MONITORING OF THE ENVIRONMENT AS A WHOLE

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Summary

This contribution endeavors to give a general appraisal of environmental monitoring trends from a global perspective.

It is necessary to have a global perspective in order to achieve effective monitoring of the environment in its ecological, social, economic, and political dimensions. However, environmental monitoring is not an absolute concept. Therefore, a conceptual framework which will allow each region to know how far it is from attaining the dimensions of environmental monitoring is necessary. The factors that influence global monitoring trends must be analyzed and an index to evaluate these factors must not only be developed, but must be nurtured to maturity.

The most serious constraints to the attainment of effective global monitoring systems are poverty, the lack of political will by individual countries, high rates of illiteracy especially in countries of the southern hemisphere, the existing institutional environment, the need – despite advances toward democratization in Africa, Latin America and the Caribbean – for reform to strengthen the civil society, the absence of

social consensus between the population and its leaders regarding the meaning of global monitoring trends and the controversy surrounding the Kyoto Agreement.

Positive factors in the attainment of effective global monitoring systems include advances in environmental institutions, the knowledge of regional and global ecology, and increased participation of civil society worldwide. Considering the problems in the globalization process, the foreign debt of countries in the southern hemisphere, especially in sub-Saharan Africa, and the large amount of money used for military expenditures, international cooperation is essential and vital now, more than ever.

1. Introduction

1.1. Definition of Environmental Pollution Monitoring

The terms monitoring and assessment are frequently confused and used synonymously. The process of environmental quality assessment is an evaluation of the physical, chemical and biological nature of the environment in relation to its natural quality, human effects and intended uses; Particular attention is given to uses which may affect human health and the health of the natural system itself. Environmental quality assessment includes the use of monitoring to define the condition of the water, to provide the basis for detecting trends and to provide the information enabling the establishment of cause-effect relationships.

Environmental quality monitoring is the collection of information at set locations and at regular intervals in order to provide the data which may be used to define current conditions, establish trends etc.

Due to the complexity of factors determining environmental quality, large variations are found between rivers, lakes, soils, vegetation and the atmosphere on different continents or in different hydro and geoclimatic zones. Similarly, the response to anthropogenic impacts is also highly variable.

1.2. Scope of Environmental Pollution Monitoring

The main reason for the assessment of the quality of the natural environment has been, traditionally, the need to verify whether the observed environmental quality is suitable for intended uses. The use of monitoring has also evolved to determine trends in the quality of the aquatic, terrestrial and atmospheric environment and how they are affected by the release of contaminants, other anthropogenic activities, and/or by waste treatment operations (impact monitoring). More recently, monitoring has been undertaken to estimate nutrient or pollutant fluxes discharged by rivers or groundwaters to lakes, oceans and soils, or across international boundaries. The assessment of background quality of the natural environment is also now widely undertaken as it provides a means of comparison with impact monitoring. It is also used simply to check whether any unexpected change is occurring in otherwise pristine pollutants. However, it should be noted that natural environmental quality is very variable depending on local conditions.

General definitions have been proposed for various types of environmental observations which may be interpreted for the natural environment as follows:

1. Monitoring – Long term, standardized measurement, observation, evaluation and reporting of the environment in order to define status and trends.

2. Survey – A finite duration, intensive program to measure, evaluate and report the quality of the environment for a specific purpose.

3. Surveillance – Continuous, specific measurement, observation and reporting for the purpose of environmental quality management and operational activities

Monitoring, survey and surveillance are all based on data collection, evaluation and reporting. Data are principally collected at given geographical locations in the water, soil, air or vegetation body, often described by the longitude and latitude of the sampling or measurement site (x and y co-ordinates) and further characterized by the depth at which the sample is taken (vertical co-ordinate z). Monitoring data must also be characterized and recorded with regard to the time (t) at which the sample is taken or the *in situ* measurement made. Thus, any physical, chemical or biological variable will be measured as a concentration (C), or number, which is a function of the above parameters: $C= f(x,y,z,t)$.

In rivers, the flux determination and the data interpretation also require the knowledge of water discharge (Q), thus: $C= f(x,y,z,t,Q)$. Monitoring data must, therefore, provide an unequivocal determination of these parameters in order to be used for data interpretation and environmental quality assessments.

2. Objectives and Purpose of Environmental Pollution Monitoring

No monitoring program should be started without critically scrutinizing the real needs for environmental quality information. Since environmental resources are usually put to several competing beneficial uses, the monitoring should reflect the data needs of the various users involved. Consequently, there are two different types of monitoring programs:

Single – objective monitoring which may be set up to address one problem area only. This involves a simple set of variables such as pH, alkalinity, and some cations for acid rain and oil spills on water and soil, nutrients and chlorophyll pigments for eutrophication, various nitrogenous compounds for nitrate pollution, or sodium, calcium, chloride and a few other elements for irrigation.

Multi-objective monitoring which may cover various environmental uses such as drinking water supply, industrial manufacturing, intensive animal husbandry, fisheries or aquatic life, thereby involving a large set of variables. The Commission of the European Communities has a list in excess of 100 micro-pollutants to be considered in drinking water alone.

The implementation of the monitoring program objectives may focus on the spatial distribution of quality (great number of stations), on trends (high frequency of sampling), or on pollutants (in-depth inventories). Full coverage of all three requirements is virtually impossible, or very costly. Consequently, preliminary surveys are necessary in order to determine the necessary focus of an operational program. Table 1 summarizes the existing types of environmental quality monitoring programs in relation to their main objectives.

The process of determining objectives should start with an in-depth investigation of all factors and activities which exert an influence, directly or indirectly, on environmental quality. Inventories have to be prepared on:

- The geographical features of the area: including topography, relief, lithology, pedology geomorphology, hydrology, land-cover/vegetation etc.
- Environmental uses: including large-scale farmlands, tree crop plantations, wildlife sanctuaries/reserves, wastes dump site, dams, canals, water withdrawal for cities and industries, agricultural activities, navigation, recreation, fisheries etc.
- Pollution sources (present and expected) including domestic, industrial and agricultural, as well as their stage of pollution control and waste treatment facilities. The emphasis in a pollution source inventory should be put on environmental uses and their specific water, soil, air, vegetation etc quality requirements, particularly in the future. Economic trends should be predicted for at least five years ahead since monitoring design, implementation and data interpretation takes a long time

In addition to the above investigations, preliminary environmental quality surveys may be undertaken for the following specific purposes:

1. To determine the time and space variability of the quality of the natural environment in order to select sampling stations and frequencies.
2. To determine the key descriptors to be considered
3. To determine the feasibility and cost of a monitoring program.

It cannot be over-emphasized that the benefits of an optimal monitoring operation drawn from careful preliminary planning and investigation by far outweigh the efforts spent during this initial phase. Mistakes and over-sights during this part of the program may lead to costly deficiencies, or overspending during many years of routine monitoring.

	Type of monitoring	**Major focus of environmental quality monitoring**
1.	Multipurpose monitoring	Space and time distribution of environmental quality in general
2.	Trends monitoring	Long term evolution of pollution (concentrations and loads)
3.	Basic survey	Identification and location of major survey problems and their spatial distribution.
4.	Operational surveillance	Environmental quality for specific uses and related water quality descriptors (variables).
5.	Background monitoring	Background levels for studying natural processes used as

		reference point for pollution and impact assessments
6.	Preliminary surveys	Inventory of pollutants and their space and time variability prior to monitoring program design
7.	Emergency surveys	Rapid inventory and analysis of pollutants, rapid situation monitoring following a catastrophic event.
8.	Impact surveys	Sampling limited in time and space, generally focussing on few variables, near pollution sources
9.	Modeling	Intensive environmental quality monitoring and assessment, limited in time and space and choice of variables, for example, eutrophication models or oxygen balance models in water.
10.	Early warning surveillance	At critical environmental use locations such as major drinking water intakes or fisheries, (continuous and sensitive measurements).

Table 1. Objectives and aims of environmental quality monitoring operations

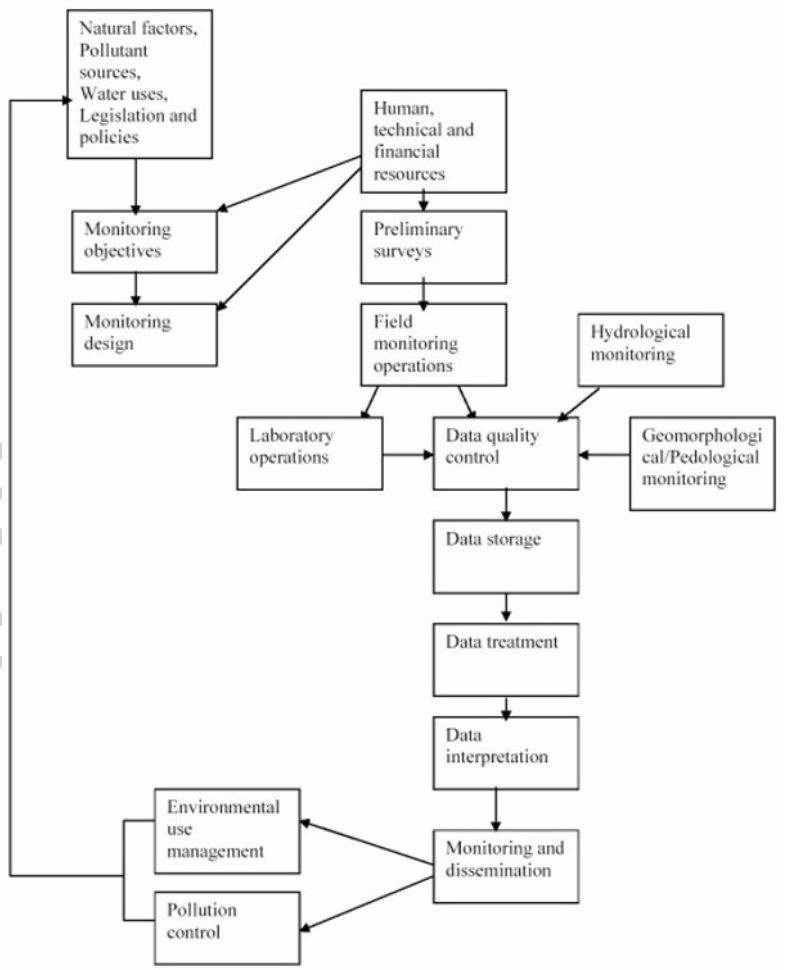

Figure 1. The structure of environmental quality monitoring and assessment operations

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Biographical Sketches

Dr. I.T.Aighewi had his undergraduate education at the Tuskegee Institute, Alabama and his graduate studies at the University of Minnesota, Minneapolis, both in the United States. He obtained his Ph.D. in Soil Chemistry from the University of Minnesota. He is currently an Assistant Professor of Soil Science at the University of Maryland, Easternshore in the United States. He is happily married with three children. He is actively engaged in research in the sub-discipline of Soil Chemistry and environmental pollution.

Dr.E.O. Ekundayo had his undergraduate education at the University of Benin, Benin City, Nigeria. He had his graduate studies at the University of Ibadan, Ibadan, Nigeria and the University of Benin, Benin City, Nigeria where he obtained his Ph.D. in Soil Microbiology at the age of 28 years in Soil Microbiology. He has also been a Post – doctoral research fellow at the Departments of Plant and Soil Sciences and the Departments of Molecular and Cell Biology, both of the University of Aberdeen, Aberdeen, Scotland in the United Kingdom between August, 1996 and July, 1997 where he conducted research on the use of genetic marker systems, DNA sequencing techniques and Polymerase Chain reaction methods to monitor the movement of nitrifying bacteria and petroleum degraders in contaminated soils. He has over 20 research publications to his credit in both international and Nigerian

academic journals of repute. He is currently an Assistant Professor (Senior Lecturer) of Soil Science at the University of Benin, Benin City, Nigeria and his papers are been currently assessed for promotion to Assocaite Profesor of Soil Science of the same university. Dr.E.O. Ekundayo is happily married to Dr. Ifeoma Ekundayo (nee Udoye) and they are blessed with 2 children. He is scheduled to relocate to an institution in Canada before the end of 2005 as a visiting research fellow.