3]Alternatively, the government could grant each mine a permit that gives it the right to discharge a specified amount of pollution, with the sum of permits across mines equaling the total desired pollution load in the river (tradeable permits). Mines can discharge more pollution than allowed by their permit only if they purchase unused permits from other mines. This type of system is used in the U.S. for sulfur dioxide emissions from power plants, but it has not been applied to water pollution from mines.

might vary due to differences in soil, topography, type of coal, and size of lease). This means that, in the aggregate (across mines), pollution-control costs are higher than they need to be under the command-and-control approach.

The principal disadvantage of the economic-instruments approach is that it can result in severe local pollution problems when pollutants do not mix readily and evenly into the river. Reliance on effluent fees alone involves considerable uncertainty about ultimate pollution loads. If the fee is set too low, pollution will be greater than desired; if it is set too high, pollution will be lower than desired. For this reason, effluent fees are often combined with standards: the fee is much higher for pollution concentrations above the standard than below. However, the system will not work very well when monitoring data are unreliable or enforcement is weak. But then, neither does the command-and-control system.

8.5 Recommendations

- **To the extent possible, quantify during the AMDAL process the likely downstream impacts of water pollution, and consider these impacts in deciding whether to grant a mining permit** — The ANDAL should indicate the impacts of mining on water quality and downstream activities, given pollution-control measures proposed by the company. The government should then decide whether the impacts are acceptable. If not, the company should be given an option to propose an alternative abatement plan. Given that existing data on downstream impacts are limited and will remain so for some time (even if more effort is put into preparing ANDALs), the government's decision will necessarily involve a significant amount of judgment. To ensure that the best decision is made, the government would be well-served by seeking input from a range of experts and all the parties involved, i.e. downstream communities as well as mining companies.

- **Require feasibility studies for future mine sites to include adequate plans for coal washing and water treatment, in terms of both equipment and land** — In areas exposed to extreme rainfall like Kalimantan Timur, settling ponds should be used as the last stage of a process that begins at the washing plant, not as the primary or only line of defense against discharge of turbid water. Both companies and government need to investigate other technologies and systems for coal washing and sorting that reduce the discharge of turbid water and fine coal from the washing area.

- **Use the RPLs as one avenue for increased standardization of data on water quality** — The types of pollutants measured and sampling points can be standardized across mines, and a minimum compliance check list can then be provided to ease the mine inspector's task.

- **Monitor mine pit drainage more closely** — Because pits usually drain first into small streams rather than directly into the river, their impact is largely ignored. From a

biological standpoint, however, the impact may be more severe because there is less water to dilute suspended solids and dissolved compounds.

- **Conduct a study of the cumulative and combined impacts of mining on water quality in the Mahakam River** — The large number of mines along the Mahakam makes it a "hot spot" case worth investigation. Results of the study could inform policy on coal mining discharge for the next 20 to 30 years that mines along the Mahakam will be operational.

- **Evaluate the feasibility of implementing effluent fees on key water pollutants** — Given the country's currently limited capacity for monitoring water quality, the existing standard-based system, under which mines face the suspension of their licenses for repeated violations of water-quality standards, should be retained. The government should consider adding to this system effluent fees on key pollutants, to induce mining companies to internalize the costs of water pollution. Funds generated by the fees could be used to upgrade the government's monitoring and enforcement capabilities. The fees would also increase the incentive for mines to recover fine coal from discharge water.

- **Review the adequacy of the number, training, and remuneration of mine inspectors** — Monitoring and enforcement are essential activities, regardless of whether the regulatory process is based on command-and-control or economic-instruments approaches. The monitoring and enforcement capabilities of the Ministry of Mines and Energy must rise, if for no other reason than to keep pace with the expansion of the industry.

9 Reclamation

All companies suffer from a lack of experience with reclamation in Indonesia's humid tropical conditions. Large foreign operators gained most of their experience mining in arid or semi-arid conditions. Thus there is great deal of uncertainty about which reclamation methods will succeed over the long term. This uncertainty is compounded by a lack of consensus on the long-term objectives of reclamation efforts.

9.1 Current practices

Although mining companies in Indonesia are expected to rehabilitate mine sites during the period of their permits, Indonesian laws and regulations do not clearly define what is meant by reclamation. ANDALs, RKLs, and RPLs tend to be vague on this matter. In practice, reclamation has meant backfilling opened areas, spreading topsoil, and planting trees. Beyond this there has been little open debate or consideration of exactly what constitutes rehabilitation, or what the ultimate goals of reclamation should be.

Visits to five mine sites in Kalimantan Timur revealed varying interpretations of what reclamation means in practice. The mines have a mixed record on backfilling, recontouring, and spreading topsoil. The dangers of neglecting these tasks are obvious in mined-out areas where rehabilitation efforts were negligible: large numbers of deep pits remain, and in many areas steep slopes have eroded into a series of gullies with little or no plant cover. The land is now essentially worthless.

Although companies today seem well aware of their responsibility to reclaim exposed lands, for some the backfilling and topsoil operations have fallen far behind the mining. Backfilling and mining should run concurrently so the bulk of the work is completed and costs are incurred while the mine still yields a steady cash flow. The two activities are not necessarily at odds with each other. Depending on the topography of the site and the characteristics of the coal deposit, backfilling may be an essential part of mining. As the drag lines or shovels progress along the coal seam, they need to remove overburden and deposit it as close as possible to reduce costs, which usually means in the area just mined. While this is especially true of strip-mining on relatively flat ground, the same principle applies to pit mines if properly planned.

Another reason to proceed with reclamation as quickly as possible is that exposed topsoil is leached and eroded by rainfall and degraded by exposure to the sun. In the process, it loses the nutrients and microorganisms that make it fertile. Stored topsoil should be planted with temporary vegetation to slow this process, but some companies neglect this measure.

There is little evidence that companies are recontouring mine sites to resemble the original topography, although this is hard to determine because the mines are located in low, hilly land. Most simply construct benches to reduce erosion. In several mine sites, the slope

of the benches is too steep, and topsoil has washed away, exposing overburden. It appears that companies are rarely if ever asked to recontour or rebench in these cases. Another impact that receives little attention is the rerouting of streams. In many sites streams now dump into old mine pits, and during the dry season there is no flow below the pits. This is not necessarily an undesirable modification of the landscape: several villages in one area have asked mining companies to leave newly formed lakes and ponds in the mined-out area to meet the villagers' water needs.

As long as there is adequate topsoil and grades are not too steep, revegetation as it is currently practiced does not seem to pose any significant problems for mine operators in Kalimantan Timur. With only a few exceptions, replanting proceeds soon after backfilling, and it is delayed only by this preliminary step. For the most part, mine operators or their subcontractors replant with fast-growing, nitrogen-fixing trees in genera such as *Albizzia* and *Acacia*, which need little attention after the first year and establish sufficient cover to satisfy mine inspectors. *Albizzia* can be propagated simply by placing trimmed branches in the soil.

Fast-growing trees do a good job of binding and shielding the soil from direct sunlight, and they improve infiltration and drainage. When planted as monocultures, however, they may be more vulnerable to disease. It is also unclear whether they in fact add much nitrogen to the soil. Recently, the Ministry of Forestry asked companies to try a different species of *Acacia*, to increase soil benefits. Some firms have experimented with fruit trees, with mixed results. Fruit-bearing trees require more maintenance, are sometimes stolen by local inhabitants, and grow much more slowly. The latter feature can open companies to criticism from mine inspectors.

Mine planning plays an important role in reclamation success. Some mines have multiple open pits and face problems with stockpiling and transporting overburden. The mine with the least evidence of reclamation activity was using multiple pits to extract coal of different calorific values that could be mixed to meet the exact requirements of buyers. Although the specifics of mine planning are beyond the scope of this paper, significant work has been done on this topic outside Indonesia (e.g., in Australia, Canada, and the U.S.). Regulatory authorities in the U.S. provide guidelines on planning for mine operators. Officials from the Ministry of Mines and Energy feel that companies could reduce both production and reclamation costs through better site planning.

9.2 Costs of reclamation

Costs of reclamation depend critically on the goals of reclamation. In many countries, reclamation is officially or unofficially viewed as the restoration of land to its pre-mining value and use. Achieving this has proven costly in some western parts of the U.S., where a lack of rainfall and thin topsoil make it difficult to reestablish the same vegetation that existed before mining. In some extreme cases, the reclamation costs far exceed the market value of the land before mining (Gillis 1991). Thus it is not sufficient merely to define the goals of reclamation;

these goals must also be balanced against reclamation costs. The deciding factors are not only the technical feasibility of rehabilitating land for a particular use, but also the level and distribution of costs and benefits (Leathers 1977).

In Kalimantan Timur it may not make sense to require companies to rehabilitate current mine sites to forest cover, even if one follows the restoration principle. Most current mine sites previously supported only limited agriculture and grazing for a sparse population. Much of the area was heavily logged in the 1970s and 1980s and burned during the forest fires of 1982 and 1983, leaving little forest cover. Much of it, though classified as conversion forest, was actually *alang-alang*. If soil erosion and siltation of water courses constitute the principal environmental problems caused by inadequate reclamation, planting grasses may make better economic sense than planting trees.

Future coal mines will be located increasingly in commercial production forests. The government will need to decide whether mining companies should reestablish these forests, plant fast-growing pulpwood species, or convert the land to another use. Reestablishing forest cover with species diversity comparable to that in the original forests will almost surely be technically impossible, or at least incredibly expensive. Using more native species than is currently the practice, and planting several together rather than in monocultures, are more realistic goals, particularly in light of the great advances in dipterocarp regeneration made by the Ministry of Forestry and TROPENBOS in recent years.

Estimating the costs of reclamation is complicated by the fact that backfilling is in many cases an integral part of coal extraction. As noted above, the degree to which this holds true depends on the topography of the mine site and the geology of the coal seam. Earthmoving is the most expensive activity. In the U.S., earthmoving and other heavy-equipment work account for 70-90 percent of the total cost of reclamation (Leathers 1977). In Indonesia as elsewhere, the amount of effort required for backfilling depends on the depth of overburden removed and the amount of recontouring needed to establish an acceptable slope. Thus mines within Kalimantan Timur face very different earthmoving costs. For example, PT Adaro is mining a very thick seam near the surface, with a stripping ratio better than 1:1, but several mines along the Mahakam face stripping ratios of 7:1 or higher.

In contrast, revegetation is labor-intensive and relatively inexpensive. The current method of propagation requires at most a small nursery. Revegetation accounts for 5 percent or less of the total reclamation bill in the U.S. Although comprehensive data on these costs are not available for Indonesia, some examples support the conclusion that revegetation and other non-earthmoving costs amount to a tiny fraction of revenues. At one site, a staff of 10 workers replanted 150 hectares in four years; in 1993, the total cost was less than $5,000. At another site, the total annual bill for revegetation, water treatment, water testing, community development, and environmental training is about $8,000. According to 1994 data from a mine along the Mahakam River, the quarterly cost of replanting 15 hectares, plus water treatment at the washing plant and water quality testing, totaled less than $4,000. One notable exception

was a mine that had fallen far behind in its revegetation work. Mined-out areas in this lease had little topsoil left after six or seven years of erosion, and the cost of reestablishing trees is now much higher than it would have been if the company had proceeded with revegetation in step with backfilling. For a modest and timely investment, revegetation in Indonesia will at least preserve the soil for future use and reduce siltation, and at best provide commercial pulpwood or other commercial plant products.

Some mining companies in Kalimantan Timur complain that reclamation costs are too high, and that 100-percent compliance would make their operations unprofitable, particularly if world coal prices drop, because they are in a marginal business. This claim must be treated carefully. Mining companies have a valid point if the mandated level of rehabilitation costs more than it is worth. On the other hand, if a deposit is uneconomic from a social point of view — the costs of production, including economically justified reclamation efforts and all environmental externalities, exceed the benefits — then it should not be mined in the first place.

9.3 Recommendations

- **Factor in reclamation costs as well as benefits in determining the appropriate level of rehabilitation** — The goal of reclamation is not only to provide short-term environmental protection, such as by reducing erosion, but also to make possible economically valuable post-mining land uses, and to do so at a cost that is justified on the basis of short-run and long-run social benefits. Rehabilitation should be viewed as an investment, not as an effort that is worthwhile regardless of the cost.

- **Involve local communities in reclamation decisions** — If rehabilitated land will be turned over to local communities, they should be consulted about how they intend to use the land. Many mine operators fear that all the trees they have planted will be cut down immediately after they cede control of the lease area. If this happens, it proves that the future land users have different ideas about how best to use the land.

- **To ensure that revegetation keeps pace with backfilling, consider implementing annual area targets** — To date, no mine has been subject to penalties for falling behind in revegetation. If targets are implemented, they should specify priority areas for immediate action. For example, one mine has developed detailed plans for revegetation, but it is focusing most of its effort on narrow strips of land adjacent to roads in its lease area. This gives the impression of significant revegetation progress, but in fact many areas at greater risk of erosion remain bare.

- **Upgrade the capabilities of mine inspectors to determine the appropriateness of on-the-ground reclamation efforts** — Mine inspectors from the Ministry of Mines and Energy tend to stick to a fairly strict interpretation of reclamation plans approved during the permitting process. This causes problems when the mining company finds it needs

to modify the plans. Revegetation of steep slopes and areas with a shortage of topsoil provide a good example: the most successful way to prevent erosion in these areas is to use *alang-alang* grasses, but this practice is generally frowned upon.

- **Utilize more fully the technical expertise of the Ministry of Forestry in revegetation efforts** — Many existing mines are located on land that was, and may some day again be, under the supervision of the Ministry of Forestry. Although the Ministry should have a keen interest in how this land is reclaimed, it has not invested much time or effort in advising reclamation programs. It does review the environmental plans of each company during the permitting process, and thus it has an opportunity to suggest changes or make recommendations. Ministry officials also inspect some mine sites at least once each year. If the Ministry develops more concrete guidelines for revegetation, it should increase the frequency of visits and treat them more as technical missions to share expertise and monitor progress.

- **At the earliest opportunity, transfer control of rehabilitated land to parties that have an interest in its long-term productivity** — Many existing mines will be productive for another thirty years. As mining continues, more and more land will be in some stage of rehabilitation, and parts of it will be ready for another use, such as timber plantations or farming. Under existing law, lease areas revert to the control of the Ministry of Mines and Energy two years after the exploitation period for the *entire* lease ends. But once a company has met its basic requirements for reclamation, it has little interest in the productivity of the land. It might make sense to transfer control of rehabilitated land to local communities, agro-industries, or the Ministry of Forestry before the entire mining operation is complete. These parties are better positioned than a mining company to decide how to prepare and use the land. One caveat worth mentioning is that mine operators worry about their liability for anything that happens in lease areas that have been released to other parties, and about interference in their mining operation from other parties' use of land near existing operations. These are legitimate concerns that would need to be addressed by effective legislation.

10 Ensuring compliance with environmental regulations

The preceding sections have indicated that the record on environmental management in Indonesia's coal sector is mixed. The government must find a way to improve the overall performance of mining companies, or it will face the prospect thirty years from now of thousands of hectares of ruined land, hundreds of kilometers of polluted rivers, and an enormous clean-up bill. For some industries it may be possible to use public funds to cover the costs of environmental remediation after a company closes down, but in mining it is far cheaper to minimize environmental damage from the outset.

10.1 Factors affecting compliance

There is some evidence that larger companies make a better effort at pollution abatement and land reclamation. Larger companies enjoy economies of scale that allow them to dedicate more resources for these tasks, establishing environmental departments with their own equipment and mandate. By contrast, the smallest mines have made the smallest investments in systems for reducing turbidity in discharge water and suffer from poor planning, which hampers reclamation.

Foreign operators in particular have more experience dealing with strict regulatory regimes, collect more consistent and more comprehensive data to monitor their environmental efforts, and have better access to international expertise that is lacking in Indonesia. Mining companies that market their coal internationally also must worry about their reputation abroad. Publicity about poor practices in Indonesia can affect their operations in other countries, and anger shareholders.

Local companies often must rely on contractors to supply equipment and to do much of the mining. Contractors are paid on the basis of the amount of overburden they remove and the amount of coal they produce, but they have little direct interest in pollution mitigation or reclamation.

10.2 Performance bonds

Whether companies are big or small, or foreign or domestic, one way to encourage them to meet their environmental responsibilities is through performance bonds. Performance bonds are particularly applicable to reclamation requirements. The basic idea is that the operator guarantees payment to the government to cover the costs of any environmental remediation that remains when the mine closes down.[4]

Several types of performance bonds are used for coal mining in the U.S. With a *surety*

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[4]Much of the following discussion on the U.S. experience with performance bonds comes from McElfish and Beier (1990).

bond, the mine operator pays a fee to a surety company, which assumes the risk that the operator will fail to meet reclamation requirements. The operator typically pays a percentage of the total bond amount to the surety company each year. A study by the Office of Surface Mining found that on average operators paid 5-6 percent of the total bond value over the course of a five-year permit (McElfish and Beier 1990). The rate varies depending on the perceived risk of failure. New mine operators generally must pay more. The surety usually requires the operator to post collateral, with the amount again depending on perceived risk. An advantage of this type of bond is that the surety closely monitors the performance of the mine operator for the life of the mine, to reduce risk of forfeiture.

With *collateral bonds*, the mine operator posts collateral directly with the regulatory agency in the form of a certified check, money order, or some other type of guaranteed financial instrument. Collateral bonds are a large financial burden to mining companies. In the absence of a bonding system, companies finance reclamation from current cash flows, and treat this as an operating cost. A collateral bond requires the company to cover a much large portion of the reclamation bill up front. This can tie up a significant sum of money for the duration of the project.

In either type of bond, the government retains some portion of collateral and/or bond value until the mine site is judged to be sufficiently reclaimed, based on an evaluation of recontouring and revegetation, restored hydrological balance, and satisfactory water quality.

One of the major challenges for a performance bond system is setting the value of the bond. In some U.S. states, the bond value is based on a worst-case scenario, in which mining stops when reclamation costs are at their highest. As earthworks are the most expensive component of reclamation, this value is set on the assumption that the mine operator could forfeit the bond when the "greatest amount of earth remains to be moved" (McElfish and Beier 1990). Other states set bond values using a flat area-based fee.

10.3 Implementation issues with performance bonds in Indonesia

The U.S. experience with performance bonds is by no means problem-free. To implement such a system in Indonesia would require careful consideration of institutional issues related to mining companies, the quality and depth of available financial services, and regulatory agencies.

Sureties base their fees on a credit appraisal and an appraisal of the mining company's past reclamation record. The former requires that the company keep standard and accurate accounts and be financially secure. This requirement could automatically disqualify some of the smaller domestic mining companies. The record of loan failures in Indonesia indicates that many companies do not provide accurate accounts, and that financial services companies often do a poor job of appraisal. A U.S. government study found, not surprisingly, that poorly financed mining companies have trouble finding a bond market. Several companies operating

in Kalimantan Timur would have trouble satisfying the second condition because of their poor reclamation record.

If surety companies become insolvent, the government gets stuck with unfunded bonds. In 1987, the state of Indiana had $20 million worth of unfunded reclamation bonds due to the failure of five sureties (McElfish and Beier 1990). In Indonesia, where the financial services industry is still young and poorly regulated, the problem of insolvent sureties would probably be more acute.

The lack of consensus in Indonesia on what constitutes reclamation would make setting bond values difficult. Moreover, in the Indonesian context, the U.S. practice of setting bond values at the point of highest reclamation cost might not ensure that the government would have sufficient funds for remaining reclamation activities in the event of forfeiture. This practice yields sufficient funds only when companies meet their reclamation obligations right up to the point of forfeiture (McElfish and Beier 1990). That is, the bond is not intended to pay retroactively for reclamation activities that should have been but were not, conducted before forfeiture. In Kalimantan Timur, many mining companies have already fallen behind in their obligations.

Subcontracting introduces additional complications. When actual mining is subcontracted to another firm it is unclear who should bear the costs of bonding. In two of the mines inspected for this study, the leaseholder carried out revegetation work and water-quality control measures, while the subcontractor was responsible for backfilling. One option would be for the leaseholder to post the full value of the bond, but to make some percentage of its payments to subcontractors contingent on their (subcontractors') progress. For similar reasons, it might make sense for PTBA to share the burden of bonding with its contractors.

A performance bond system in Indonesia could be simplified by following the example set by some states in the U.S., which use a flat per-acre fee structure. In some cases, the fee is the same for all mines, and in others, it varies by the characteristics of the site and the operator's record of compliance. More information would be needed on the costs of reclamation to set a per-hectare bond value for Kalimantan Timur. In the U.S., the bond values varied from $1,000 to $3,000 per acre in the mid-1980s, though in some states the maximum was much higher (McElfish and Beier 1990). Adjusting for inflation, a similar fee structure would work out to Rp 6.5-19.6 million per hectare in 1993. In fact, reclamation costs are probably lower, on average, in Indonesia than in the U.S.

To ensure the fairness and success of any bonding system, the government would also need to address some of the problems mentioned in earlier sections of this study. For example, a clear definition of reclamation objectives and pollution abatement, and the typical costs of achieving those objectives, would be needed to set realistic bond values. The government would also need to clarify standards for measuring the attainment of these objectives, in order to judge when and how much of the bond could be released.

10.4 Recommendation

- **Despite the caveats mentioned above, the government should prepare the industry for some type of performance bonding system, even if it must accept less than full coverage of the risk of forfeiture.**

11 Resource rents

The preceding sections focused on issues purely within the coal sector. The broad message that emerges is that environmental impacts must be taken into account if Indonesia is to derive maximum benefits from the development of coal mining. But appropriate responses to environmental impacts are not sufficient for ensuring that the development benefits generated by coal mining will be sustained. This requires, in addition, that the economic surpluses generated by mining be used in particular ways.

11.1 Rent capture

As a natural resource, coal mining generates resource rents: returns in excess of total costs, including returns to capital and risk. Resource rents represent the maximum payment the government can collect from a mining company for the right to exploit coal resources.

Resource rents represent an attractive source of revenue because, in theory anyway, they can be captured without introducing distortions that reduce economic efficiency. In contrast, personal income taxes reduce the incentive for individuals to work, sales taxes discourage consumption, and payroll taxes induce firms to employ less than the optimal amount of labor. If governments forgo the capture of resource rents, they must tax other activities at an unduly high level, and this typically distorts economic decisions.

Government rent capture also helps to discourage inefficient mining companies from operating. The higher the proportion of rent captured by the government, the lower a mining company's extraction costs must be if it is to remain in business. The failure to capture rents can reduce incentives for companies to reduce mining costs through improved management, technological innovation, or operation at a more appropriate scale.

When mining companies are foreign-owned, rent capture is justified for an additional reason: retained value. In the absence of government rent capture, much of the resource rents may wind up being repatriated. If this happens, the host country loses a potential source of development capital and suffers a reduction in the net foreign exchange earnings of the sector.

Whether the Indonesian government actually collects revenue comparable to the full resource rent from either contractors or KP holders is unknown, as careful studies have not been conducted. Royalties in Indonesia are, however, very low relative to those in the U.S. As in Indonesia, royalties in the U.S. vary with the type of mining, but they are based on a percentage of the sale value. The royalty rate is expected to range between 8 percent and 12.5 percent in 1995.[5] Using market prices for different qualities of Indonesian coal in July 1994,

[5]U.S. royalty rates vary by region because they are adjusted for state taxes (non-income) and allowable deductions. Data comes from the *Final Environmental Impact Statement*, Federal Coal Program, Department of the Interior, 1985.

it is possible to convert Indonesia's specific royalty rates ($0.30-0.60/ton) to a percentage basis. Table 4 shows the results. A. best, the royalty will capture only 2.1 percent of sales revenue from coal in 1994, assuming an average price of $28/ton.

Production-sharing complicates the estimation of rent capture in the case of mines operated under coal cooperation contracts. If we view the production share as revenue to the government, the contribution in fiscal year 1993/94 was roughly $65 million.[6] Apart from taxes and other fees paid on behalf of foreign contractors, however, this money does not enter the economy through the budget process (though it certainly enters through other channels). PTBA spends some of the proceeds from the production share on costs related to managing the contracts, including surveying, insurance, administration, and overhead. Royalties, corporate income tax payments, and dividends represent the only direct payments by PTBA to the government. Since 1992, PTBA has been allowed to retain dividends to finance research and development activities related to coal briquettes.

A more explicit way to capture rents through production sharing contracts is to follow the example of Pertamina, which has many such contracts with foreign oil companies. Each contractor is allowed to retain a certain amount of "cost oil" to cover exploration and production costs. The remaining oil is split between the government (85 percent) and the contractor (15 percent). This method takes into account the unique circumstances of each contractor, with the amount of cost oil reflecting production costs and the riskiness of the investment.

Taxes on mining companies deserve a careful review to ensure that the government is capturing the maximum possible benefit from the industry. In theory, the government can design a revenue system that captures most of the available rent without affecting investment in the industry. In practice, implementing such a system is difficult because the government needs accurate information about the private returns to coal mining, which depend on company costs and market prices. Both of these vary widely across Kalimantan Timur, and over time. Calculating royalties annually, on a company-by-company basis, would deal with these variations but is not feasible in the near term because of limited information.

11.2 Utilization of rents

Tax revenue from mining can be put to a variety of uses. If the intention is to promote sustainable economic development, economic theory predicts that a portion of the total resource rent (not just the amount captured by the government) must be invested to offset the depletion of mineral stocks. That is, other, reproducible forms of capital must be built up to sustain economic activity after the natural capital represented by mineral wealth is depleted. In technical terms, the portion of the rent that must be invested equals the quantity extracted times

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[6]Assumes production-sharing contractors produced 20 million tons in 1993/94, and an average domestic price of $24.

Table 4

Royalties as a Percentage of Coal Price in Indonesia

Coal price ($/tonne)	Royalty ($/tonne) 0.15	0.30	0.60
24	0.6%	1.3%	2.5%
26	0.6%	1.2%	2.3%
28[a]	0.5%	1.1%	2.1%
30	0.5%	1.0%	2.0%
32	0.5%	0.9%	1.9%
34	0.4%	0.9%	1.8%

a. The average price for coal given to PTBA or sold on PTBA's behalf by contractors was $29/tonne in 1993. It was expected to drop to $28/tonne in 1994.

the marginal resource rent, i.e. the difference between price and extraction cost for the last unit extracted during a given period. "Investment" here is defined broadly: it includes not only gross fixed capital formation in the form of equipment and structures, but also expenditures on education and other activities that build up human capital. The link between investment of resource rents and sustainability is known as Hartwick's rule, after the paper by Hartwick (1977) that first set it forth.

Hartwick's Rule provides the intellectual foundation for "natural resource accounting." A country or region can predict whether or not its economy is sustainable by adding up all types of investment, deducting both ordinary depreciation and the depletion value for natural resources, and checking whether the resulting net investment figure is positive or negative. Sustainability requires that the figure be positive. One of the best-known natural resource accounting exercises was done for Indonesia by World Resources Institute (Repetto et al. 1989). This exercise determined that net investment was indeed positive in most years during 1971-84.[7]

A fundamental policy question is whether the economy to be sustained is the regional one, where the resource originates, or the national one. Achieving and sustaining the highest level of economic activity requires investing rents in the opportunities that yield the greatest return. These opportunities are often outside the resource-producing region. That is, it might make the most economic sense from a national standpoint to use resource rents from one region to finance investments in other regions of the same country. This would sustain the national economy, but not necessarily the regional one.

In the case of Kalimantan Timur, it is safe to say that most of the rents flow out of the province. The government returns only a portion of royalties, and none of the income tax payments and dividends, to the province; PTEA faces no requirement to share revenue from the sale of its production share with the province; foreign contractors repatriate rents they capture; and domestic contractors and KP mines probably invest much of the rents they capture in more industrialized parts of the country. On the other hand, the central government provides financing for development expenditures (e.g., infrastructure), and the private sector invests in local commercial and industrial opportunities. What is important for sustaining the provincial economy is that the outflow of rents be at least offset by inflows of other investment funds, and that the new investment contribute to the development of economic activities that can eventually substitute for mining. Currently, most investment in the province is linked to resource-based industries, such as coal mining; whether the province is an attractive location for other, more sustainable industries remains to be seen. Given transmigration schemes and other efforts to promote development in the outer islands, the government is obviously operating under the assumption that sustainable development is possible in Kalimantan Timur.

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[7]The case for sustainability is even stronger than the results indicated, because Repetto et al. overstated the resource depletion allowances by using the full value of the resource rent instead of just the portion necessary to satisfy Hartwick's Rule.

At the local level, the sustainability issue boils down to whether or not communities and businesses that have developed around the mining industry can sustain themselves once the mines are exhausted. In more remote areas of Kalimantan Timur, such as Sangatta (the location of the biggest mine, Kaltim Prima Coal), this seems unlikely. Since most of the mines in Kalimantan Timur are still young, the government has not yet had to deal with the decommissioning stage of the industry. One important aspect of mine decommissioning is to predict the impact on local economies in terms of employment and control of land.

11.3 Recommendations

- **Conduct a study to estimate available rents, and therefore potential maximum royalties, from mining at different stripping ratios, transport distances, and for different types of coal** — PTBA is the best source of the detailed information on mining costs required by such a study. It has records of its own operations, as well as those of its contractors. This experience spans several different sites and different mining methods.

- **Review the 13.5-percent production share to determine whether it is appropriate for the 1990s** — The review might also consider whether the production share should be fixed for the duration of a contract or allowed to vary.

- **Assess the advantages and disadvantages of replacing the current production-sharing system by one modeled after the "cost oil" approach used by Pertamina.**

- **Institutionalize natural resource accounting at the national and provincial levels, to bring the economic depletion costs of resource-extractive industries to policymakers' attention.**

- **Conduct a study to assess the long-term, post-mining viability of local economies in the vicinity of coal mines.**

- **Evaluate whether the types of investments most conducive to sustainable development are more likely to be made by the government, through the budget process, or PTBA, through its expenditure of the rents it captures** — The findings could be used to guide the allocation of rents between the two, through the relative magnitudes of royalties and production shares. For example, if expenditure by the government is found to provide greater development benefits, the government could consider increasing the royalty. This would not increase the burden on contractors, as it would simply reduce the portion of the production share retained by PTBA and redirect a greater share of rents to the budget.

12 Conclusions

There is no doubt that Indonesia has benefitted from the development of coal mining, and that these benefits will expand with the industry. To the extent that coal provides rents, and these are invested in productive activities, the benefits will be visible long after the coal is gone. The *net* benefits depend on the costs of mining, including environmental damage, and the forgone benefits from other land uses. These costs are not well documented, and they are much harder to measure over the long term than are the benefits. The danger is that Indonesia will underestimate environmental and other external costs *because* they are less tangible, and as a result will make suboptimal decisions about when, where, and how to extract coal. Actions that help Indonesia to estimate these costs, and to compel mining companies to internalize them, would clarify the trade-offs for the nation and the private sector. They hold the key to maximizing the net benefits from coal-sector development.

This paper has suggested several specific actions, based on a review of current policies and recent experience with mining. Taken as a whole, some broad themes emerge from these suggestions.

- To date, **long-term planning by the government** has focused on coal production and the country's future coal needs for domestic use and export. But a long-term plan must incorporate a much broader range of issues than a region's technical potential for mineral output. Better land-use planning, for example, is critical for understanding mining trade-offs and for setting reclamation goals. The former requires information about current land uses and the value of those uses, and the latter depends on how land can and should be used *after* mining. Both require closer cooperation between all interested parties. When mining occurs on land with little value, it may even offer an opportunity to *increase* the post-mining value of the land. During the recontouring, backfilling, and revegetation operation, mine operators are in a unique position to restore some qualities lost through overlogging, forest fires, and erosion, at potentially little additional cost. The provincial government and local communities may never again be in a position to make such changes once the mines are exhausted.

- Better **planning by mining companies** is also needed to minimize the environmental impacts of mining and the costs of reclamation. Field visits provided ample evidence of the increased costs to the environment and to companies from poor planning of mine pits, the sequence of mining, coal washing operations, and revegetation.

- The critical input to long-term planning at the national, regional, and company levels is **accurate, timely, consistent data on the economic, social, and environmental impacts of mining**. Existing data are insufficient for evaluating the environmental impacts of mining and thus for formulating future mining policies, and they tend to be spread between agencies that have overlapping mandates and competing interests. The solution to this problem requires defining environmental goals clearly and establishing

consistent requirements on where, when, and how companies and government agencies should monitor environmental impacts.

- Improving the **ability to analyze and act on data**, both by mine operators and regulators, is as important as data collection. The current AMDAL process generates enormous amounts of information, but the information is not used to the full extent for mine planning and regulation. Companies appear to share little environmental information with each other. Local sources of expertise on the environmental aspects of mining could be tapped more fully. These sources include the Directorate of Environmental Geology, the Mineral Technology Research and Development Center, the Mining Human Resource Development Center, the Mining Faculty of Universitas Pembangunan Nasional, Sriwijaya University, and the Bandung Institute of Technology. The government should explore or expand cooperation with these organizations to establish joint research projects in active mining areas, with the cooperation and participation of mine operators.

- Until better data become available, the government should **err on the side of environmental protection** in deciding where to allow mining. Most of the existing coal mines in Kalimantan Timur are located on low quality land near the coast. Environmental costs will rise as mining moves inland. The magnitude of these costs is currently unknown, both at the level of individual mines and at the regional level. Yet, any rational process for deciding whether to mine a particular coal seam requires identifying and estimating such costs, at least in qualitative terms. Of particular concern are irreversible losses, such as species extinctions, which cannot be restored by any amount of investment in reclamation. Through the AMDAL and land-use planning processes, the government should identify areas with unique ecological characteristics and steer mining activities away from them, to buy time to learn more about their value and the long-run environmental impacts of mining.

- Local, smaller mining companies have much less expertise in environmental management than foreign operators. This raises the question of **who can best develop the coal industry**. The coal mining sector has been closed to foreign investment since 1991, and the 19 new cooperation contracts are all domestic ventures. Apart from their lack of environmental expertise, these companies will probably need to subcontract much of the mining activity to third parties. In the process, they will lose some control over environmental impacts. The exclusion of foreign investors was intended to promote local mining. But from an efficiency standpoint, the most important criteria for evaluating investment projects is their expected return, not their ownership. Thus the government should recognize that the exclusion of foreign ventures comes at a potentially high cost, particularly in the environmental area.

- The **financial strength and profitability of mining operators** will also influence environmental policy. The competitiveness of Indonesia coal in world markets comes

from its exceptional quality. Production costs, transportation in particular, are higher than those of its closest competitor, Australia. This is particularly true of smaller mines. Cost containment will become increasingly important as the industry moves inland. The danger for Indonesia is the ever-present temptation to curtail companies' environmental obligations to preserve their competitiveness. Although the government can make more coal deposits commercially viable by ignoring the full costs of mining, the nation would suffer if it does so. A better way to promote the expansion of the industry is to deal with infrastructure problems that raise the cost of transporting coal. The government has begun this process by building a deep-water loading facility near Balikpapan, and it is now planning a railroad from the Mahakam basin to this facility. But by excluding large foreign companies from investing directly in coal mining, the government has lost one important source of financing for infrastructure investments.

All of the problems faced by the government in regulating coal mining will become more pressing as the industry expands. Environmental impacts will become more widespread and more costly due to the sheer number of mines and the cumulative effects of their activities, and also due to the progression of mining into land that is less degraded than near the coast. With the industry still in its youth, now is the time for Indonesia to address these challenges.

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