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**ENVIRONMENTAL ASPECTS OF BAUXITE AND
ALUMINIUM PRODUCTION IN INDONESIA**

A country case study prepared by the UNCTAD secretariat

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I. INTRODUCTION

1. The present study is one of a series of country case studies on various commodities prepared within the UNCTAD programme on "Improved Natural Resources Management in the Commodity Sector". The programme consists of a series of activities which are linked together around the unifying objective of achieving a sustainable use of natural resources while maximizing the contribution of the commodity sector to development. The case studies undertaken under the programme have two main objectives:

(a) To formulate, against the background of practical experience, conclusions that can be applied in devising and implementing policies aimed at improving environmental protection and natural resource management in the commodity sector in developing countries;

(b) To raise awareness in commodity importing countries, funding agencies and the international environmental community of the opportunities for, and constraints to improvement of environmental conditions associated with commodity production and processing in developing countries.

2. The present study on Indonesia is one of three on bauxite, alumina and aluminium. The other two countries for which case studies on these commodities are under preparation are Brazil and Jamaica. Information for the study was collected during a mission in August/September 1993. The study attempts to:

-identify the environmental effects of bauxite and aluminium production in Indonesia,

-describe present technical and regulatory measures aimed at dealing with these environmental effects,

-evaluate the effectiveness of these measures, and

-draw conclusions which may allow generalizations that could be of use to other countries.

II. BAUXITE AND ALUMINIUM PRODUCTION IN INDONESIA

1. Technology

3. Bauxite is the main raw material used to produce aluminium. It is composed of one or more aluminium hydroxide minerals and impurities of silica, iron oxide and titanium. Grades of bauxite and their different applications are determined by the percentages of alumina, silica, titania and iron they contain. A high alumina content is desirable in practically all uses of bauxite. At least 80 per cent of world bauxite production is from surface mines, with the rest, mainly in southern Europe, the former USSR republics and Hungary, from underground mines. On some surface deposits there is no overburden, while on others the bauxite may be covered by more than 70 meters of rock and clay. Deposits that are hardened may require blasting in order to release the ore. Once the bauxite is loosened into manageable pieces, it is crushed and washed. Unlike base metal ores, bauxite does not require complex processing because most of the ore mined is of an acceptable grade or can be improved by a relatively simple process of removing clay. This is done by some combination of washing, wet screening and cycloning, or even by hand picking and sorting. The bauxite is sometimes dried before shipping.

4. Bauxite is converted to alumina (aluminium trioxide) through the Bayer process. In this process, concentrated caustic soda is used to extract alumina from bauxite at elevated temperatures and pressures. This produces a slurry which consists of a super-saturated aluminate solution and a solid phase commonly called red mud or bauxite residue. This residue is separated from the saturated aluminate solution, which is cooled and seeded to induce crystallization and precipitation. The crystals generated from precipitation are washed and calcined to remove water.

5. Primary aluminium is produced by electrolytic reduction of alumina using the Hall-Héroult process. Alumina is dissolved in a molten cryolite bath and electrolysed in a reduction cell by direct current. Cells are connected in a series and comprise a carbon cathode insulated by alumina or refractory bricks inside a steel shell. Carbon anodes are suspended from above the cells. A direct current passes from the carbon anode through the bath to the cathode. Liquid aluminium is deposited at the cathode in the bottom of the cell and oxygen combines with the carbon anode. Alumina is added to the molten bath and dissolves as the electrolysis proceeds. Fluoride compounds are also added to the bath as required to replenish material removed or consumed. Molten aluminium is periodically withdrawn from the cell by vacuum suction.

2. Bauxite and aluminium in Indonesia

6. The bauxite/aluminium industry in Indonesia consists of two operations: P.T. Aneka Tambang's bauxite mine on Bintan Island, and P.T. Indonesia Asahan Aluminium's (Inalum) smelter at Kuala Tanjung on Sumatra ¹.

2.1. Bauxite

7. Aneka Tambang is a state owned mining company which produces several different minerals and metals, including nickel, gold, silver and bauxite.

8. Bauxite mining started on Bintan Island in 1935, during the colonial period. Following independence, the operations were nationalized. Bintan Island is situated south of Singapore and is part of Riau province. Mining takes place on two different concessions, one of 2 392 hectares near Kijang, where the port, capable of taking ships up to 40 000 tons, is located, and one of 5 630 hectares close to Tanjung Pinang, about 25 kilometers from Kijang. Bauxite from the latter area is brought to Kijang in barges after crushing and washing. There is no drying process, and the bauxite is exported wet.

9. The bauxite deposits are relatively flat, about three meters in thickness with little or no overburden, mainly a thin layer of topsoil. Mining also takes place in shallow water during low tide (there is a two meter difference between high and low tide). About 500 hectares have been mined, and on average 35 to 40 hectares are mined per year at present. The bauxite is of the gibbsite type, with the deposits having an average alumina content of 40 to 45 per cent. The average alumina content of the exported bauxite is 50 per cent. Production was between 500 000 and 1 million tons per year in the 1980s (see table 1). In recent years it has been close to 1.3 million tons. The determining factor is the capacity of the washing plant. The bauxite is mainly exported to Japan under a five year contract with prices linked to aluminium quotations at the London Metal Exchange. Some bauxite is also exported to the Republic of Korea under a long term contract expiring in 1996². The mine shows a modest profit. The operations employ around 800 people permanently, of which 400 in the mine, and about 450 on a temporary basis for loading, exploration and reclamation. The mine introduced a third shift in 1993. Most of the employees are from Bintan Island.

10. Reserves are sufficient for seven to eight years' production at the current rate of mining. Aneka Tambang is at present exploring for bauxite in Kalimantan. The possibility of establishing an alumina refinery close to the mine has been under study for several years. The establishment of a refinery on site would allow the mining of lower grade bauxite reserves. At present, the future of the refinery project depends, inter alia, on the results of the exploration campaign in Kalimantan.

2.2. Aluminium

11. Inalum's aluminium smelter is located at Kuala Tanjung, on the eastern coast of Sumatra, about 120 kilometers southeast of Medan. The smelter began operations in 1982. Its production capacity is 225 000 tons per year. The smelter has however never reached full capacity utilization, due to a shortage of electrical power (see below). In most years, production has been about 200 000 tons. In the summer of 1993, the smelter operated at about 80 per cent of capacity, with parts of two potlines (out of three) closed down.

12. The company is owned 41.13 per cent by the government, with ownership exercised by the Department of Industry, and 58.87 per cent by Nippon Asahan Aluminium Co. Ltd., a consortium of several Japanese companies with interests in the aluminium industry. The present ownership shares reflect an agreement made in 1987, when the financial package for the smelter was changed. Before that, the government held 25 per cent of the equity, and Nippon Asahan 75 per cent³.

13. Like almost all aluminium smelters built during the 1980s, the smelter is of the prebaked anode type, which has advantages both from the point of view of production economy, in particular energy efficiency, and environmental impacts, over the older, so called Söderberg technology. It was built using Japanese technology from Sumitomo. The operations consist of the potroom, where the electrolysis of alumina is carried out, a cast-house, where the molten aluminium is poured into ingots, an anode production facility, where petroleum coke and pitch are combined and baked to form the anodes used in the electrolysis, a power transformation plant, and a port capable of taking ships up to 20 000 tons. Outside the operations area itself, and managed by a different company, are the facilities for constructing cathodes of refractory brick and pitch. The spent cathodes are broken up in the same facilities.

14. The smelter is supplied with electric power from the company's own two hydro power stations, which are located on the Asahan River, close to Lake Toba, about 100 kilometers from the smelter. The power stations have not been able to deliver the planned amount of power since they started operations, due to the unstable water level in the lake. While annual rainfall is sufficient, runoff from the mountains surrounding the lake varies more than expected. It is believed that the larger than expected variations in runoff result from large scale logging having taken place on the mountainsides. The company is considering plans to add a third power station, which would yield another 120 Megawatts in addition to the 500 Megawatt nominal capacity of the existing stations. A small amount of electric power, about 10 Megawatts, is transferred to the government network.

15. Alumina is imported mainly from Alcoa of Australia's refineries in Australia, with additional quantities coming from India. 60 per cent of the smelter's production goes to the members of the Nippon Asahan consortium, under an agreement made in December 1988, following negotiations over the division of production⁴. The rest goes to the domestic Indonesian market.

16. Due to the difficulties of reaching full capacity utilization, Inalum has had losses in most years since its establishment. The smelter employs about 2 300 people, of whom most are from the surrounding countryside.

2.3. Economic importance of bauxite/aluminium production

17. Table 1 summarizes production and export data for bauxite and aluminium in Indonesia. Both in absolute terms and as a percentage of total exports, the exports peaked in 1988, when aluminium prices were very high, and exports reached 1.6 per cent of total merchandise exports. Due to lower aluminium prices and the rapid growth

in overall Indonesian exports, the share of total exports has since fallen to around 0.5 per cent. Thus, although significant, bauxite/aluminium exports do not constitute a major share of Indonesian export earnings. The industry's contribution to GDP, government income and employment is lower, in particular given the capital intensive nature of the production.

Table 1 Bauxite and aluminium production and exports

Year	Bauxite		Aluminium	
	Production (thousand tons)	Exports (million US dollars)	Production (thousand tons)	Exports (million US dollars)
1981	1203.0	12.4	-	-
1982	704.0	11.1	32.5	21.3
1983	778.0	11.8	114.8	128.8
1984	1003.0	12.8	199.0	204.4
1985	831.0	9.0	216.8	259.3
1986	650.0	6.7	218.8	194.2
1987	635.0	7.3	201.4	237.9
1988	518.0	5.6	185.1	302.1
1989	862.0	10.8	196.9	290.8
1990	1206.0	11.3	192.1	202.8
1991	1406.0	14.9	173.1	161.6
1992	1350.0	14.4	180.0	155.7
1993	1350.0	13.2	180.0	143.1

Source: UNCTAD: Commodity Yearbook (1981-91), estimates by UNCTAD secretariat (1992-93)

III. EFFECTS ON THE ENVIRONMENT OF PRODUCING AND PROCESSING BAUXITE AND ALUMINIUM¹

1. Bauxite production

18. The potential environmental impacts associated with bauxite mining may be categorized into those impacting on the physical and natural environment and those having a socio-economic impact. The former are concerned mainly with air and water pollution, noise, solid waste, land disturbance, changes in natural ecosystems and aesthetic aspects such as visual disamenity and other nuisance. Air pollution problems are relatively insignificant in bauxite mining, and relate mainly to dust. Problems regarding water pollution and solid waste are also less serious than in base metal mining in general, since the process water is not acidic and since the tailings do not contain toxic elements. If released in water courses, the tailings are however detrimental to marine life, since they cover sea and river bottoms and contain no nutrient elements. Since bauxite deposits are often shallow and cover a large surface, mining often occupies a large area and results in significant changes to ecosystems. On the other hand, mined out areas are relatively easy to restore.

19. Socio-economic impacts are concerned mainly with the whole range of impacts on the human socio-cultural system, as well as on other areas of economic activity. Most importantly, since bauxite mining often uses large areas of land, conflicts with other land uses may occur².

1.1 Impacts on the physical and natural environment

20. Bintan Island, where Aneka Tambang's bauxite mine operations are located, has a tropical climate with high rainfall (about 2000 millimeters per year) distributed relatively evenly over the year with a minimum in February of 89 millimeters and a maximum in December of 212 millimeters. The island has no accessible ground water, and there is a shortage of fresh water. The soil consists of laterites not very well suited for agriculture. The original vegetation has to a large extent been cleared away and replaced by low forest and shrubland. In most places along the coastline, there is a narrow belt of mangroves.

21. The environment management report for the bauxite mine was approved in 1992. An environmental impact assessment for an alumina refinery on the island has also been prepared and approved. A monitoring plan is under preparation. Inspections are carried out by the Department of Mines and Energy every three months.

22. Before mined out areas are revegetated, the ground is first plowed to improve its permeability, since there is a relatively impermeable layer of kaolinite below the bauxite. Revegetation is carried out by digging holes which are filled with topsoil and natural and chemical fertilizer, and planted with trees. Mainly species that are not native to the island are used, in particular acacia magnum. No attempt is made to restore topsoil between the holes dug for trees. The trees grow quickly, and reach a height of about four meters within two years. The visual impact of mining is thus

eliminated very soon after operations have finished in a particular area. While the original ecosystem is not restored, the ecosystem existing before mining was already affected by logging and agriculture. It is expected that ground cover will be restored within ten years after planting.

23. The cost of reclamation is between 2.2 and 2.5 million rupiah per hectare (US dollars 1050 to 1200), meaning that the cost of rehabilitating the land mined in a year is about 40 000 dollars. So far, of the 500 hectares mined, 200 have been rehabilitated. At present, rehabilitation proceeds at a rate slightly higher than that of mining, in order to make possible the rehabilitation of previously mined, non-rehabilitated areas. The reclamation programme has been under-way for several years, but was intensified in 1991, partly as a result of the environmental review process.

24. The bauxite is washed on site using sea water. Tailings are sent to tailings ponds, where the tailings, consisting mainly of soil and fine fractions of bauxite, settle and the water floats back to the sea through the overflow. Since the water is not treated further, and since the fine fractions do not always settle completely, some tailings are released to the sea. There are two tailings ponds in the western part of the island with an area of 29 and 12 (to be expanded to 24) hectares respectively. The final thickness of the tailings is three meters. Revegetation of tailings ponds is done in the same way as for mined out areas, except that the ground is not plown before planting.

25. Dust problems are mainly confined to the mining areas themselves, since the bauxite is wet after washing. Spraying with sea water is carried out when needed in the mining areas. Loading of ships in the port is done using a conveyor with water to minimize dust.

26. No effects on marine life have been identified from the release of water from the washing process or from the mining in shallow water. Considering the fact that rainfall, and consequently runoff, is high, and that the areas where water is released or where mining is carried out are all directly connected with the sea, effects would be expected to be limited to the sea bottom, where material may settle. However, no systematic investigation has been made.

27. In summary, while examples of more ambitious rehabilitation programmes exist in the international bauxite industry, for instance in Western Australia, very significant progress in this regard has been made at Aneka Tambang's operation on Bintan Island. Compared to most bauxite mines, in particular in developing countries, the mine has limited negative impact on the environment.

1.2 Socio-economic impacts

28. Bintan Island has a population of about 50 000 and is densely populated. The closeness to Singapore is obviously of great importance to the local economy, and Bintan Island forms part of the "Growth Triangle" consisting of Singapore, the state of

Johore in Malaysia and Riau province in Indonesia. Local fishing and agriculture depends on the Singaporean market, and tourism, in particular from Singapore, is expanding rapidly. The price of land has increased as a result of plans for establishment of new industries, and there are signs of potential conflicts between mining and other land uses. A planned industrial zone overlaps with one of the mining concessions, and another part of the concession will become a catchment area for water that will be piped to Singapore. The mining company hopes that it will be allowed to mine certain pieces of land before they are taken for other purposes.

29. The company has built a village of 290 houses, housing some of its employees. A primary school, sports facilities and a hospital with 46 beds and three doctors are located in the village.

30. Income levels for mine employees are somewhat higher than the average on the island, where incomes are higher than the national average.

31. In summary, the socio-economic impact of the bauxite mining on Bintan Island has been limited, but conflicts with other land uses are likely to become more important in the future.

2. Aluminium production

32. Among impacts on the natural and physical environment, the main environmental problem in aluminium smelting is air pollution caused by fluorides emitted from the aluminium reduction cell. The fluorides come from the molten cryolite used as a bath for the electrolysis and as a result, the fumes emitted from the electrolytic cell contain gaseous fluorides (mainly hydrogen fluoride) and particulate fluorides. Gaseous fluorides from the recycling of anode butts are also contained in the exhaust gas of the anode baking furnace. Excessive intake of fluoride can cause fluorosis (skeletal disorders) in humans. No such cases have been reported for workers in modern aluminium smelters or for inhabitants around smelters. Farm animals can be affected by fluorosis by ingestion of fluoride in contaminated forage. Vegetation is variably susceptible to fluoride. Some species may be injured at low concentrations. Other, less important emissions to the atmosphere from aluminium smelting include coal tar pitch volatiles from cell cathode relining, carbon, alumina and fluoride dusts arising at various stages of the production process, sulphur dioxide from electrolytic cells when petroleum coke containing sulphur is used for anodes and from anode baking, and nitrogen oxides from anode baking furnaces and cast-house furnaces.

33. Emissions to water of fluorides and suspended solids of alumina and carbon may result from wet scrubbing of fumes from electrolytic cells. Fluorides and cyanide may be leached from spent cell linings if these are stored inadequately.

34. The major solid waste problem relates to spent cell linings, which contain fluorides, sodium and small amounts of carbides, nitrides and cyanides. Skimmings

and drosses from cast-houses can generate dust or, if wetted, gases, including ammonia³.

2.1 Impacts on the physical and natural environment

35. The smelter at Kuala Tanjung is located on flat land on a drained coastal swamp. Sand was pumped from the sea to raise the level of the land by four meters. The climate is tropical with about 1500 millimeters of rainfall per year, most of which falls in the period September to December. The rest of the year is relatively dry. The coast was almost deserted before the smelter was constructed, and is still sparsely populated, with fishing, small scale animal husbandry, gardening and rice farming being the main activities. Farther inland are large palm oil and rubber plantations.

36. As already mentioned, the smelter was constructed using Japanese technology, including environmental control, and a large portion of the staff underwent training in Japan. The master agreement concluded between the Indonesian government and the Nippon Asahan Aluminium consortium sets certain standards as regards emissions, since at the time of construction there was no specific environmental legislation in Indonesia. Emission standards for aluminium smelting have still not been defined by regulation, probably because the Inalum smelter is the only operation of its kind in the country and it is considered to be sufficiently regulated through the master agreement. There are no inspections from government authorities, but the company submits reports on environmental management to the government every three months.

37. A baseline environmental study was carried out before construction started. Continuous monitoring of fluoride levels in air, soil, ground water, surface water, rain water, sea water, vegetation and animals (specially kept for this purpose) is carried out at different distances from the smelter. The monitoring programme has detected no raised levels of fluoride.

38. The smelter uses a dry scrubbing system with bag filters to clean fumes from the electrolysis. Alumina and fluoride are recycled. Gaseous fluoride combines with alumina under pressure in the recyclers to form aluminium fluoride which is returned to the cells. Virtually all particulate fluoride and 97 per cent of the hydrogen fluoride is recovered in the dry scrubbers. The exhaust gases from the anode baking furnace are cleaned using electrostatic precipitation. The used anode butts are broken, and the carbon is separated from alumina and fluorides using a sieve.

39. The smelter operates with self-imposed emission standards that are somewhat more stringent than the ones set in the master agreement. Table 2 shows these standards as well as emissions during the first six months of 1993. Current emission standards for fluoride in aluminium producing countries are generally between 0.5 and 1.25 kilograms per ton aluminium produced⁴. Actual emissions at Inalum are well below the industry average and compare favourably with the emissions achieved in the most recently constructed smelters. Sulphur emissions are below the detectable level, since the sulphur content in the petroleum coke used for anodes is very low.

40. As regards solid waste, spent potliner is put in a ditch lined with clay to ensure impermeability. The company is considering the introduction of a system for treatment of spent potliner. Relining of the pots is carried out by a sub-contractor, and does not form part of Inalum's operations. Dross from the casting-house is skimmed off and sold. The dross is stored under roof. At the port, unloading of alumina is carried out using a suction loader. The alumina is transported to the smelter in closed conveyors to avoid spillage.

Table 2 Fluoride emissions, Inalum smelter

	Gaseous fluoride, kg/ton aluminium		Particles, gram/cubic meter	
	Master agreement	1.2		0.2
Self-imposed standard	1.0		0.16	
Results first six months 1993	1st quarter	2nd quarter	1st quarter	2nd quarter
From reduction process	0.168	0.343	0.001	0.001
From anode baking	0.050	0.070	0.060	0.028
Total	0.218	0.413	0.061	0.029

Source: Inalum

41. Process water is recirculated, and no leaks to the groundwater from the spent potliner have been detected.

42. Workers' health and safety appear to be adequately handled. Employees are given twice yearly medical checkups. The maximum permitted noise level in the potroom is 80 dB. From the absence of visible fumes in the potroom, it can be concluded that collection systems for exhaust gases are adequately operated, thus posing little or no hazard to workers' health.

43. As already mentioned (see chapter II), the smelter has had problems reaching full capacity because of a shortage of power resulting from the uneven water level of Lake Toba. While the variations in the water level may result from leakage through cracks in the lake bed (the region is tectonically active), they are considered more likely to be due to illegal logging on the mountains surrounding the lake which has reduced the buffering capacity of the mountainsides, rainfall being highly variable.

44. In summary, negative impacts on the environment have been successfully minimized at Inalum's smelter, and it would probably be appropriate to rank it among the best internationally in environmental practices.

2.2 Socio-economic impacts

45. The company has built a townsite with 1340 houses 16 kilometers from the smelter. The townsite includes a school, a hospital and sports facilities. Electricity and water are supplied by the company, which also handles sewage. The population of the immediate surrounding region is estimated at between 7000 and 8000.

46. Income levels at Inalum are above the regional average. In addition to the increased income, the establishment of the smelter has resulted in some stimulus to the local economy through increased demand for locally produced food. As far as can be determined, the smelter has not displaced or affected negatively any other economic activities.

47. The company's school and medical facilities are open also to non-employees in the surrounding area. In general, the health of employees is considerably better than that of other inhabitants of the region, as a result of better housing and regular medical checkups. Respiratory diseases are common in the area, due to the low quality of dwellings. Dengue fever is relatively common, although there are no cases among Inalum employees.

IV. DESCRIPTION OF GOVERNMENT POLICIES

1. General economic policies

48. Over the past decade, the Indonesian economy has gone through a major restructuring process. This process, which was made necessary by the fall in oil export revenues, has reduced the dependence on oil exports drastically and has resulted in a rapid diversification of the economy. An important ingredient in the restructuring process has been regulatory reforms, including deregulation of financial markets, of investment decisions and of foreign trade.

49. In the early 1980s, industrial production in Indonesia was held back by a multitude of regulations and procedures. Both foreign and domestic entrepreneurs had to contend with a complex regulatory environment which, together with a protective import regime inhibited competition and flexibility, encouraged rent seeking and slowed down productivity improvements. The main elements of the regulatory framework were a restrictive investment and capacity licensing system, extensive regulations of foreign investment, rigid land and labour laws and regulations. Foreign exchange controls, however, were lifted in 1970/71. Starting in 1985, a number of measures were taken by the government in order to simplify the investment approval process and relax controls. Also during the second half of the 1980s, the government implemented a series of trade deregulation packages. The primary objective of these trade reform measures was to move away from a trade regime based on license protection towards one based on tariffs.

50. The economic reform process is likely to have had significant indirect effects on environmental management. While these are difficult to identify exactly and to quantify, it is likely that the greater freedom accorded to enterprises in matters such as choice of suppliers and location, use of imported technology etc. has been of at least potential benefit to environmental management. On the other hand, the earlier detailed licensing procedure provided ample opportunity for environmental authorities to intervene. The abolition of this procedure means that the environmental authorities have had to institute their own procedures and strengthen their organizational infrastructure.

2. Environmental and mining legislation and institutions

2.1 Legislation

51. Environmental legislation in Indonesia has been significantly strengthened in recent years, partly because of increased awareness of environmental problems among the general Indonesian public, but also as a result of widespread international criticism of environmental practices in the country, in particular as regards exploitation of tropical forests.

52. Article 33 of the 1945 Constitution of the Republic of Indonesia states: "The state shall administer the national resources yielded in the land, water and air and

shall utilize them for the people's welfare; and shall administer the means of production which are vital to and influence the life of a majority of the people."

53. The main enabling law for the constitution's environmental requirement is **Act No. 4 of 1982**. This act serves as a basis for all legislation containing provisions related to aspects of the living environment. Defined under the act are:

- * The right of every individual to have a good and healthy environment and the obligation of every individual to maintain and protect the environment;
- * The "polluter pays" principle;
- * The requirement for analyses of any environmental impact for every planned project that is considered likely to have a significant effect on the environment;
- * The authorization of a system of incentives, disincentives and licensing requirements to promote environmental management; and
- * Compensation for victims of environmental damage and pollution, and restoration of the environment.

54. Existing legislation relies exclusively on administrative enforcement of regulations. The introduction of economic incentives is however being considered and may be introduced in the future. In this connexion, it should be mentioned that environmental control costs are considered to be part of operating costs and are therefore deductible for tax purposes.

55. Detailed regulations of the Act No. 4 of 1982 are contained in **Government Regulation 29 of 1986**. Regulation 29 prescribes an environmental impact assessment process. This is supported by a ministerial decree containing general guidelines for implementation and procedures for the establishment of environmental impact assessment review commissions in sectoral departments and provincial governments responsible for implementing the regulation.

56. The regulatory instrument used depends on the activity proposed. A presentation of environmental information (PIL) is required for less extensive projects. It is intended to explain the project design and its likely environmental consequences and to present plans to remedy any negative environmental impact. For large or complex projects, an environmental impact analysis (AMDAL) is required.

57. Other related regulations of importance to mining and metal industries are:

Government Regulation No. 20 of 1990. Under this law liquid waste can only be discharged into water with the permission of the governor of the affected region; and standards for constituents of effluents can be established by the Minister or, in some cases, the governor concerned.

The **State Minister of Population and Environment No. KEP-03/MENKLH/1991** provides for liquid waste quality standards for activities already in operation.

58. Laws pertaining to conservation of nature and natural resources are embodied in **Act 5 of 1967** - Basic Law on Forestry, and the Nature Protection Ordinance. In addition, a large number of national regulations address pollution control, and extensive regulations concerning air, water and effluent quality and hazardous waste pollution control measures have been issued at the provincial level. The regulations generally use performance rather than process standards, and are based on spatial rather than sectoral considerations. Provincial governments are meant to play a prominent role in the establishment of standards, based on their understanding of the absorption capacity of the areas under their jurisdiction. Obviously, the competence of provincial governments in this respect varies.

59. There are several pieces of legislation that regulate the operations and environmental aspects of various sectors of the Indonesian mining industry.

60. **Law No. 11 of 1967** (Basic Provision on Mining) encourages foreign investment in development of the country's mineral resources by permitting the Ministry of Mines and Energy to enter into "contracts of work" (COW) with foreign companies.

61. Under this law, development of minerals classified as strategic (oil and gas, tin, nickel, radioactive minerals, cobalt and coal) is not permitted except through the state-owned mining companies or the government agencies especially assigned by the Minister of Mines and Energy. The government can however contract foreign companies to develop strategic mineral deposits. Development of vital minerals (gold, silver, lead, zinc, iron, manganese, molybdenum, chromite, tungsten, copper, platinum, diamonds, fluorspar, bauxite, sulphur and various other metallic minerals) and other minerals (such as clay and building materials) may be carried out by the private sector and cooperatives.

62. The COW is a detailed legal document that substitutes for regulations and requirements in many instances. It is approved by the parliament. In general a COW spells out the contractor's right to search and explore for minerals in the contract area, to develop and mine any mineral deposit found in the mining area, to process, refine, store, transport, market sell or dispose of all the product inside and outside of Indonesia. It also spells out the environmental obligations of the contractor. The mandatory feasibility study has to include an environmental impact study into the effects of the operation of the mine on the environment and outline measures the company intends to use to mitigate adverse impact. (See Annex 1 for environmental requirements attached to a typical COW). A COW may only be transferred or assigned with the prior consent of the government. The government does not attempt systematically to screen applicants for COWs with regard to their past environmental performance.

63. Plans for rehabilitation are included in a COW and rehabilitation has to be carried out on a continuing basis. COWs do not, however, contain any provisions regarding the establishment of a rehabilitation fund.

64. All other mining authorizations (ordinary mining licenses) outside of the scope of COWs are covered by mandatory environmental measures based on the following provisions of law:

* **Article 30 of the Mining Law of 1967** states that "After completion of mining for minerals in any mine, the holder of the relevant mining authorization is obliged to restore the land in such condition so as to not to evoke any danger of disease or any other hazards to the people living in the surrounding of the mine". The law does not prescribe any particular procedures to be followed as regards the financing of rehabilitation.

* **Regulation No. 4 of 1974** is on the management of activities and measures to prevent any adverse effects and pollution due to mining activities;

* **Presidential Decree No. 1 of 1976** regulates mining activities with regard to agrarian affairs, forestry, transmigration and public works; and

* **Article 16 of Act No. 4 of 1982** states that "For any plan which could be expected to create an important impact to the environment, an Environmental Impact Analysis (EIA) should be carried out, the implementation of which is guided by Government Regulations."

* **Article 6(1) and (2) of Regulation 29** state that the EIA is a part of the feasibility study and that costs of environmental management are part of the normal project costs.

65. Sanctions against operators that do not conform to the conditions on which approval has been given include fines, prison and suspension of mining permit. So far, conditions laid down have been followed and no actin has had to be taken.

66. The Mining Law of 1967 is in the process of being revised and proposals are being prepared. One of the changes being considered is to integrate environmental provisions in the mining law.

2.2 Institutional Framework

67. Environmental matters were previously under the overall management and coordination of the State Ministry of Population and Environment. As of the VIth Development Plan, beginning in 1993, the Ministry of Environment was established, illustrating the increased importance of environmental matters. Significant responsibilities are, however, widely distributed among a variety of departments and agencies of the government, including the Department of Mines and Energy for non-renewable resources, including offshore mining, energy and electricity.

68. BAPEDAL is a new environmental impact control agency created primarily to ensure enforcement of environmental regulations. It reports directly to the President. The creation of BAPEDAL is one indication of the government's efforts to address inadequacy in the sectoral enforcement of environmental regulations. This agency drafts standards in cooperation with other government agencies and carries out on site inspections. It relies heavily on non-governmental organizations to get reports about breaches of regulations.

69. The Department of Mines and Energy (DME) has authority over mining sector. It has established a Central Commission for Environment and a Technical Commission for Environment to attend to the required presentation of environmental assessment reports. Approval of environmental impact analyses, management and monitoring plans is under the Central Commission for Environment with the assistance of the Technical Commission.

70. Matters related to the downstream processing of mineral products falls under the administration of the Ministry of Industry. Primary smelters are handled by the Directorate General for Metal Based Machinery and Electronics while metal manufacturing and recycling is under the Directorate General of Small Industry.

71. There are no specific procedures for obtaining the views of local communities on proposed activities that could influence the environment, it being assumed that local and provincial government authorities will automatically notify the central authorities of any local objections.

2.3 Environmental impact assessment legislation and practice

72. Article 16 of the Act No. 4 of 1982 states: "Every plan which is considered likely to have a significant impact on the environment must be accompanied with an analysis of environmental impact, carried out according to government regulations".

73. The administrative regulations stipulate that the analysis of environmental impact must indicate precisely the negative and positive impacts of a particular activity so that steps may be prepared as early as possible in order to abate its negative impact and develop its positive impact. The major impacts to be considered are:

1. The total number of people affected;
2. The size of the area affected;
3. The length of time during which the impacts will persist;
4. The intensity of the impact;
5. The number of other environment components affected;
6. The cumulative nature of impact; and
7. Reversible or irreversible impact.

74. A proponent of a mining project, irrespective of the type of mining license, is required to submit several EIA documents, including proposals for rehabilitation and monitoring procedures. Negotiations for Terms of Reference with the proponent is conducted on the basis of the detailed regulations and standards. To ensure unbiased and high quality EIA reports, baseline measurements are carried out by independent consultants paid by the proponent. Local interests are represented by local (provincial and district) governments. Approval of EIAs is discussed in the Central Commission for Environmental Impact Analysis where the Ministry of Environment is represented. Since the implementation of EIA regulations and until the end of June 1993, 141 EIAs on mining projects had been approved. Proponents are required to monitor their own activities and report regularly to the appropriate government agency for review. The

relevant government authorities carry out inspections in response to reports from local governments, public reaction etc. BAPEDAL can however carry out surprise inspections and take samples even in the absence of the operator. The EIA process is summarized in Annex 2.

V. ASSESSMENT OF POLICIES AND ENVIRONMENTAL PRACTICES

75. The bauxite/aluminium industry in Indonesia is too limited in size and too specialized in terms of its environmental effects for a general assessment of policies and environmental practices to be based on conditions in this industry. Results of the present case study will be compared with studies on bauxite, alumina and aluminium production in two other countries (Brazil and Jamaica) in order to evaluate how environmental and other policies affect the environmental performance of the bauxite/alumina/aluminium industry. In this context, significant differences between countries if any will also be identified. Some limited conclusions can however be attempted already on the basis of the present study.

76. Environmental policies as established by legislation appear to have had very limited effect on aluminium production in Indonesia. The only aluminium smelter was designed and started at a time when detailed environmental legislation was largely non-existent in the country, technologies and environmental targets were transposed from experience in another country (Japan), and subsequent regulatory changes have had no discernible effect on environmental management practices. The main reason for the absence of any effect of regulatory changes is of course that the operation satisfies any requirements that could reasonably be formulated by the responsible authorities. Had the practices been less in line with good industry standards, regulatory changes might or might not have led to improvements. The changes that have occurred in the composition of the ownership of the smelter, with the Indonesian government acquiring a larger share, have not, as far as can be determined, affected environmental performance or management. Neither have the dramatic downturn in aluminium prices over the past few years, which must have resulted in significant changes in profitability, or the failure of the smelter to achieve a 100 per cent operating rate.

77. It is interesting to note that the failure of the smelter to reach full capacity utilization appears to be directly attributable to a failure of environmental regulation in another area, that of forestry management. If the forests on the mountain slopes surrounding Lake Toba had not been illegally logged, the water level in the lake might have been more stable and it might have been possible to utilize the full generating capacity of the power stations. The problem illustrates the difficulty of ensuring compliance with environmental regulations in Indonesia. It also provides a demonstration of the direct economic effects of non-compliance - in addition to the loss of environmental values, which in the case of Lake Toba, which is a natural reserve, are considerable.

78. Bauxite mining appears to have been more directly affected by the process of strengthening of environmental requirements and regulations. Although rehabilitation of mined out areas had been initiated before regulations were strengthened and before

the environment management plan was reviewed and approved, it is probably significant that rehabilitation was speeded up and procedures improved following the approval of the plan. Evidence of the improvement in procedures is seen from the considerably better results achieved in areas that have been replanted in recent years compared to those that were replanted in the 1980s.

79. Compared to conditions in other industry sectors in Indonesia, environmental practices in the bauxite/aluminium industry, and indeed, in mining and metals production in general, appear not to pose any major problems, and government monitoring and enforcement of environmental regulations are judged to be effective in this industry. This does not mean that environmental problems are completely absent, or that they will not materialize in the future. Government officials responsible for monitoring and enforcement agree that neither financial nor human resources would be sufficient at present to ensure by themselves a good environmental performance. The Department of Mines and Energy has requested that half of the central government's share of royalty and land rent income (20 per cent of the total, with the rest going to provincial governments) be earmarked for monitoring and enforcement costs.

80. The relative absence of environmental problems in this industry in Indonesia may be attributed to its dominance by large foreign enterprises which are applying technologies and management systems developed in their home countries, where stringent regulations have been in force for a longer time. The Inalum smelter is an example of this. As the availability of private domestic investment capital improves, it may be expected that more domestic companies will enter into mining. Unless the access of these companies to appropriate technology is assured and the regulatory infrastructure is strengthened, this process may lead to mining and metallurgy becoming a more important source of environmental problems. This is already seen from the large problems arising from mining of non-metallic minerals, because the provincial governments, who are responsible for monitoring and enforcement of regulations concerning exploitation of these minerals, lack the necessary expertise and resources to be effective.

81. A general problem with the present environmental regulation process appears to be that it is oriented towards fulfilling legal and formal requirements - which it does very well - while it often lacks clarity on substantive matters. The substantive and technical requirements are thus often stated in very general terms and leave a great deal to the discretion of regulators. There have, however, also been examples of the opposite approach, where regulations have been set out in unnecessary detail. In both cases, the difficulty of finding the right level of detail appears to reflect that the system has been in force only for a relatively short period of time and that experience of its functioning is still being acquired.

82. As mentioned in chapter IV above, the present environmental legislation is based on administrative enforcement, but the introduction of economic instruments is being considered. The scope for such instruments in the mining and metals industry is however likely to be limited, given the heterogeneous nature of the industry and the small number of operations, which would seem to rule out market based instruments.

As regards rehabilitation, however, the use of economic incentives, specifically the mandatory establishment of rehabilitation funds, may be possible and would be likely to result in some improvement of the present situation.

ANNEXES

Annex 1**ENVIRONMENTAL REQUIREMENT ATTACHED TO A TYPICAL CONTRACT OF WORK**

* The company shall include in the feasibility study of each mining operation an environmental impact study to analyse the potential impact of its operations on land, water, air, biological resources and human settlements. The environmental study will also outline measures that the company intends to use to mitigate adverse impact.

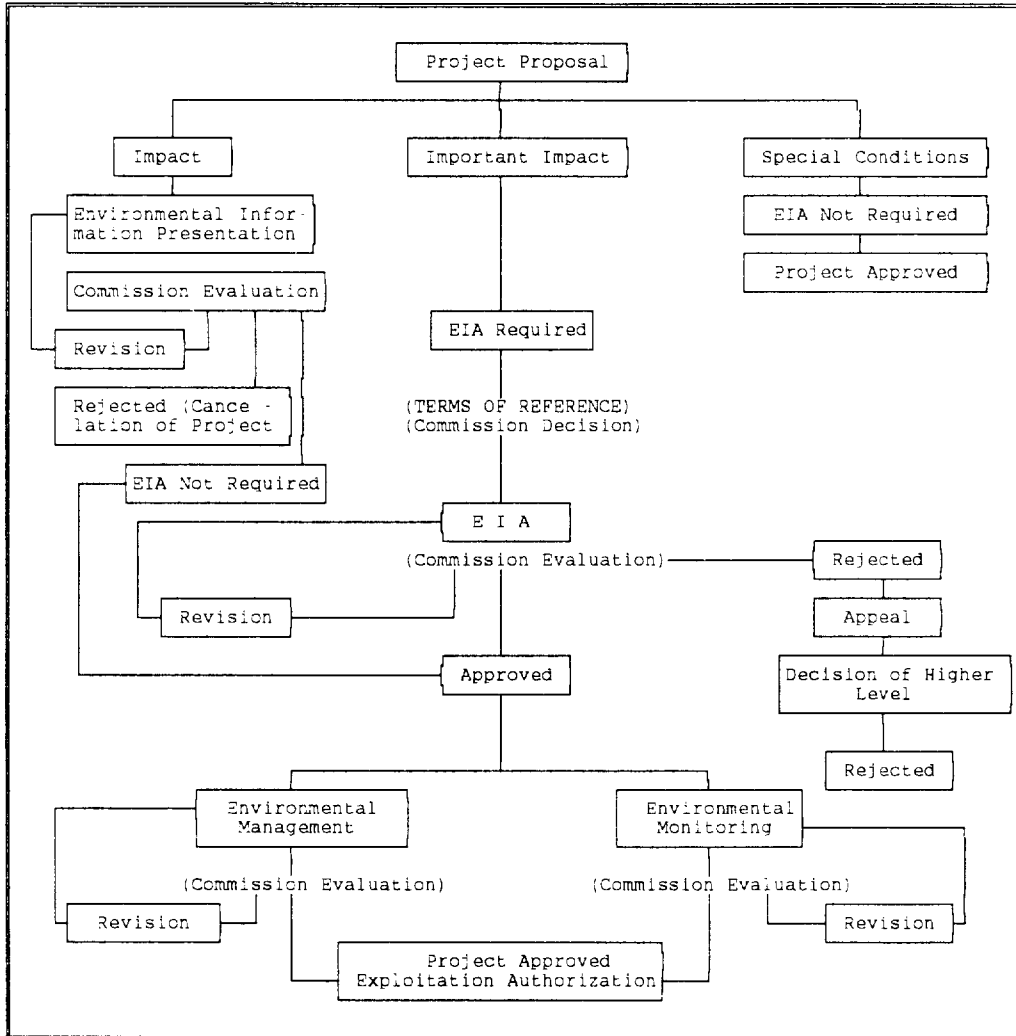
* The company shall, in accordance with the prevailing environmental and natural preservation laws and regulations of Indonesia, conduct its operations so as to control waste or loss of natural resources, to protect natural resources against unnecessary damage and to prevent pollution and contamination of the environment, and in general to maintain the health and safety of its employees and the local community. The company shall be responsible for reasonable preservation of the natural environment within which the company operates and especially for taking no actions that may unnecessarily and unreasonably block or limit the further development of the resources of the area.

* The company must operate in such a manner as to minimize harm to the environment and shall use recognized modern mining industry practices to protect natural resources against unnecessary damage, to minimize pollution and harmful emissions into the environment in its operations and to dispose of waste materials in a manner consistent with good waste disposal practices.

Under the Terms of a typical COW, the Minister may take exception to the contractor's plans and designs and withhold approval if their implementation would "disproportionately" and "unreasonably" damage the surrounding environment, limit its further development potential or significantly disrupt the sociopolitical stability in the area. The COW provides that the Minister shall not unreasonably withhold such approval. An arbitration clause of general application is a part of most COW's and could be invoked should the contractor and the Minister not be able to resolve their differences.

Annex 2

APPROVAL PROCESS FOR AN ENVIRONMENTAL IMPACT ANALYSIS



Annex 3

List of persons interviewed, 23 August to 4 September, 1993

Department of Trade

Mr. Bakir Hasan, Secretary-General

Mr. Taufiek Abbas, Secretary of Directorate General for Foreign Trade

Mr. Hans-Joachim Glasmeier, Team Leader, Indonesian-German Government Cooperation, Advisory Assistance to the Ministry of Trade

Department of Mines and Energy

Mr. Ridwan Mahmud, Environment Advisor to the Minister

Mr Kosim Gandataruna, Director General of Mines

Dr. Thamrin Sihite, Head, Division of Environmental Management and Spatial Zoning

Department of Environment

Dr. R.E. Soeriaatmadja, Assistant Minister of State

Department of Industry

Mr. Achmad Mahsyus, Inspector, Metals Industry Directorate

BAPEDAL (Environmental Impact Management Agency)

Mr. Harro Salim, Head, Sub-Directorate of Coastal Pollution Control

BKPM (Investment Control Board)

Mr. Asril Noer, Director of Overseas Promotion

P.T. Indonesia Asahan Aluminium

Mr. Motoji Minamiura, President Director

Mr. A. Tarigan Sibero, director, smelting plant

Mr. Syahrani Syukur, General Manager, Production Division, Kuala Tanjung, and colleagues

P.T. Aneka Tambang

Mr. Oloan P. Siahaan, Vice President

Mr. Amsaruddin Rasad, Vice President

Mr. Antonius Soedjarwadi, Director, Environment

Mr. Amran Abdullah, Unit Chief, Kijang, and colleagues

Association of Indonesian Mining Professionals

Mr. Priyo P. Soemarno, General Secretary

Mr. Rachman Wiriosudarmo, consultant

Indonesian Mining Association

Mr. Widartoyo, Executive Secretary

1. Unless otherwise indicated, information in this chapter has been supplied by the companies concerned.

1. Unless otherwise indicated, information in this chapter has been supplied by the companies concerned.
2. International Bauxite Association Quarterly Review: October-December 1986.
3. Metals Week, New York, 22 June 1987.
4. Japan Metal Bulletin, Tokyo, 15 December 1988.
5. Unless otherwise indicated, information in this chapter was provided by the companies concerned.
6. For a more detailed description of potential impacts and guidelines on their abatement, see United Nations Environment Programme: Guidelines for the Environmental Management of Alumina Production. UNEP 1984.
7. For a detailed description of environmental impacts of aluminium smelting and guidelines on environmental management, see United Nations Environment Programme: Guidelines for Environmental Management of Aluminium Smelters. UNEP. 1986.
8. In the United States, EPA standards are 1 kg/ton aluminium (30 day average). In Sweden, the standards are 1 kg/ton for Söderberg cells and 0.5 kg/ton for prebaked anode cells (United Nations Industrial Development Organization: Pollution Prevention and Abatement Guidelines for the Aluminium Industry, Draft, January 1993). In the state of Rio de Janeiro in Brazil, standards are 1.25 kg/ton (Setepla: Case study on aluminium sector in Brazil. Report prepared for UNCTAD, September 1993, to be published).