

# **CHEMISTRY AND THE ENVIRONMENT: SCOPE FOR REGIONAL AND INTERNATIONAL COOPERATION**

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While chemistry, over the years, has made immense contribution to human wellbeing, it also has added to some major world problems such as pollution, global warming, acid rain, deforestation, ozone layer depletion and increased risk of cancer. These are currently subjects of global concern. Such concern, although more evident in more advanced countries, but concrete actions, to combat these problems now, are lacking worldwide and at best are patchy. There is need to develop political awareness to these issues in the less advanced countries. There is also considerable scope for initiating further national, regional and international cooperative action to avert the future risks, as currently predicted, to the world community. Towards this end, an outline ten year regional and global programme, under the Commonwealth auspices, with an initial outlay of US \$ 1 million per annum is suggested to complement other ongoing efforts.

## **INTRODUCTION**

An understanding of the chemical changes in the environment is an area of fundamental importance. This is linked not only to man's quest for knowing how and when life began, but also to ensuring future continuity of life. The chemistry of the environment is therefore both a subject of great fascination and a matter of practical reality.

Since the beginning of time, the chemistry of the environment has been undergoing changes due to evolutionary processes and natural activities. Such changes have been enhanced and altered by human activities. In pursuit of its developmental objectives, human interventions often brought about dramatic changes to the environment encompassing land, water, air and even outer atmosphere. It is now evident that major changes to the environment have taken place over the last hundred years (Ramasami *et al.*, 1988) and most of these changes are in the directions that predict dramatic imbalances in the ecosphere.

To satisfy human desire for knowledge, and to meet demands for new and better products, the chemical sciences are undergoing phenomenal advances. Much of human progress to date, be it in meeting basic needs such as food, fuel, clothing, shelter and potable water or for satisfying comfort and recreational needs, is dependent on advances in chemical sciences.

Nevertheless, there is also a darker side of this bright picture. Developmental activities, including those in chemistry have made adverse contributions in a number of ways. Desertification, deforestation, acid rain, global warming, pollution of land, air and water, increased risk of cancer and other diseases are all part of the negative spin-offs of development. The continuation of life, as we know at present, is now at risk. Therefore, a new perception of development has become imperative. Development must be sound, sustainable and ecologically balanced. Developmental issues and their impacts are long term and global and should be considered as such. Current problems should be tackled on a global basis. There is, therefore, considerable scope for regional and international cooperation on issues such as chemistry and the environment.

The need for such cooperation is urgent. It has to be pursued on a multidisciplinary basis, with appropriate attention to both scientific and policy issues. Considerable political awareness of environmental issues in the West is now evident (Communique, 1989). There is a need to increase similar awareness in developing countries. Time is therefore opportune to strengthen ongoing national, regional and global efforts on chemistry and the environment and to embark on new ones, so that current forecasts of dire future consequences of this planet can be averted.

## ISSUES OF CURRENT CONCERN

Issues of current concern are well known. It is encouraging to see the worldwide awareness on environmental issues. Environmental concerns, more popularly known as "green issue", have achieved political respectability in the West.

A succinct but an eloquent overview of major issues related to Chemistry and the Environment has been presented in the paper by Ramasami *et al.* (1988). The paper provides a good basis for considering specific areas for future cooperative action. Only three concerns, the greenhouse effect, acidity in fresh water and depletion of the ozone layer are briefly mentioned below as illustrations of the potential magnitude of such problems.

### **The greenhouse effect (Global warming)**

The earth is warming up due to carbon dioxide and other greenhouse gases from power stations, vehicle exhausts and other sites where fossil fuel is burnt. Such global warming will melt huge ice sheets in Antarctica. It is estimated that by the

year 2050, as a result of global warming, the sea level may rise by up to 5-7m, although current scientific consensus is more conservative and is in the range of 20 cm to 1.4m. Nearly one third of all human beings live within 60 km of coast line. A rise in the sea level of even half a meter could therefore have profound effects on habitation patterns, causing many people to move and many of the world's most important cities and ports to come under threat of flood. Whatever may be the actual rise, it is certain that large chunks of land will be under water if the potential threat of global warming is not contained and minimized. Although reliable predictions of regional climate do not exist, there is consistent scientific consensus that a significant global climate change will be induced due to man's activities. Another fear of global warming, apart from large scale flooding, is reduction in rainfall in summer, and greater evaporation of water both in winter and in summer. The net effect in Britain, as estimated by the British Institute of Hydrology recently could be a 40% reduction in the amount of water collecting in British reservoirs.

### **Acidity in fresh water**

Atmospheric pollution, apart from global warming also leads to increasing the acidity in fresh water. As reported by the British Government's Acid Water Research Group (HMSO, 1989) in April 1989, Britain should restrict emission of sulfur dioxide to half of what they were in 1984 to improve the acidity of stream water. Reduction of around 30% in discharges of overall atmospheric pollution will hold acidity at present level. Only a reduction of 90% in emissions of sulfur dioxide and nitrogen oxides would neutralize surface water almost completely. The report warns that even with major curbs "the response to any deposition reduction will be delayed by up to several decades and some water may never recover".

### **Depletion of the ozone layer**

Deterioration of the ozone due to the release of, in the main, chloro-fluorocarbons constitutes another major threat to humanity. Life on earth is as much dependent on ozone as on oxygen and water. According to the UNEP (Anon., 1989b) overall ozone levels have not yet dropped, but measurements made during the Antarctic Spring have shown that levels there have fallen by 40% in just a few years creating a "hole" in the ozone veil. The thinning of the ozone layer will let in much more of the Sun's ultraviolet radiation, not only damaging agricultural yields and ocean ecosystems, but giving rise to a large increase in skin cancer and eye disease. About 100,000 people die of skin cancer annually and UNEP calculates that a 3% reduction in ozone would produce another 20,000 cases annually in the US alone.

## **REVIEW OF INTERNATIONAL AND REGIONAL ACTIVITIES**

Although a full review of international and regional activities is beyond the scope of this paper, some mention of such activities is pertinent in the context of this paper.

### **International activities**

In the United Nations system, a number of specialized agencies are involved in work related to environment, most notable amongst these is the United Nations Environment Programme (UNEP) established following the 1972 Stockholm Conference on Human Environment. UNEP undertakes wide ranging activities on environmental issues. During 1979-83 UNEP had a fruitful collaboration with the Commonwealth Science Council on a CSC project on Management of Water Hyacinth with Dr Thyagarajan as its Regional Coordinator and Professor Haider as the National Coordinator for Bangladesh. Both the authors of this paper were closely involved in the formulation and implementation of this project. There were a number of outcomes of this project aimed at exploring various ways of tackling an environmental problem, the fast growing water weed. The findings of the project were reported through a number of CSC publications and through the Proceedings (Thyagarajan, 1984) of the Conference on Management of Water Hyacinth held in Hyderabad in 1983 to mark the termination of this very successful and interesting regional project. In addition to UNEP, there are a number of other UN agencies such as FAO, WHO and WMO with activities related to the environment. Besides, there are a number of international agencies outside the UN system which are concerned with environment. In terms of developing public awareness internationally, Greenpeace movement is unparalleled. In terms of carrying out work of scientific significance, International Council of Scientific Unions (ICSU) and International Union of Pure and Applied Chemistry (IUPAC) deserve mention.

### **ICSU**

The International Council of Scientific Unions (ICSU) has been studying the problem through its various Unions and its international interdisciplinary research programmes such as the International Geophysical Year (1957-58), the International Biological Programme (1964-74), the Upper Mantle Project (1961-70) and for a study of interactions between various parts of the biosphere and geosphere, the Global Change Programme which was launched in 1986 by the 21st ICSU General Assembly. ICSU has initiated special studies such as those on Radioactive Waste Disposal & Disposal of Toxic Wastes and those carried out by the Scientific Committee on Problems of the Environment (SCOPE) on Environmental Consequences of Nuclear War (ENVWAR) and on Toxic Chemicals (CHEMRAWN).

The Global Change Programme or the International Geosphere- Biosphere Programme as it is now called, will, in the words of Sir Kendrew, its President, "will certainly be the most ambitious, the most wide-ranging, and in its impact on our understanding of the future possibilities for mankind, the most important project that ICSU has ever undertaken. Its purpose is to study the progressive changes in the environment of the human species on this Earth, past and future, to identify their causes, natural or man-made; and to make informed predictions of the long term future

and thus of the dangers to our well being and even to our survival; and to investigate ways of minimizing those dangers that may be open to human intervention. From the point of view of fundamental sciences it is the extended study of the dynamics of the whole Earth System—its geology, its oceans, its atmosphere and its climate, and the thin green layer on its surface that we call the biosphere; a scientific enquiry offering immense intellectual challenges and rewards. So the programme will be scientifically exciting as well as immensely significant in charting the future of our species. It will necessarily continue for many years and will require the collection and analysis of huge amounts of data of all kinds using the most sophisticated techniques and the most powerful computers. It will be a major endeavour of the scientific community in every country of the world".

The IGBP is being planned by a Special Committee appointed by the ICSU Executive Board under J J McCarthy as Chairman. A separate presentation on the IGBP is included in the programme of the workshop, so any further details on IGBP will not be given here.

## **IUPAC**

The International Union of Pure and Applied Chemistry (IUPAC) has a number of ongoing and proposed projects on Global Atmospheric Chemistry (Anon., 1989a). These include:

- (i) Glossary of terms on atmospheric chemistry;
- (ii) Inventory of tropospheric sampling networks;
- (iii) Evaluation and recommendation of units for use in atmospheric chemistry;
- (iv) Global climatic changes caused by atmospheric trace gases and depletion of stratospheric ozone;
- (v) Review of analytical methods for the measurement of contaminants in the work place;
- (vi) Evaluation and compilation of Henry's Law constants as related to atmospheric chemistry;
- (vii) Worldwide inventory of emissions; and
- (viii) CHEMRAWN Conference on atmospheric chemistry. The aim is to approach atmospheric chemistry as one coherent system of reactions leading to different aspects such as acid deposition, the oxidant problem, the arctic ozone hole and global climatic change.

On the national level also the UN agencies have been helping some of the vulnerable countries in working out suitable mechanism to tackle environmental problems. For example, a project entitled "Establishment and Initial Operation of Major Accident Hazards Control Systems" was launched in India in December 1986 with total outlay of US \$ 1.64 million with assistance of ILO. The objective of the

project is to strengthen the national system for prevention of occupational accidents in industrial activities involving one or more hazardous substances and processes which have the potential to result in major accidents leading to serious injury inside or outside the industrial installations. The project will help in setting up, with ILO's advice, a Major Hazards Control Advisory Centre in the Central Labour Institute in Bombay. It is hoped that this Centre will then share its experience and facilities with countries of the region who may need it.

### **Regional Activities**

There are various UN agencies which are active on environmental problems in this region. They include ESCAP and SPC.

With the assistance of UNDP, a South Asian regional project on 'Safety and Control of Toxic Chemicals & Pollutants' was launched in 1988 involving UNDP outlay of about one million dollars. Being executed by ILO/SEARO, the project covers Burma, India, Indonesia, Sri Lanka and Thailand. The project aims at developing coordinated national priority programmes for chemical safety and control of environmental health hazards by:

- (i) Supporting national focal point institutions on intersectoral action needed for reviewing the existing legislation and control mechanisms and quality standards and establishing the required regulatory framework as well as developing operational procedures for management including information storage and retrieval systems, environmental monitoring and risk assessment and programme evaluation;
- (ii) Providing training for upgrading the technical planning and managerial skills of the national staff; and
- (iii) Establishing 'Poison Centres' at national level for handling information on anti-dotal treatment of acute toxicity cases and involving health workers at community level in activities related to control of health hazards of pesticides.

To appraise the status of Chemical Safety in the region, promote awareness and identify key priority areas for action, an inter-country workshop was recently organised on 'Chemical Safety in South East Asian Region' which was attended by centres of the region and leading experts from developing countries and IPCS/Geneva.

It is expected that on completion of the project, apart from emergence of a coordinated programme at national level, review of and improvement in the national legislation for chemical safety and environmental hazard control would have been effected and a national system for hazardous chemicals registration and licensing would have been established in the three major participating countries i.e. India, Indonesia & Thailand and a review made on the monitoring, assessment, inspection and enforcement procedure in all the five participating countries.

Strategy for prevention of chemical accidents and emergency measures and procedures to cope with chemical accidents would also be worked out through specific studies in India, Indonesia and Thailand.

## POLITICAL AWARENESS

### The western economies

In the western economies, environment has become an important issue and the topic has gained political respectability and is attracting political support at the highest level. It is, therefore, only natural that the subject was given such prominence in the recent deliberations of the heads of Government or State of seven major industrial nations (the US, Britain, France, West Germany, Canada, Japan and Italy) and the President of the Commission of European Communities (Communique, 1989). They recognized the world-wide awareness of the necessity to preserve the global ecological balance and expressed great concern at the growing pollution of air, lakes, rivers, oceans and seas; acid rain, dangerous substances; and the rapid desertification and deforestation. They felt that decisive action was urgently needed to understand and protect the earth's ecological balance and agreed to work together to achieve the common goals of preserving a healthy and balanced global environment in order to meet shared economic and social objectives and to carry out obligations to future generations. Their deliberations were wide ranging and included the following:

- *Scientific research*—All countries were urged to give further impetus to scientific research on environmental issues, to develop necessary technologies and to make clear evaluations of the economic costs and benefits of environmental policies. The persisting uncertainty on some of these issues should not unduly delay action. In this regard all countries should combine their efforts to improve observation and monitoring on a global scale;
- *Technology development and transfer*—International cooperation needs to be enhanced in the field of technology and technology transfer to reduce pollution or provide alternative solutions;
- *Role of industry*—Industry has a crucial role in preventing pollution at source, in waste minimization, in energy conservation, and in the design and marketing of cost-effective clean technologies;
- *Role of agriculture*—The agricultural sector must contribute to tackling problems such as water pollution, soil erosion and desertification;
- *Environment and development*—Environmental protection is integral to development. Environmental considerations must be taken into account in economic decision-making. For sustainable development, compatibility of economic growth and development with the protection of the environment was a prerequisite.

Intensified efforts for technological breakthrough are important to reconcile economic growth and environmental policies. World Bank and regional development banks were urged to integrate environmental considerations into their activities. International organisations such as the United Nations and OECD were asked to develop analytical techniques/environmental indicators to help governments assess appropriate economical measures to promote the quality of the environment. The 1992 UN Conference on Environment and Development was expected to give additional momentum to the protection of the global environment;

- *Developing countries*—Through use of economic incentives, including aid mechanisms developing countries should be assisted to deal with past damage and to encourage them to take environmentally desirable action. In some cases past debts should be written off in return for environmental action. The financial and technological requirements of developing countries to sustain the growth of their economies and to meet environmental challenges should be recognized;
- *Depletion of ozone layer*—This was alarming and called for prompt action. Production and consumption of chlorofluorocarbons as covered by the Montreal protocol should be terminated as soon as possible and not later than the year 2000. Specific attention should be given to the ozone depleting substances, not covered by the Montreal protocol. Development and use of suitable substances and technologies should be promoted. More emphasis should be given on projects that provide alternatives to chlorofluorocarbons;
- *Environment and climate*—There was a need to limit emissions of carbon dioxide and other greenhouse gases which threaten to induce climate change, endangering the environment and ultimately the economy. The work of the Intergovernmental Panel on Climate Change required support. The world-wide network of observatories for greenhouse gases should be strengthened and the World Meteorological Organization's initiative to establish a global climatological reference network to detect climate change should be supported. An umbrella convention on climate change should be concluded, energy efficiency increased, energy conservation promoted and relevant techniques and technologies developed. Nuclear power plants can limit output of greenhouse gases, provided highest safety standards for plant operation and waste management are ensured for which international cooperation is to be strengthened;
- *Deforestation*—Deforestation damages the atmosphere and must be reversed. To preserve the scale of the world forests suitable forest, management practices should be adopted. Relevant international organizations should complete reports on the state of world forests. Strong support should be given to the FAO's Tropical Forest Action Plan adopted in 1986. Financial and technical cooperation should be given to nations with tropical forests. Temperate forests, lakes and rivers should be protected against effects of acid rain;

- *Marine environment*—Indiscriminate dumping of polluting wastes in oceans was condemned. For sustainable management of the marine environment, international cooperation was needed in preserving it and in conserving the living resources of the sea. Relevant United Nations bodies were asked to prepare a report on the state of the world's oceans. National, regional and global capabilities to contain and alleviate the consequences of maritime oil spills need to be improved. All countries were urged to make better use of the latest monitoring and clean-up technologies and to adhere to and implement fully the international conventions for the prevention of oil pollution of the oceans. International Maritime Organization was requested to put forward proposals for further preventative action;
- *Environmental law*—The Italian Government will host in 1990 a forum on international law for the environment with scholars, scientific experts and officials to consider the need for a digest of existing rules and to give in-depth consideration to the legal aspects of environment at the international level;
- *International institutions*—Existing environment institutions within the UN system should be strengthened. UNEP requires strengthening and increased financial support. Establishment of a new institution within the UN system is worth considering;
- *Flood in Bangladesh*—There was an urgent need for effective, coordinated action by the international community to support Bangladesh to find technically, financially, economically and environmentally sound solutions to the recurring flood problems in Bangladesh; and
- *Desertification*—Political support was given to set up an observatory of the Saharan areas to monitor the development of that fragile region and to protect it more effectively.

### **Awareness in developing countries**

Awareness in developing countries on environmental issues is at best patchy and limited, in the main, to the scientific communities. The overwhelming poverty, progressive worsening of their economic situation and their inability to cope with recurrent natural disasters leave little scope for these countries to develop a long term global perspective on environmental issues. Although, the vast majority of the world population lives in developing countries, in relative terms their contribution to global environmental problems at present is minor. However, as some of these countries make economic progress, become industrialized and achieve a higher standard of living for their population, unless adequate measures are taken, their contribution to the environmental problems will become significant. Their planned economic advancement will therefore be equally at the peril of their future population.

For the future survival of all nations, developed or developing, it is therefore essential that there is close, meaningful and sustained cooperation on a global scale from now, while there is still prospect for containing the problems at their present

level, and give nature a chance to make a recovery however slow and long term it may be.

Developing country participation in international cooperative projects will require scientific, technological and financial input from developed countries. These needed to be forthcoming without protracted futile negotiations as in some other fields which leave developing countries tired, bewildered and withdrawn. Developed countries should also make conscious efforts and enact necessary laws nationally and internationally so that their environmental problems, for example, toxic wastes, are not exported to developing countries taking advantage of their ignorance, innocence or economic vulnerability. In the long term, this is only a useless and self-defeating measure.

Unlike countries in the West, where the population is better educated, and public opinion plays an important and often decisive role in shaping political view point and direction, in developing countries, the vast majority of the population is illiterate and preoccupied with managing a bare existence. They have little or no political influence, nor any collective concern on long term global issues. The scientific community is small, fragmented and unable to make any sustained and meaningful political impact. Political view point is often catalyzed by disasters rather than forecasts based on systematic learned assessments. External pressures particularly by donor countries or agencies are also able to influence political thinking. International collaboration can therefore play a vital role in developing a proper political attitude in developing countries on environmental issues which is important for tackling the environmental problems globally.

## CONCLUSIONS

There is an urgent need and considerable scope for regional and international collaboration on environmental issues vis-a-vis chemistry and the environment. The international climate for initiating such endeavours is right as can be seen from the political support that is evident from the declarations of western governments and the encouragement and support currently received by international environmental agencies.

The foremost requirement for initiating a new regional and/or international activity would be to establish an appropriate framework which should be purposeful, effective and should strengthen and extend ongoing efforts. The Commonwealth Science Council with its successful track record of promoting scientific collaboration involving countries both within and beyond the Commonwealth and its ability to work in harmony with other agencies could provide an ideal framework for such an endeavour. This workshop may therefore wish to recommend to the Commonwealth Science Council to embark on a programme on Chemistry and the Environment. The Council's sponsorship of this workshop illustrates that the subject is among its priority areas. However, for the Council to deliberate on this idea, it will require an outline proposal indicating the scope, participating agencies, and their task allocation, coordination and review mechanisms, funding requirements and duration.

Any such proposal should ideally encompass both policy considerations and scientific issues, for instance:

### **Policy**

This should include:

- (i) Development of legal and administrative framework nationally and internationally; and
- (ii) Development of environmental protection standards for limiting pollution on land, water and air.

### **Scientific Issues**

The inputs should be:

#### *(i) R & D*

- Development of alternatives to chlorofluorocarbons.
- Improvement of energy efficiency, promoting energy conservation, reduction of the use of fossil fuels, development of alternative energy technologies and environmentally sound techniques and technologies.
- Limit toxic emissions. Safe handling, storage, transport and disposal of chemicals and toxic wastes.
- Risk analysis, risk minimization and safe handling and disposal of accidental emissions and spillages.
- Climatic change.
- Development of analytical techniques and methods.

#### *(ii) Information/Data*

- Production of a Newsletter.
- Production of safety literature, films and video (in English and in local language) and their wide distribution.
- Regional data banks on chemical hazards/accidents.
- Global Climatological Reference Network (WMO).
- World-wide network of observatories for greenhouse gases.
- Network for Environmental Technology Transfer.
- Development of Expert Systems on hazard control.

#### *(iii) Training*

- Safe handling, storage, transport and disposal of chemicals and toxic wastes.
- Risk analysis, risk minimization.

- Safe handling and disposal of accidental emissions and spillages.
- Environmental chemistry.
- Development and management of computer based systems.

For political sensitization, workshops involving policy makers and leading scientists would be of immense value as well as brief but well presented literature aimed at politicians so that they not only can understand the issues involved but also know what specific action that can be taken at the political level. Often such literature do not answer the second aspect, thereby creating a sense of awe and helplessness in the minds of the politicians.

The Commonwealth Science Council is well experienced in organizing regional and international workshops, conferences and training courses. It also has a broad mechanism for information dissemination which could be further strengthened to respond to new and specific demands.

A programme of this nature, of necessity, should be flexible and long term and should take into account current national, regional and international activities. The idea of duplication of efforts in this instance should not be regarded as entirely unnecessary. The problem is overwhelming and world response to date is fragmentary at best and concrete action usually postponed beyond the magic year 2000. Such a programme should be well funded and well coordinated. A ten year programme, with 3-5 yearly reviews with annual funding of about a million US dollars made up of local and external contribution would constitute a serious and a meaningful response to the current challenge faced by the global community of which the Commonwealth is an important and integral part. Apart from government departments, universities, research establishments and industries, participation of national, regional and international chemical societies would be of immense value and should actively be sought.

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