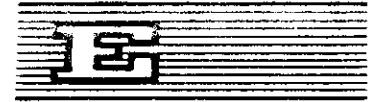




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**ENVIRONMENTAL ASPECTS OF THE DEVELOPMENT OF MINING  
AND MINERAL PROCESSING INDUSTRIES IN AFRICA**

	<u>Paragraphs</u>	<u>Pages</u>
I. INTRODUCTION	1-9	1-2
II. MINERAL EXPLORATION AND THE ENVIRONMENT	10-16	2-3
Changes in the physical environment		
Human environment		
III. MINERAL EXTRACTION AND THE ENVIRONMENT	17-33	4-6
Modifications of the physical and chemical characteristics of the environment		
Human and cultural environmental impacts		
IV. MINERAL PROCESSING AND THE ENVIRONMENT	34-45	6-8
Impact on the physical and biological environments		
Mineral processing and the human cultural environment		
V. INTERCOUNTRY ENVIRONMENTAL CONSIDERATIONS	46-49	8
VI. MULTINATIONAL COMPANIES AND ENVIRONMENTAL MANAGEMENT	50-53	8-9
VII. POSSIBLE ACTION TO COPE WITH ENVIRONMENTAL PROBLEMS IN THE DEVELOPMENT OF MINING AND RELATED ACTIVITIES	54-59	9-10
VIII. CONCLUSION	60-61	10-11

ENVIRONMENTAL ASPECTS OF THE DEVELOPMENT OF MINING AND  
MINERAL PROCESSING INDUSTRIES IN AFRICA

I. INTRODUCTION

1. In pursuance of its economic and social objectives for the region as concerns the development of mineral resources, ECA has decided, as one of its medium-term projects during the period 1980-1983, to define a common strategy and guidelines for regional co-operation, (E/CN.14/76, para. 83). This would conform to ECA Resolutions 223(X); 238(XI); 256(XII), para. 1 (a-j) and 261(XII), paras. 1-3, supported by General Assembly resolutions 3016 (XXV.I), paras. 1-6; 3201 (S-VI), para. 4 (e,h,j,p,q,t) and 3202 (S-VI), section I (1), III-IV-V-VII-VIII.

2. The basis of these legislative authorities was a recognition that not enough was known about existing mineral resources and their potential at national, subregional and regional levels, and that there was a need to co-ordinate research and survey programmes at these levels and current trends in development. It was also recognized that the region's mineral resources were being exploited by foreign-based companies and that the countries of the region were not profiting from these activities as they should.

3. Furthermore, all the countries of the ECA region were investing a great deal of national and foreign capital in mineral exploitation and processing. Rightly or wrongly, they regard this approach as the panacea for most, if not all, of their economic ills. This investment effort has drawn them into the cross-currents of international economics and politics and has greatly increased their importance in the international relations network.

4. In this strong bid to exploit their mineral resources and improve their economies so as to reduce dependence on external aid with all its ramifications, little attention, if any, has been paid to the effects of such mining and mineral processing activities on the natural or human environment.

5. The development process, though aimed at improving man's relationship with his environment, has almost always had its negative aspects, even when plans were scrupulously implemented. This is a fact that all countries have to reckon with, particularly in the development of mineral resources, since many by-products of this development affect the human body's metabolism and the equilibrium of the ecosystem. Unfortunately, these environmental considerations are usually taken for granted until they begin to have a serious negative impact on the environment in terms of:

(a) Physical and chemical characteristics of the environment - soil, water, atmosphere and other physical resources;

(b) Biological conditions - flora and fauna, their structure and functions;

(c) Cultural factors - land use, recreation, aesthetic and human interests, cultural status and man-made facilities and activities;

(d) Ecological relationships - salinization of water resources, eutrophication, forest succession, carrying capacity of land, cycles and rhythms.

6. Measures can usually be taken during feasibility studies and during mineral extraction and processing to reduce the environmental impact of these activities to a minimum. Measures can also be taken to render those areas where mineral development and processing activities are taking place more economically sound and aesthetically pleasing than they were before.

7. One major problem in mineral exploitation, development and processing in Africa is the absence of an intra-African code of mineral activities that would impose certain environmental protection obligations as mining begins. Many countries have shared mineral resources, but are hardly aware of the conditions prevailing in the neighbouring country, therefore making it impossible to tackle similar problems in a co-ordinated and thus more economical way. This is because international consortia determine the potential of a mine not according to local economies of scale, but rather according to their international transmineral economies of scale based on the exploitation of more than one mineral. The same seems to be true even when national mining concerns hold shares in local mining enterprises.

8. In the face of this situation, the countries of Africa have no choice but to work together in an effort to establish rules and regulations applicable to the development of mining and mineral processing so that they are deprived of neither the national incomes so derived nor the enjoyment of a healthy and aesthetic environment. A common environmental code regulating mining activities should be agreed upon by all Governments of the region to ensure greater environmental returns from their mineral resources.

9. The intention of this paper is to highlight the environmental implications that the development of mining and mineral processing can have within the ECA region and to provoke discussion and action within the countries concerned. In this way it may be possible to learn from past mistakes made by African countries and by others elsewhere and to maintain a high level of environmental salubrity through preventive rather than curative measures.

## II. MINERAL EXPLORATION AND THE ENVIRONMENT

10. Environmental aspects of mining activities should be considered from the stage of exploration, at which time the monitoring of environmental impacts should also begin, since this early stage may involve pre-mining excavation activities that might affect the physical as well as the human environment.

### Changes in the physical environment

11. In areas where excavation may be necessary during the prospection phase, damage might be caused to the vegetal cover, encouraging soil erosion. If excavation work is done on a large scale, negative changes are likely to occur in the landscape and in land use in the vicinity of the prospection area. At this stage, therefore, precautions must be taken particularly against long-term damage to vegetation and the soil structure, landscape deformation and upsetting those aspects of the physical environment that are essential in maintaining a balance with the human environment.

12. During exploration for some minerals, notably hydrocarbons, it becomes necessary to release into the air amounts of subsurface material that might have a toxic effect on both the physical and human environments by interfering with the atmospheric composition of particulate material. Test waste may sometimes overcast the immediate environment and directly or indirectly influence the area's fauna, its terrestrial and aquatic flora and general ecological relationships. The extent of the potentially pollutive effects of mineral development should be assessed, and measures to limit them should be incorporated in all regulations dealing with mineral exploration activities.

### Human environment

13. At the exploration stage the impact of these activities on the human environment is usually not immediately visible but is incipient, regardless of whether or not the minerals are found in exploitable quantities and mines set up in the longrun. There exists a problem of rising expectations as propaganda is spread to make people support the projects. This might cause unexpected disruption in the social and cultural status of the area as hopes for employment might rise, causing population movements and related problems.

14. Changes might also be initiated in land use patterns to cope with the expected mineral industry. It is usually at this stage that it becomes rewarding to introduce agricultural innovation. However, measures should also be taken to see that land use practices do not worsen soil erosion and other related problems that result from the effects on the physical environment mentioned in paragraph 12 above.

15. Another aspect of the human environment that might be affected at this stage is recreation. A mine might be prospected for on lands which hitherto were used for recreational purposes; the problem of alternative recreational sites might then arise. These are also socio-cultural environmental considerations which should be taken into account even at this initial stage of mineral development.

16. At the exploration stage of mining development, therefore, environmental problems begin to surface, becoming more manifest in the later stages of extraction and processing. Environmental assessment procedures and corporate legislation should be laid down for those firms engaged in mineral prospection, whether they are national or foreign.

### III. MINERAL EXTRACTION AND THE ENVIRONMENT

17. Mineral extraction involves the excavation of valuable mineral materials either from the surface of the earth (open cast) or from the earth's crust. No matter which process is involved, mining implies a modification and more often a destruction of the existing state of the physical as well as the human environment. It is at this stage that the environmental effects and aggregate impact on the environment become most obvious and can be assessed even though they vary from one mineral extraction activity to another.

18. These extraction activities, whether they involve drilling (wells, etc.), surface excavations or subsurface excavations and blastings, leave imprints on a given environment which can easily be observed and measured in terms of the physical and human environments and the general ecological equilibrium.

#### Modification of the physical and chemical characteristics of the environment

19. The problem of landscape modification resulting from landform deformation and the alteration of ground vegetation cover as a result of surface excavation has been evoked above in the context of the effects of mineral exploration. Whereas the effects of exploration activities might be short-lived, depending on whether the explorations are successful or not, they are most likely to be permanent at this extraction stage if the necessary long-term precautions are not taken.

20. Subsurface excavations and tunnelling for minerals might have short- or long-term environmental consequences, depending on the structure and competence (hardness) of the rock being excavated or tunnelled. If the structure of the rock is weak, then small- and even large-scale subsidence may result, causing damage to farmland and/or landscape. Tunnelling and subsurface works may also affect the general structural stability of the area from a geological point of view.

21. Instability in structural dynamics is also likely to cause disruption in the drainage behaviour of a basin where mining activities are under way. This may cause an oligotrophic basin to behave as if it were eutrophic, possibly modifying the course of drainage systems and increasing the rate of sedimentation (eutrophication) which might affect the aquatic ecosystem of the area.

22. The chemical constituents of bodies of water constitute an important characteristic of the environment in a mining area. Minerals that are toxic, potentially toxic or radioactive deserve particular mention. The mining of such minerals may have dangerous environmental effects if the tolerated standards are not observed by both national and foreign mining companies.

23. The environmental problem of water pollution resulting from mining development is heightened when the water basin is shared by many countries. Pollution spreads to areas which not only have nothing to do directly with

the mines but also have no legal or legislative means of redress. This is one of the pressing reasons to establish an intra-African mining environmental code of operation that would take care of such situations.

24. Another area of grave environmental concern is off-shore water pollution often found in petrol and hydrocarbon mining areas. The pollution caused by these mining operations affects the quantity and quality of marine and marine-related fauna and disrupts recreational areas, general aesthetics and the ecosystem of the region. Again, the problems are complicated when the source of pollution cannot be controlled by the region that is affected by it, a problem, for example, in cases of shared waters.

25. Drilling and underground excavations can also affect the water level in an underground reservoir if the mining works out across a water-containing stratum. This causes seepage to a lower stratum and deprives the human population, fauna and flora at the surface of the water they had before. This might result in emigration of both the wildlife and human populations, in the destruction of vegetable and other forms of life and in aridity.

26. In open cast mining the top soil is scraped away and the biological conditions and controls are severely affected, rendering the environmental impact on life forms landscape and land use even more immediate and intense than those referred to in paragraph 25 above.

#### Human and cultural environmental impacts

27. The impact of mining activities on the human and cultural environments is felt primarily in the areas of land use priorities and health concerns, some of which have been alluded to in the preceding paragraphs. It is necessary, however, to indicate a few more here as a matter of emphasis.

28. Only a very limited land area in any country is naturally suitable for agricultural use. Consequently, mining activities in these areas must be carried on cautiously. The major potential on-shore hydrocarbon resources of Africa are located in sedimentary basins which are also the main areas with agricultural potential; the major iron, zinc, copper, tin, bauxite, uranium and some potentially radioactive mineral deposits are located in areas favourable to high cereal production and livestock raising, most of which have not yet been fully developed.

29. Mineral exploitation in these potential agricultural areas not only reduces the surface area which can be used for farming but also has a considerable negative impact on the quality and quantity of agricultural production through erosion and loss of pastures and other natural characteristics that contribute to high agricultural production. In forest areas, marketable wood is destroyed, in most cases without projects and activities for reforestation.

30. Another environmental effect on agriculture is that the local population as well as those farther away will abandon agriculture to work in the mines. This will result in agricultural under-production under the present

technological conditions, higher food demands made on the few remaining farmers and a chain reaction ending in malnutrition and starvation, as well as inflation and all its related problems.

31. Mining activities introduce new and alien cultural patterns into the environment, including the settlement structure. Mining companies usually introduce housing schemes designed to provide for the basic needs of the mine workers without affecting company profits. In doing this, the companies create an urban settlement with all its representative facilities, but lacking any quality. Since habitat and the socio-cultural attributes of a people are closely related, the new way of life and habitation thus introduced brings with it modifications and sometimes radical changes in the socio-cultural environment and modes of subsistence, recreation and aesthetic perception.

32. Environmental health is also an important aspect of mining activities, since the miners are always brought into direct contact with the ores, some of which can be dangerous to the person's health and that of his family. Health problems also arise from the quality of the facilities provided in the mining towns, such as water supply and sewage disposal, both of which can be responsible for serious and debilitating water-related diseases and epidemics. There is also a problem with respect to population movement into these towns and the incidence of those vector-borne diseases that can be related to the movement of affected populations: malaria, schistosomiasis, etc..

33. Paragraphs 17-32 give indications of environmental considerations to be taken into account during the extraction phase of the development of mining and mineral processing in conjunction with Africa's related activities. The environmental implications of this phase are obvious in the modifications of the physical environment which directly or indirectly affect human health, attitudes, tastes, behaviour and even the psychological environment within a given milieu. All these factors can be improved or further harmed during the next phase, that of mineral processing.

#### IV. MINERAL PROCESSING AND THE ENVIRONMENT

34. Some environmental effects of mineral processing are immediate, sometimes dramatically so; however, during this stage most of the effects are slow to appear or be felt. A fair number of these long-term effects tend to be environmentally disastrous if allowed to persist. More often than not, they involve those elements of the physical environment that are essential to man's health.

##### Impact on the physical and biological environments

35. Two areas of the physical and biological environments are important and deserve consideration: water quality and atmospheric pollution.

36. Water pollution can result from mineral processing by the introduction of processed soluble toxic chemicals or particulate suspensions into the

water which can be dangerous to man if consumed beyond a certain number of parts per million. This pollution can destroy or contaminate some aquatic flora and fauna which are sources of vitamins and proteins for man.

37. Examples of causes of water pollution are the refining of petroleum for energy sources and of petroleum-allied products as well as the processing and recycling of phosphates and nitrates near water sources. These activities might result in eutrophication, causing oxygen depletion, increased water turbidity, the growth of toxic algae and the eventual elimination of fish species. Lead and mercury, for instance, can be harmful to man if introduced into a water supply system since they are only very slowly excreted from the body; their accumulation can have dangerous debilitating long-term effects on the risk population. Water may also be contaminated by radioactivity from materials in nuclear and allied plants: uranium, zinc, iron, cobalt, manganese, and chromium plants, to name just a few. All these minerals are found in Africa.

38. The emission of industrial gases from a plant into the atmosphere is not uncommon and usually produces smog, which consists of visible solid pollutants in the air or invisible matter producing visible effects. These gases can be toxic, causing difficulties in breathing or respiratory tract diseases like asthma, lung cancer and emphysema; they include carbon monoxide, nitrogen oxides, sulphur oxides and hydrocarbons.

39. Emissions of industrial gases, as well as emissions produced as a result of domestic energy consumption in the new settlements, are most likely to create or influence microclimatic conditions, thereby creating a micro-ecosystem.

#### Mineral processing and the human/cultural environment

40. The environmental impact of mineral processing industries can be assessed, as in the case of mineral extraction activities, in terms of population movements resulting from the siting of the industry, modifications in agricultural and related land use, environmental health conditions, recreation and the general equilibrium of the ecosystem.

41. When an industry is set up, the site immediately becomes the nucleus of an urban centre as people begin to move there in search of jobs. The rate of growth of the population will depend on the labour demands of the industry and the dynamism of the local population. Under any circumstances, urbanization, with all its implications, will result, and there will be significant modifications in population redistribution and density, cultural patterns and life-styles.

42. This population immediately becomes a disease-risk population if the minerals being processed or their by-products are toxic. The population will be exposed to "factory floor" diseases such as those of the respiratory tract, radiation or chemical poisoning. As mentioned in paragraph 32 above, population migration to these areas may also result in the "migration" of certain diseases like malaria and other social contact diseases, all of which might have short- or long-term effects, sometimes fatal or debilitating, on the population concerned.



43. The industry might also adversely affect the recreational and general aesthetic aspects of an environment; a scenic view could be marred by air pollution and smog, which could affect recreational activities and tourism.

44. The emission of industrial waste and its disposal might affect the general equilibrium of the local ecosystem through eutrophication and consequent brush encroachment through a discharge of waste rich in nitrates and phosphates, etc. and through the probable development of disease-carrying insects.

45. One aspect of the human environment that also deserves consideration here is that of noise and related industrial nuisances. Noise pollution in industry tends to have an effect on the employees' general psycho-neurotic conditions and may be a cause of employee neurosis.

#### V. INTERCOUNTRY ENVIRONMENTAL CONSIDERATIONS

46. All the environmental considerations mentioned so far could easily be evaluated, assessed and managed if they came under the jurisdiction of one national system. Unfortunately, while political boundaries are superficial and artificial demarcations, mineral deposits are subsurface, following rock beddings which very often traverse more than one national boundary. A look at a potential petroleum resources map of Africa indicates that these areas cross through many countries: the North African band extends to the Middle East; the Arabian Gulf deposits run into East Africa; the Chad basin is shared by four countries. There are also iron deposits along the Liberia-Guinea frontier, bauxite along the Ivory Coast-Ghana frontier and many other examples.

47. The environmental problems arising from the development of mining cannot therefore be the concern of one country alone. Should the mineral activities be located in a shared drainage basin, the effects of water pollution are bound to be transnational, requiring a transnational approach to the solution of related problems.

48. The movement of airmasses does not respect national boundaries either; thus air pollution can be a transnational problem, and even countries that have nothing to do with a particular mineral processing industry might find themselves solving environmental problems caused by an industry situated elsewhere, and over which they have no legislative or legal authority.

49. Transnational environmental problems should, therefore, be dealt with through a comprehensive environmental management programme based on much needed co-operation among the countries concerned.

#### VI. MULTINATIONAL COMPANIES AND ENVIRONMENTAL MANAGEMENT

50. Of major concern in mineral resource development in Africa is the fact that African mineral resources are generally exploited by foreign-based companies and exported with little local processing. Mining

legislation does not always serve national interest nor does it take into account the latest technical developments", (E/CN.14/706 p. 82 para. (b)). It is therefore very important to assess the role of foreign, usually multinational, mining companies in environmental management, since it is they who finance these works to make a profit. Even when national mining concerns are established, they are almost always a small part of a foreign-based multinational consortium,

51. In order to discuss and initiate solutions to the environmental problems associated with the development of mining and mineral processing industries in Africa, the problems must be addressed to the multinationals. The present situation would seem to indicate a deliberate attempt on the part of multinational companies to play down those environmental problems which are bound to encroach on their profits. In all cases, the economic return of developing mine is not determined by the interest of the country concerned but by that of the consortium.

52. It was pointed out in paragraphs 46-49 above that many natural resources, particularly minerals, lie across national boundaries and are consequently shared natural resources. It is therefore surprising that there are no common environmental or other rules and regulations concerning the exploitation and management of such minerals. This is true even in cases where the same given mineral consortium operates all over the continent under a multiplicity of names and should therefore be aware of the environmental implications of its activities. It is also surprising that while these foreign-based companies operate and have been operating all over the world and are in a position to co-ordinate activities that will promote environmental protection, only token projects in this direction are usually included in their programmes, and these are seldom carried out.

53. This potential role of multinationals should be given serious thought by the countries of the region.

#### VII. POSSIBLE ACTION TO COPE WITH ENVIRONMENTAL PROBLEMS IN THE DEVELOPMENT OF MINING AND RELATED ACTIVITIES

54. Many of the negative environmental impacts of the development of mining and mineral processing industries in Africa discussed above can be avoided, with others reduced to their barest tolerable minimum, if necessary preventive measures are taken from the outset and during the different stages of the development process. ECA must see to it that, through agreed package short-term evaluation programmes, the prescribed environmental protection measures are observed.

55. At the mineral exploration stage measures must be legislated to safeguard the environment; such legislation should reflect the particular problems of a given environment or country.

56. Guidelines should also be legislated to protect the environment both during and after the extraction phase and should include:

- a) Land alteration measures like soil erosion control, landscaping, mine sealing and waste control;

(b) Resource renewal measures, including reforestation, wildlife protection, restocking and management, fertilizer application and possible introduction of exotic flora and fauna;

(c) General waste emplacement and dumping location for extraction wastes.

57. Mineral processing industries, particularly when the minerals or their by-products are toxic, must take into account the:

(a) Choice of plant site in relation to population concentration, agricultural and related land use practices, as well as other cultural and aesthetic factors;

(b) Waste disposal and/or recycling processes with regard to gaseous waste, solid or particulate waste and liquid effluent discharge controls;

(c) Health of the risk population: industrial health considerations, public health facilities and related standards, and industrial regulations regarding the tolerable presence of toxic mineral pollutants in domestic water and the air.

58. There must be legislation at national and intra-African levels to co-ordinate strategies concerning environmental problems arising from mineral development. At the national level there must be a national environment office (see diagram) under the direct authority of either the President's or Prime Minister's office and thus removed from any inter-departmental or inter-ministerial squabbles. This office would ensure that the projects of and contracts for mining concerns have an explicit environmental protection component. The Ministry of Mines would see to it that the mining consortia observe the environmental regulations, and the environment office could request to audit directly a consortium's activities. Ministries such as health, agriculture and others could be requested by the environment office to ascertain that the environmental conditions of concern to them are safeguarded. These national environment offices or machineries could then co-ordinate their action at the intra-African level.

59. In addition to the machineries mentioned above, each country should establish a standards board which would ensure that tolerable pollution levels are not exceeded. These pollution levels could easily be calculated and coded for each mineral, a practicable task since all countries of Africa have at least one research institution, whose capabilities could easily be strengthened to carry out this work.

#### VIII. CONCLUSION

60. The aim of the preceding paragraphs has not been to discourage the development of mining and mineral processing concerns in Africa, nor has it been to deny the existence of any positive environmental aspects of

these sorely needed economic activities. On the contrary, there are positive aspects, such as the regeneration of mine sites as tourist attractions and for agricultural production, as in the case of fruit growing at the Mokanje bauxite mines in Sierra Leone and grain growing in the reclaimed lands of the tin mining area at Jos in Nigeria. Resettlement problems might also be solved.

61. It is important for African Governments to be aware of the environmental problems of mining and related activities and to take concrete action in:

(a) Establishing control measures and adopting environmental legislation;

(b) Giving ECA the mandate to ensure that all countries concerned with the mining of minerals adhere to agreed rules and regulations through an African commission for the development of mining and mineral processing industries in the region;

(c) Making it obligatory for the multifaceted, multinational foreign-based consortia to co-ordinate the flow of information concerning prevailing conditions in the different areas of the region where they operate.