INTRODUCTION

Emissions of toxic wastes from automobiles, mining, electrical power stations, heavy industry, large incinerators and from many other local point sources, is a worldwide problem. Protection of the environment is a global responsibility. However, at the Scientific Committee on Problems of the Environment (SCOPE) Workshop on Metal Cycling in the Environment (Toronto, September, 1984), it became clear that data came mainly from industrialized nations. Only limited amounts of information on the heavy metals of concern at the workshop, namely, lead, arsenic, cadmium and mercury, are yet available from the developing world.

There are several reasons for this lack of information. Firstly, in most developing countries, the degree of industrialization, and consequently the volumes of emissions from coal-fired power stations and heavy industry, are generally not at a level which give rise to obvious, widespread damaging effects upon human populations and natural environments. Nevertheless, localized and sometimes severe cases of pollution (e.g. from large cities and from mining and smelting areas) do occur. Secondly, countries of limited resources which have predominantly subsistence economies and which are ravaged by droughts, floods, disease and malnutrition, must consider the amelioration of immediate distress to their people as their first priority. For the present, food requirements, basic education, health care, and communication claim preference over environmental matters. Monitoring of, and protection from, pollution competes for these resources. Thirdly, within
many Third World countries there is a lack of expertise and facilities to undertake the type of analysis and data-base assessment required.

THE PROPOSAL

Clearly the Third World is not yet in a position to participate fully in monitoring programmes. To overcome this I should like to propose the following strategy:

1. A three-tier system for monitoring be established, each tier catering for a particular need and incorporating an appropriate technique for sample collection, preparation and analysis.

2. Special books of techniques be prepared so that a uniformity of methods be established for purposes of international compatibility.

3. International collaboration and financial aid be sought to support this scheme. Such aid is essential for the establishment of functional laboratories, the preparation of appropriate books on methodology, the coordination of programmes of investigation and monitoring, and the training of personnel.

4. An overall coordinating body be established to optimise resources and alleviate wastage.

THE REASONING FOR THE ESTABLISHMENT OF A THREE-TIERED SYSTEM OF MONITORING

The monitoring system would consist of three levels of precision and accuracy.

First Level

Simple techniques sufficient to identify potentially detrimental concentrations of metals in the environment are required. Methods would be relatively cheap with a low degree of precision. Examples of target areas include large cities and industrial areas, and areas down-wind of mines, smelters and coal-fired power stations. The aquatic systems to be monitored would include rivers and lakes supporting major populations and/or industries, sewage outflows, and industrial and mining effluents.

Second Level

This is an intermediate level with a higher degree of precision required for the better understanding of metal cycling. For example, investigations may be needed to distinguish between different species of metals and their
monitoring of heavy metals, or to know more accurately the concentrations of metals for environmental and human health purposes. The use of standard reference material would be introduced at this level.

Third Level

This employs the highest degree of precision and accuracy in the assay of heavy metals. Quality control would be most stringent. Both internal and external standard samples would be included in batch sample analyses. Cross-checking with other laboratories would be a matter of standard practice.

The relatively simple techniques proposed for the First Level would make it particularly suitable for use in undergraduate classes at universities and technical colleges. It would be an appropriate level for adoption initially by government laboratories (local and nation-wide) for their routine monitoring programmes. The advantage of this standard of analysis is threefold, namely, (i) It would educate a larger number of people in concepts of environmental protection and give them some practical knowledge, (ii) it would provide a pool of students with suitable qualifications for further training and, (iii) members of the public would become more familiar with their environment and become more aware of possible sources of pollution. It may also help local or central governments to pinpoint areas requiring more detailed study and populations or environments particularly at risk.

The Second Level would be more appropriate for use in government and university laboratories where fundamental research is carried out. Overall programmes of investigation made up of individual research projects would need to be identified carefully to provide the most suitable facilities.

The results from the Third Level analyses would provide the base-line data for monitoring programmes which could be used with confidence in global assessments. The establishment of environmental protection agencies and suitable laboratories in each country would be required in order to coordinate monitoring within and between regions.

PREPARATION AND DISTRIBUTION OF BOOKS

A basic necessity for the execution of this scheme is the preparation of handbooks of agreed techniques which provide details on methods of sample collection and analysis of heavy metals at each of the three levels. The books should be as comprehensive as possible, be underpinned by the necessary theory, and be distributed free of charge (or at subsidized costs) by international agencies. The organization of air monitoring networks, for example, in developing countries was addressed in a publication of the World Meteorological Organization (WMO, 1977).
INTERNATIONAL FUNDING

This proposal can only become a reality through international collaboration and financial aid. This would support educational and exchange schemes for training personnel, and establish functional laboratories in appropriate countries. The International Council of Scientific Unions (ICSU) and SCOPE, which is a sub-group and through which the current proceedings have evolved, are organizations which clearly should be involved. United Nations bodies (e.g. FAO, UNESCO, UNEP and UNDP) which are responsible for aid programmes to developing countries possess the infrastructure and potential to support training schemes and develop the necessary facilities, while the International Atomic Energy Agency, Vienna (IAEA) and the International Union for the Conservation of Nature (IUCN) are widely experienced in monitoring the environment. Scholarships and Training and Travel Awards from industries and organizations within the developed countries would provide another valuable contribution.

THE COORDINATING BODY

It is essential that an overall coordinating body for these programmes be set up. Such a body would help to optimize resources and alleviate overlap and wastage which all too frequently occurs when funds from a range of independent organizations are involved. They would establish priorities and could liaise with current monitoring centres, such as the Monitoring and Assessment Research Centre in London (MARC), the Institute for Environmental Studies at the University of Toronto, Canada or the Canadian Centre for Inland Waters (CCIW) at Burlington, Ontario, Canada, for a uniformity of procedure worldwide.

CONCLUSION

Specialist training for suitably qualified scientists, and the establishment of laboratories for metal analyses is desperately needed in many developing countries. In the long term, shortages of personnel can be ameliorated through education where projects using relatively simple methods of analysis are introduced into colleges and universities. Steadily, general knowledge would be increased, research would be encouraged and the core of local expertise would be strengthened. A reliable monitoring programme would become established and the public would become more aware of their environment. This offers the hope that some of the misfortunes of pollution perpetuated in the industrialized countries will not be repeated in the Third World.
REFERENCES
