Presidential Address

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Can We Monitor the Environment?

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Environment has become a buzzword in scientific, technical and in journalistic writings. Perhaps in recent times, no other theme has attracted so much attention. Volumes of literature have been produced and continuously churned out. Conferences at various levels have been organized to highlight how quickly we are heading towards "doomsday". Writing skills are tested in describing the deadly situation approaching us. The international gatherings like earth summit either in Rio or in Johannesburg have become a platform for accusations, bargaining, eco-treats and eco-diplomacy. Under a situation where national, regional, local and community interests are being safeguarded, how environment-related issues will get priority? Whether we can monitor the environment? If yes, at what level such exercise should be conducted?

The policies, legislature and compulsions have forced to adopt a national approach towards monitoring of the environment. For certain issues it may be in tune with the global priorities, but at some places it may also go at a tangent. Further, within the national framework, there are a host of institutions directly or indirectly associated with environment-related issues. In fact, such issues go far beyond the purview of the Ministry of Environment and Forests or its specialized agencies. Which are the issues to be monitored? How are they related with each other? Whether in a developing country like situation what are the priorities, i.e. environment vs. development? These questions are intricate. Perhaps there cannot be ready answers to these questions. But at least some attempt must be made to initiate monitoring the environment.

The Environmental Base

There are major physiographic zones in the country. These are (a) Northern Mountains, (b) Great Plains, (c) Central Highlands, (d) Peninsular Plateau, (e) East Coast, (f) West Coast, and (f) Islands. The height varies up to over 6,000 meters above the mean sea level. The climatic conditions and associated phenomena like floods, droughts and the like are dependent on the physiography. Another important feature is the river system and the hydrology which are also dependent on the physical features. The soils in the country are closely linked to the physiography and the drainage. All these factors govern the cropping system in the country. Over centuries different soils have developed, such as black soils, red soils, alluvial soils and the like. They are associated with soil depth and contribute to land capability. But such an arrangement has been disturbed

by pollution of all sorts. Such pollutions are localized at present but have potentialities to spread in order to cover a wider area.

The physical and man-made factors have contributed towards land use. Due to different pressures on land and technology to modify the environment, the changes in the use of land have become phenomenal. Considering different factors, fifteen agro-climatic zones have been identified. Different types of natural vegetations are associated with them. They are (a) tropical evergreen, (b) tropical deciduous, (c) tropical thorn, (d) temperate, (e) sub-tropical, (f) temperate, (g) alpine & sub-alpine, and (h) littoral & swamp. Water resources are additional feature for environmental monitoring. Rivers, ground water, estuaries, lagoons, marshes, lake and swamps contribute to it.

An important but irregular phenomenon is the natural hazard which includes earth quakes, cyclones, droughts, floods and tsunamis. The man-made problems are created due to high population density, higher population growth; both are more prominent in the cities and towns. In some places larger number of livestock also creates environmental problems. In addition, there are several other factors which broadly affect the environment. There are institutions and agencies to monitor the changes. They provide broad environmental scenario of the country.

Sources of Pollution

The above environmental issues are generally static in nature and their impacts are concerning larger area. Nevertheless, the issues which are to be monitored are fast changing and spatially limited but more harmful. They are associated with industries, vehicle, consumption patterns and the like. They affect the health, quality of life, and flora and fauna. The pollutants are from both, metal and non-metal based industries. There are examples of deadly pollutants from steel plants, engineering, electrical, zinc and copper based industries. The non-metallic industries like cement, chemical, fertilizer and oil refineries produce pollutants which are bad for health. Vehicular demography and fuel consumption patterns indicate the character of air pollution, particularly in the cities. Vehicular emission load is measured in terms of (a) particulate matter, (b) sulpher dioxide, (c) Oxides of nitrogen, (d) hydrocarbon and (e) carbon monoxide. These parameters are related to the number of vehicles per km. of road length. Further, fuel consumption pattern of motor spirit, high speed diesel and unleaded petrol is also indicative of air pollution, particularly in bigger cities. It is monitored by Oil Co-ordination Committee of the Ministry of Petroleum and Natural Gas. Water pollution is determined by the volume of wastewater generation, process of treatment and disposal, cost of treatment and generation of organic load.On the basis of the rate of water supply, the class of cities can be classified into following categories: (a) low (<100 lpcd), (b) normal (100-200 lpcd), (c) high (200-300 lpcd) and (d) very high (>300 lpcd). Generation of organic load in different sectors is calculated in kg per day. per 5000 sq. km area. In larger cities like Delhi, Kolkata and Mumbai this is more than 2, 00,000 kg per day. On the other hand, the municipal solid wastes generation can be classified. The average composition of such waste consists of (a) ash, fine ash (58%) (b) compostable (35%), (c) Metals (0.31%) (d) Glass (0.94%) (e) Plastics (1.57%)

(f) Textiles (1%) (g) Leather (0.38%) and (h) Paper (2.80%). CPCB closely monitors municipal solid wastes. Solid wastes also include hospital wastes. Their load varies with the size of the cities, and their management has become a challenge for the municipal administrators. However, the hazardous wastes are not necessarily urban in nature. They include cyanide, metal finishing, bearing wastes of Hg, As, Cd, etc, non-halogenated hydrocarbon, paints, pigments dyes, asbestos, pesticides, herbicides, acid and discarded containers and liners of hazardous and toxic wastes. Nuclear and chemical wastes have different origin. Mining and mineral exploration of coal, petroleum, bauxite or manganese do produce hazardous wastes.

The ambient air quality is understood in terms of SPM and RSPM. There are several methods to measure them. The other factors are AQ assessment and its exceeding factor, SO_2 and $N0_2$. In order to keep track of such parameters, a National Ambient Air Quality Monitoring Programme (NAAQM) has been established. Natural and anthropogenic factors to analyze the extent of non-attainment of air quality have also been mooted.

Similar to air, the surface water quality is also being monitored, particularly of the rivers. Statewise distribution of water quality is being carried out. For this purpose, a water quality index has been worked out. Further, biological assessment of water quality and water quality status is also being monitored. Along the sea, Coastal Water Quality Monitoring Programme has been in operation. Furthermore, identified sources of water pollution have been noted. In case of ground water, its quality, sources of contamination, chemical characteristics and sodium absorption ratio are regularly being monitored.

Monitoring and Control

Under the umbrella of the Ministry of Environment and Forest there are specialized institutions to monitor different aspects of the environment. The Central Pollution Control Board, Botanical Survey of India, Zoological Survey of India, Forest Survey of India and Fisheries Survey of India have been established. There are State Pollution Control Board Offices as well. In addition, specialized Research Institutions are also in action, such as National Environmental Engineering Research Institution and University Departments of Geography, Geology, Environmental Studies, Botany, Zoology and the like. Following environmental parameters are closely monitored.

Since independence the five plans were focused on agriculture, health, family welfare and the like. In the fourth five year plan the problems and issues related to environment got attention. This resulted in the establishment of the National Council of Environmental Planning and Co-operation in 1972 at the Department of Science and Technology. Based on recommendation of the Empowered Committee in 1980, a separate Department of Environment was established which was subsequently upgraded to the Ministry of Environment and Forests in 1985. This became a focal point for planning, promotion and co-ordination of environmental and forestry programmes at the national levels. The associated institutions were the state departments of environment, pollution control board offices at the central and state levels, Botanical, Zoological

and Forestry surveys, National River Conservation Authority (formerly Central Ganga Authority), National Afforestration and Eco-development Board, Indian Council of Forestry Research and Education, Wildlife Institute of India and the like. Some of these institutions have the regional offices located in several parts of the country or the respective state. For example, Botanical Survey of India with its headquarters at Kolkata, has nine circle offices. Similarly, Zoological Survey of India has sixteen regional offices, apart from its headquarters in the same city. The Forest Survey of India has four regional offices with headquarters at Dehra Dun. They bring out State of Forest Report after every two years.

The Environmental Protection Act was enforced in 1986 through the Ministry of Environment and Forests at the central level and the respective Department of Environment at state level. This act confers powers on Central Government with regard to the protection of the environment of the country and taking all necessary measures for protecting quality of environment; co-ordinate action of states, officers and other authorities under this act; planning and execution of a nation-wide programme for prevention, control and abatement of environment pollutants; laying down standards for quality of environment; restriction of areas in which any industries, operations or processes may not be carried out; laying down safeguards for prevention of accidents; laying down procedures and safeguards for handling hazardous substances; issuing directions to any persons, officer or authority including the power to direct closure, prohibition or regulation of any industry, operation or process or stoppage or regulation of supply of electricity, water or any other service etc. Obviously in this act, there was no scope to monitor the environment.

Further, the National Conservation Strategy and Policy Statement on Environment and Development was adopted in 1992 which lays down the strategies and actions for integration of environmental considerations in the development activities of various sectors of the country, thus paving the way for achieving sustainable development. Different ministries, departments, institutions and regulatory bodies were expected to reorient their policies and programmes accordingly (NATMO & CPCB, 2001). The establishment of Central and State Pollution Control Boards was a positive step not only towards the regulatory functions but also to monitor the environment. Technical assistance, guidance, sponsoring investigations, researches, collection, compilation and publication of reports for pollution control were added as their functions and duties. For operational purposes, the CPCB now has zonal offices with well defined jurisdiction as shown in Table 1.

In addition to the central and state pollution control board offices, there are several research institutions having implicit or explicit activities related to different aspects of environment. The most important ones are under the aegis of the Council of Scientific and Industrial Research (CSIR). There are forty-one such institutions looking into their specific areas of activity. Then there are the Indian Institutes of Technology, Department of Ocean Development, Non-governmental Organisations, and universities working on different aspects of environment.

It is quite evident that environmental issues are dealt at several stages: national,

Table 1 **CPCB Setup**

Head/Zonal Office	Jurisdiction
CPCB Headquarters, New Delhi	All over India
Kolkata zonal office	West Bengal, Orissa, Bihar, Sikkim, Jharkhand, Andaman & Nicobar Is.
Shillong zonal office	Meghalaya, Assam, Nagaland, Arunachal Pradesh, Mizoram, Manipur, Tripura, Vadodara zonal office Gujarat, Maharashtra, Dadra & Nagar Havelli, Daman & Diu Bangalore zonal office Andhra Pradesh, Tamil Nadu, Karnataka, Kerala, Goa, Pondicherry, Lakshdweep
Bhopal zonal office	Madhya Pradesh, Rajasthan, Chhattisgarh
Kanpur zonal office	Uttar Pradesh, Uttaranchal, Haryana, Jammu & Kashmir, Himanchal Pradesh, Punjab, Chandigarh

regional and local (Nag et al, 2000). The obvious question arises that with all sort of legislature, administrative infrastructure, and involvement of scientific and other agencies, why the quality of environment is deteriorating? Are we doing enough? What are the gaps? Are we moving in right direction? These questions are complicated but important but intricate. The cost of monitoring the environment itself is a burden on the resources of the country where employment, shelter and food are at priority. Is monitoring of the environment a luxury for a developing country like India?

Possible Course of Action

Perhaps all possible efforts have been made to monitor the environment. Then why the environment is deteriorating in undesirable way? Do the geographers have a role in this direction? Can there be spatial approach to this issue? Fortunately, in collaboration with the Central Pollution Control Board, the National Atlas & Thematic Mapping has prepared the Environmental Atlas of India (NATMO & CPCB, 2000). This publication provides a broad base for the monitoring of the environment. In the way, a series of maps have been prepared on Environmentally Sensitive Zones and Industrial Sites. Land degradation is based on soil erosion, riverbank erosion, shoreline erosion, leaching of topsoil and deforestation. Man-made causes for land degradation are chemical, fertilizers, pesticides, floods and mining. All these factors contribute to the extent of degraded land. Attempts are also being made to find out environmentally sensitive areas. It includes following features:

- Cities with population above 1,000,000
- Altitudinal zones
- Rivers, canals, water bodies,
- Forests : reserved, protected, unclassed
- Scrubland, wasteland, mangrove
- Flood prone areas, wetland, coral reef, spring
- Biosphere reserve, national park, wildlife sanctuary, tiger project
- Heritage sites : natural, cultural, areas with specialized skills

- Beach resort, hill resort, other places of tourist interest
- Archaeological monuments, Pilgrim centres
- Major industry, industrial growth centre, mini industrial estate
- Mining site, critically polluted areas, agricultural research station
- Pollution control offices.

Since the above aspects have combined effect spatially, the impact can only be analyzed through maps. Information collected from diverse sources has to be plotted on a geographic base. CPCB has made efforts at lower levels as well. Zonation Atlases at district level is popular. Geographical Information System (GIS) and remote sensing are also being used for this purpose (Gopalkrishnan & Rao, 1986). The best effort has been to study or assess the combined threat of all the environmental problems. Critically polluted areas or hot spots have been identified. For these areas, ground water, surface water, ambient air quality and solid, including hazardous wastes have been monitored. For example, the causes of pollution in Digboi are as follows

- Water and air pollution from Digboi Oil Refinery
- Discharge of pollutants by the refinery into the nearby Missionpara and Digboi drains
- Air pollution due to fugitive emissions from the refinery
- Other pollution problems including noise from the refinery, specially due to lack of proper improvement in infrastructure and house-keeping
- Water pollution due to non-availability of sewage disposal system.

Similar approach has been taken to assess and monitor Bhadravati, Chembur (Mumbai), Govindgarh, Greater Cochin, Korba, Manali, North Arcot, Pali, Parvanoo, Patancheru-Bollaram, Singrauli, Talcher, Vapi and Visakhapatnam. In future other such places or hot spots are likely to be identified.

Monitoring of Environment in Himalayas

The study of environment is very closely associated with Himalayas. Several contributions from geographers have been made in this direction. Realizing the strategic importance of the fragile Himalayan eco-system and the need to develop spatial methodologies for the conservation of its natural environment, the Department of Science & Technology has mooted a programme on Bio-Geo Database and Ecological Modeling for Himalayas. The objectives of this programme are as follows:

- Development of micro scale resource databases at watershed level along the altitudinal transects of Himalayan ecosystem appropriate for the district level planning.
- Formulation of a database management system and decision support systems using GIS and modeling tools to facilitate preparation of sustainable developmental plans.

- Dissemination of the information/application strategies to the user community through appropriate reports, training programmes etc.

A holistic multi-institutional scientific approach wherein multi-disciplinary research studies with special reference to natural resources and bio-diversity will be taken up in the coordinated manner covering following sectors uniformly for the identified watersheds in the Himalayan eco-systems

- Land (soil and land use)
- Water (surface and ground)
- Biological diversity (plants, agriculture, horticulture and fauna) - Agro and socio-economic aspects
- Data integration and capacity building
- Ecological modeling and analysis.

Currently, this programme has been initiated for the states of Himanchal Pradesh and Uttaranchal. Representative micro-sheds covering lower, middle and higher Himalayan altitudinal transects have been identified. At present, such assessment and monitoring is being carried out in Dabaka in Nainital district, Dhulgarh-Uttar Kosi in Almora district, Pathri Rao in Haridwar district and Fakot in Tehri district.

Conclusion

Environmental monitoring needs spatial bases. It can be analysed in terms of areas, watersheds, cities, and hot spots. Generation of data, its analysis can be linked with it. Application of statistical methods, report generation, preparation of maps and GIS has proved useful in monitoring the environment and finding the combined threat. Actions by departments, institutions, law implementing and regulatory bodies or even noise created by the NGOs are sectorial and partial (Nag & Prasad, 1993). Since the environmental conditions are fast changing, a dynamic system has to be evolved for monitoring the environment. Such systems gain more significance when we try to monitor the Himalayan environment as it has wider implications including the resources which are available there.

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