Lead, Mercury, Cadmium and Arsenic in the Environment
Edited by T. C. Hutchinson and K. M. Meema

CHAPTER 20

Heavy Metal Pollution and the Need for Monitoring: Illustrated for Developing Countries in West Africa

M. A. OLADE

Geology Department,
University of Ibadan,
Ibadan, Nigeria

INTRODUCTION

Most of the countries within the West African sub-region are emergent nations which, for a long time, have been grouped among the Less Developed Countries of the world. Due to the low level of development, these countries have generally considered economic growth, social and educational development and industrialization as key development priorities, while protection of the environment has not been given the same importance.

However, in recent years, a few of these countries, such as Nigeria and Ivory Coast have achieved significant strides in their quest for rapid economic growth through industrialization. Thus, a number of factories, usually sited haphazardly, have developed, and with increased affluence generated by income from the export of natural resources, the problems of urbanization, population explosion and the increased use of automobiles have become very common.

It is well known that environmental pollution is a product of urbanization and technology, and other attendant factors of population density, industrialization and mechanization that serve to provide the necessities of the population. For example, in cities like Lagos (Nigeria) and Abidjan (Ivory Coast), the rural–urban migration activated by the search for increased incomes has resulted in the concentration of large populations in relatively small areas under poor conditions of sanitation. Traffic jams and the legendary 'go-slow' of automobiles are everyday occurrences in these cities.

The impact of pollution in the vicinity of overcrowded cities and from industrial effluents and automobile exhausts has reached a disturbing magnitude and is arousing public awareness. At present, relatively little data are available on the extent of environmental pollution because there are no agencies charged with the routine monitoring and protection of the environment.

This review chapter therefore focuses on the critical issues of heavy metal pollution in rapidly developing nations of West Africa and proposes avenues for effective monitoring.

SOURCES OF HEAVY METAL POLLUTION

The major sources of heavy metal pollution in urban areas of Africa are anthropogenic, while contamination from natural sources predominate in the rural areas. Anthropogenic sources of pollution include those associated with fossil fuel and coal combustion, industrial effluents, solid waste disposal, fertilizers and mining and metal processing. At present, the impact of these pollutants is confined mostly to the urban centres with large populations, high traffic density and consumer-oriented industries. Natural sources of pollution include weathering of mineral deposits, brush burning and windblown dusts.

Among the heavy metals, the most serious effect of pollution is presently associated with lead (Pb) emission.

Air Pollution

In West Africa, the emission of Pb from gasoline combustion by automobiles would account for about 80% of atmospheric pollution in urban areas, the remaining 20% being contributed from industrial point sources, refuse incineration and coal combustion by power plants. There has been a phenomenal growth in the use of automobiles within the last decade as a result of increased affluence. The level of Pb in supergrade gasoline in Nigeria is in the range of 0.7 gm/litre to 0.9 gm/litre which is higher than permissible levels in developed countries, where 0.4–0.5 gm/litre is common.

Preliminary studies show that the Pb emissions in air at ground level in Lagos (Nigeria) are far higher than for cities like London (UK) and New York, but similar to those of Brazil or the Caribbean due to perturbation by roadside traffic. Roadside soils and dust are also getting increasingly contaminated. In Lagos, Pb levels of 800 μg/gm have been obtained for dust in the densely populated areas of the city, while for roadside soils, values are in the range of 70–100 μg/gm. City roads are generally untarred, thus roadsides and adjacent houses are often very dusty. It is very common to find people eating raw fruits and food exposed at dusty roadsides. More-

over, children who play on roadsides and housefronts are often exposed to airborne emitted lead.

Other sources of atmospheric pollution are industrial emissions from fossil fuel combustion, and power plants, usually located within or at the precincts of the urban areas. Incineration of solid wastes is still the major mode of disposal in the urban areas, and this often releases pollutants into the air. Power plants using coal combustion are still common features in the cities.

Disposal of natural gas by flaring is widely practised in Nigeria. The city of Port Harcourt close to the oil-fields is lit brightly at nights by gas being flared in the surrounding areas. No data are available on the extent of metal pollution associated with this wasteful practice.

Water Pollution

The pollution of surface waters is significant, though on a local scale. However, the heavy runoff associated with perennial rainfall may mitigate the impact. Several small and heavy industries involved in activities such as battery and paint manufacturing, petroleum refining, cement and ceramic production, steel production, are now being located haphazardly, mostly near metropolitan centres. No centralized sewage systems exist, and the industrial effluents from the factories are usually discharged untreated into streams, lagoons, open drains and other water bodies. This has resulted in high, although not alarming, levels of lead, cadmium and copper in some localized areas.

Studies of heavy metal contents of surface waters at Ibadan show that levels of Pb may reach 50 μg/litre (Mombeshora *et al.*, 1983). In waters of the Lagos lagoon, Pb levels exceeding 120 μg/litre have been obtained (Olade unpublished data). It is a common practice to dump solid municipal waste into streams traversing urban areas. Because of the natural acidity (pH) of these waters and oxidation, heavy metal contaminants are being released into stream waters.

Although surface water pollution has often been assumed to be a minor problem in developing countries of tropical humid regions, it has become clear that our freshwater resources are limited and care should be taken to protect them. There is an urgent need to conduct environmental impact assessment studies before industries are located, so as to ameliorate environmental pollution from point sources.

Mining and smelting operations associated with base metals are very limited in occurrence. However, around the few lead–zinc and tin–zinc mines in Nigeria, acidic drainage from disused mine shafts and open pits and dumps have contributed to localized metal pollution (Olade, see this volume, Ch. 18).

As a result of the apparent shortage of potable water from municipal

supply, many homes and industries have resorted to sinking wells and boreholes. Many of these sources of groundwater are sited close to domestic sewage tanks and solid waste dumps where they are likely to be contaminated. Water quality tests have shown that groundwaters, particularly those tapped from weathered regolith are acidic, which may promote oxidation and corrosion of steel casings and screens. There is a likelihood that heavy metals are being released into such waters although there is presently very little data available on groundwater quality.

Soil Pollution

The sources of soil pollution are quite similar to those for water pollution. However, in the quest for improved agricultural productivity and the need to rid crops of pests, fertilizers and pesticides are being applied indiscriminately in some countries of the sub-region. For example, Nigeria imported about one billion tons of commercial fertilizers in 1983, of which the heavy metal contents are unknown. It is well known that fertilizers may contain up to 400 ppm Pb which may constitute a major source of soil pollution, although phosphate lead is not often readily available to plants (Nriagu, 1978). Phosphate fertilizers also very often contain cadmium, which can be a contaminant of agricultural land and of crops.

It is not yet a common practice to apply sewage sludges as fertilizers primarily because of the lack of centralized municipal sewage systems. However, municipal composts and farmyard manure are being increasingly applied to croplands on a local scale. Heavy metal contents of municipal composts are similar to those of sewage sludges (up to 5000 ppm Pb) (Nriagu, 1978), and their applications may increase metal contents of farm soils.

An important problem associated with tropical weathering that has considerable implication for the susceptibility of soils to pollution, is the development of acid soils with low buffering capacities. Such soils lack one or more nutrients due to leaching, soil erosion and extractive farming practices. The soil acidity promotes sorption of toxic metals in both plants and soils and involves high levels of soluble aluminum. There is therefore considerable danger in the future if acid rains should develop.

Natural Sources

There are virtually no data available on the contributions of natural sources to environmental pollution. Critical issues include the amount of heavy metals released into the environment during brush burning which is a common feature of extractive farming practices. Also, there are questions of metal release into air and soils from the accumulation of litter in tropical rain forest

regions. As a matter of fact, not much is known about the biogeochemical cycles of heavy metals in tropical ecosystems.

During the harmattan season in West Africa (December–March), several million tons of wind-blown dust from the Sahara are deposited in the coastal areas. Studies are still in progress on the heavy metal contents of the Saharan dust.

HUMAN HEALTH EFFECTS

Developing countries are generally preoccupied with immediate and more pressing problems of providing basic health care to their people, and with the eradication of major diseases amongst the large populations. They are not likely to worry about the health effects of metal pollution. Also, the medical manpower is still grossly inadequate to even maintain basic health services.

Nevertheless, a few minor incidences of metal pollution have occurred and public awareness of the apparent danger of metal poisoning is increasing. There was a recent incidence in Ghana of mercury poisoning from the consumption of dressed seeds preserved for planting but sold for consumption. Galena is widely used in some parts of Nigeria as mascara by women and may constitute a health hazard. Children run the greatest risk of lead poisoning in inner city areas where inhalation and ingestion of metals like Pb and Cd from dust and ashes of household items, such as paints and batteries, are common.

ENVIRONMENTAL MONITORING

Monitoring and systematic gathering of information on heavy metal levels in the environment are essential components of any pollution-control system. The establishment of such a system often presupposes the existence of minimum pollution standards and regulations. Most of the countries within the sub-region do not have such control standards, and environmental impact studies are often not required prior to the establishment of industrial projects.

Although some government agencies in these countries have some experience with monitoring on a limited scale, none have developed a comprehensive monitoring system. This may be attributed to the fact that economic growth and industrialization, without strings attached, are their main priorities of development. Moreover, there are no sufficient technical and manpower resources to maintain effective monitoring and pollution-control.

Despite these limitations, it will be disastrous if the developing countries make the same mistakes as the developed nations by sacrificing the environment at the expense of economic development. Because of the apparent lack

of accurate information on the levels of heavy metals in the environment, it is most likely that pollution from point sources is more serious than documented. It is therefore essential to establish pollution standards and effective monitoring before environmental deterioration sets in.

Considering the fact that governments are the major sources of funding for most activities, the participation of government agencies is essential in the successful execution of any scheme of environmental monitoring. Thus, the first step in any such programme is to establish an agency to carry out these activities. Where the necessary expertise is lacking, assistance could be obtained from international agencies of the United Nations, such as UNEP and FAO, particularly in the establishment of laboratories and training of technical staff.

Research centres in universities and related institutions should also be encouraged to undertake systematic studies on specific problems related to environmental pollution. It is only by the coordination of efforts of government agencies and research-oriented institutions that the limited resources within these countries can be most efficiently utilized.

CONCLUSIONS

As developing countries of West Africa become industrialized and urbanized, heavy metal pollution is likely to reach disturbing levels. These countries should learn from the mistakes of the developed nations and recognize that rapid deterioration of the environment can occur. The critical issues however, are that preparations are not being made towards the protection of the environment.

There is a conspicuous lack of data on the nature and extent of metal pollution either at local or regional levels, particularly to assist in the understanding of metal cycling in the environment. No systematic studies are being carried out to examine the dynamics of tropical ecosystems.

Although most countries in the sub-region recognize the need to combat pollution, environmental controls are either non-existent or inadequate. Most industries discharge effluents into the environment without any prior treatment, and the manufacture of 'pollution-intensive' products are being shifted to the developing countries where strict controls do not exist. Even where controls exist on paper, there are difficulties and inadequate resources to enforce them.

The establishment of comprehensive monitoring systems and information gathering should be given priority by governments of the developing countries in the sub-region with support and encouragement from international agencies.

REFERENCES

Mombeshora, C., Osinbanjo, O., and Ajayi, S. O. (1983). Pollution studies on Nigerian rivers: the onset of lead pollution of surface waters in Ibadan. *Environ. Int.*, **9**, 81–84.

Nriagu, J. O. (1978). Lead in soils, sediments and major rock types. In Nriagu, J. O. (Ed.), *The Biogeochemistry of Lead in the Environment*, pp. 15–72, Elsevier/North-Holland.