IEI Centenary Publication

N V Modak Memorial Lecture

A Compilation of Memorial Lectures
presented in

National Conventions of Environmental Engineers

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Background of
N V Modak Memorial Lecture

N V Modak received his early education in the Government High School and Ferguson College, and then joined the College of Engineering, Poona and received his BE (Civil) from the University of Bombay in 1911. He then served the Bombay Government until 1918, and then proceeded to England on a State Technical Scholarship for special work in municipal and sanitary engineering.

On his return to India, he was appointed as an Executive Engineer in the Indian Service of Railway Engineers and posted to G I P Railway as Sanitary Engineer. Subsequently his services were requisitioned by the BB and CI Railway as a Consulting Engineer to prepare a Sewerage scheme for Dohad Station. From 1930, he was with the Bombay Municipality, first as Deputy City Engineer and then Hydraulic Engineer and in 1934, he was promoted to the responsible position of City Engineer to the Bombay Municipal Corporation.

His activities in the promotion of engineering profession have been very wide and extensive. He had been the Chairman of the Bombay Centre of the Institution of Engineers (India), and the President of the Bombay Engineering Congress. He was a Fellow of the University of Bombay, a member of its Syndicate and Dean of the Faculty of Engineering. He was also a member of the Advisory Committee of the Poona Engineering College and of the Governing Board of the Victoria Jubilee Technical Institute, Bombay, a member of the Institution of Civil Engineers and the Institution of Municipal and Country Engineers, London and a Fellow of the Royal Sanitary Institute of London.

He was elected as President of The Institution of Engineers (India) by the Council for the year 1940-41 and was re-elected for a second term for the year 1941-42. He was the first member to receive such an honour.

In memory of his dedicated service, The Institution of Engineers (India) instituted an Annual Memorial Lecture in his name during the National Convention of Environmental Engineers.

N V Modak Memorial Lecture

presented during **National Conventions** of **Environmental Engineers**

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Environmental Audit vs Environmental Statement

Shri Paritosh C Tyagi

Former Chairman, Central Pollution Control Board, New Delhi

PREAMBLE

I am grateful to the organisers of this Convention of Environmental Engineers for giving me the honour of delivering a lecture in the memory of the greatest of all public health engineers in India, Shri N .V. Modak, and addressing such distinguished professionals as are present here.

Some 35 years ago, I had the good fortune of meeting Shri N. V. Modak and seeing him in action. I vividly remember the stern eyes and compassionate heart. He was impatient and serene at the same time. He could work on earthly details while his mind would be set on a lofty goal. Indeed, it is this specific quality that is needed by persons working in the fields of sanitation and environmental management.

The subject of my lecture today has somewhat similar attributes. Environmental audit needs stern introspection for the good of all. Inspection is not an easy task, but if it is done conscientiously, the results are highly rewarding.

The Memorial Lecture, an annual event is held in the memory of Er. N. V. Modak. Er. Modak shad the unique distinction of being not only the first Indian but the first member of the Institution of Engineers (India) to be elected as President by the Council of the Institution of Engineers (India) for consecutive two terms of 1940-41 and 1941-42. To Environmental Engineers, it is even a matter of greater pride that Er. Modak had a larger part of his career in the Municipal Corporations looking after the Environmental Engineering. Services. Er. Modak was a fallow of the Royal Sanitary Institute of London apart from being a member the Institution of Civil Engineers and the Institution of Municipal and Country Engineers, London. Recognising his Contributions in Environmental Engineering, this annual event is held as part of the National Convention of Environmental Engineers. The 1995 National Convention of Environmental Engineers being held at Roorkee Local Centre of the Institution of Engineers (India) includes a Seminar on Environmental Control Technology — Advances, Law and Awareness to Curb Pseudoism. The subject of my lecture today has somewhat similar attributes. Environmental audit needs stern introspection for the good of all. Inspection is not an easy task, but if it is done conscientiously, the results are highly rewarding.

INTRODUCTION

Many persons have a notion that there is a conflict between productivity and environmental concerns. The fallacy in such a notion lies in the fact that loss of productivity and degradation of environment are often the consequences of same neglect. For mitigating such neglect, a new tool has emerged in the form of environmental audit. In essence, environmental audit is a process of detecting waste of resources and environmental damage that can be avoided in any productive activity. In 1988, the International Chamber of Commerce defined Environmental Audit as "a management tool comprising a systematic, documented, periodic and objective evaluation of how well environmental organisation, management and equipment are performing with the aim of helping to regulate the environment by facilitating management control of environmental practices, and assessing compliance with company policies, which would include meeting regulatory requirements".

Environmental Statement is introduced by the Ministry of Environment and Forests by the notification issued on 13 March 1992 as amended on 22 April 1993. It prescribes that every person carrying on an industry, operation or process requiring consent under the Water (Prevention and Control of Pollution) Act of 1974 or under the Air (Prevention and Control of Pollution) Act of 1981 or both or requiring authorization under the Hazardous Wastes (Management and Handling) Rules of 1989 issued under the Environment (Protection) Act of 1986 shall submit an environmental statement to the concerned State Pollution Control Board for the financial year ending 31 March on or before 30 September every year, beginning 1993.

THE CONCEPT

Enlightened managements have ɛt all times followed the concept of environmental audit enshrined in its definition. Environmental audit may thus not be a totally new concept, but it is a brand new practice. The concept relates to a management tool i.e. it is internal.

Environmental statement is a return on prescribed format expected to be submitted to a designated statutory agency by persons engaged in potentially polluting industry, operation or process. Essentially, the concept relates to a compulsion on the management i.e. it is external.

ENVIRONMENTAL AUDIT APPROACH

Concern for environmental protection is a necessity for the poor developing nations because they can not afford to waste resources and incur ecological losses. The practice of environmental audit is a safeguard against such wastage and losses.

A typical optimisation approach characterises the process of environmental audit. The objectives comprise minimisation of waste, reduction in consumption of energy and materials, and improvement in environmental conditions. The same approach and objectives are at the core of environmental impact assessment, environmental statement and environmental management in general. The environmental audit approach is particularly applicable to industrial production. But it is broadly applicable also to most of the development activities including construction, mining and public utilities.

ENVIRONMENTAL STATBMENT

Environmental statement asks for the details that are mostly factual and are intended to help a quick assessment of whether the industry, operation or process discharged pollutants within prescribed standards and whether the same was carried on with adequate attention to avoid wastage of water or raw materials.

It is noteworthy that conservation of energy is not specifically mentioned in the proforma, though it seems to be indirectly included in the consumption of raw materials which would include fuel. It is also noteworthy that it is not prescribed that the environmental audit shall be carried out by an external auditor.

The vast information available in the environmental statements may be regarded by the State Pollution Control Boards as material for a good data-base. The managements fear that the information provided by them in the environmental statement might be used by the State Pollution Control Boards or in a public interest litigation to substantiate offence against the environmental and pollution control laws. Such apprehension works against their willingness to provide correct and complete information, thereby rendering the data-base too vitiated to be of any use.

EVALUATION

The response to the notification on environmental statement has varied from State to State. Overall, less than 5 per cent of the person expected to have submitted environmental statements actually did so. Nearly 30 per cent of the were submitted only in Maharashtra. Whether any meaningful or serious action was taken to persuade or punish the defaulters for improving the compliance in future, is not known.

The initiative of the Union government was laudable even though it may considered as misdirected. Since the government has required submission of annual environmental statements, the environmental audit is seen as an exercise to satisfy the regulatory authorities. The fundamental point is thereby missed that environmental audit is management tool. A carefully planned compaign is now necessary to convince industry of the usefulness of environmental audit in improving productivity.

ENVIRMENTAL AUDIT

The complex nature of various industries and environmental conditions will require industry specific and site-specific considerations for environmental audit. In general, environmental audit encompasses

(a) a verification that environmental regulations and standards are being complied with;

(b) an examination of the manufacturing process So as to minimise pollution, environmental hazards and consumption of raw materials, energy and water;

(c) an identification of the environmental damage, risk and wastes;

(d) an evaluation of loss of resources and products, avoidable costs incurred on consumption of materials and energy, and benefits foregone in ignoring recycling and reuse of wastes: and

(e) an assessment of efficiency of operations, quality control and plans for meeting emergencies.

As an introspection, environmental audit exposes aspects seldom noticed by both the management and the operators. It provides information useful for process modifications, meeting emergencies and establishing credibility before regulatory authorities, insurance companies, employees, creditors and customers. If the management is prepared to use environmental audit as a tool, several useful projects may be identified in the process of audit. Project formulation, however, is not a component of environmental audit.

Those who have to get their accounts audited have looked at audit as a curb on their authority. Similar apprehension shall not be well founded against environmental audit. Environmental audit contains a degree of objectivity, multi-disciplinary inputs and ecological concerns that are not present in accounts audit.

The procedure for audit can be summarised as comprising three phases, viz. the pre-audit, at-site and post-audit phases. The activities in the pre-audit phase cover the nomination of the audit team, setting out of terms of reference and priorities, making all concerned aware of the objectives and scope of environmental audit and preparation of a background note. In the at-site phase, it is ensured that the audit team and local staff interact throughout, a thorough inspection is made in the field, sampling and tests are made as necessary, relevant records are reviewed, various persons are interviewed and tentative findings are discussed with the management. In the post-audit phase, the draft report is circulated for review and comments based on which the final report is prepared, and an action plan including a monitoring plan is evolved.

The audit team has to consist of experts in industrial process, environmental science and environmental engineering. Inputs may additionally be required for specific subjects such as industrial hygiene, occupational health and financial analysis. It is usually of advantage that the production manager of the company is included in the environmental audit team. It is imperative that training for environmental audit is properly planned and implemented in the academic institutions that are equipped to train both in biological and engineering science and technology. Research institutions, likewise, should take up specific aspects to develop methodologies, instruments and expertise to be employed in environmental audit.

Some examples of efforts made by various organizations specifically for dissemination of environmental audit skills may be mentioned here. The Central Pollution Control Board has carried out the training for the staff of the Central and state pollution control boards and published Guidelines for Environmental Audit, certain case studies under the titles shown as Environmental Audit (NOCIL AGROCHEMICALS) and Environmental Auditing in Polluting Industries. The Confederation of Indian Industries and the National Productivity Council have held a large number of orientation and training programmes for various groups including the industrial managers. The National Environmental Engineering Research Institute in collaboration with the British Council organised an Indo-British Workshop on three topics including the environmental audit. The Government of India sponsored several training workshops in selected institutions.

PROFESSION OF ENVIRONMENTAL AUDITOR

The environmental auditor, like any other professional, works for the benefit and satisfaction of his client. Three distinct roles of the environmental auditor emerge on the basic of the corporate objectives of his employer. The role resembles that of an inspector if the environmental auditor is employed by the insurance company or the regulatory body for evaluating compliance with prescribed norms; that of an advocate if he is employed by the management for the satisfaction of the insurance company or the regulatory body; and that of a physician if he is employed by the management solely to improve industrial and environmental performance and to remedy faulty practices.

There is little doubt that environmental audit shall emerge as a profession in a short time. A forum is needed to institutionalise the profession. Government may consider establishment of such an institution or the professionals active in the field should come forward to do so. The earlier this is done, the better it will be.

CONCLUSIONS

Environmental audit is central to sustainable development. It is relevant equally to the developed and developing countries. The environmental audit approach has a definite role in the various developmental activities including industry, mining, construction and public utilities.

Environmental audit is not merely a compliance with the requirement to furnish an annual environmental statement. The importance of environmental audit lies in introspection, self discipline and enlightened self interest.

Special efforts are necessary in India to harmonise the perspectives which the academic institutions, professionals, users of environmental audit (e.g. the industrial managements), the regulatory and governmental agencies, and the public have for environmental audit. Besides the need for harmony, there is an even greater need for co-operation

because the various role players depend on one another in certain respects, and some can significantly influence the others.

Fear or apprehension that environmental audit may serve as a regulatory tool rather than a management tool is not without basis. It will be a good idea to dispel such fear and apprehension from the minds of corporate managements by an appropriate official announcement or by practice.

Municipal Solid Waste Management in India: Integrated Approach for Betterment

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INTRODUCTION

Urbanization is now becoming a global phenomenon, but its ramifications are more pronounced in developing countries. Natural growth of population, reclassifications of habitation and migration trends are important factors contributing to the unmitigated increase in urban population in India. The population of urban India was 285 million as per 2001 census which accounts for 27% of the total population. Global experience shows that when a country's urban population reaches almost 25% of the overall population (as in the case of India) the pace of urbanisation accelerates (Singh 1999). The uncontrolled growth in urban areas has left many Indian cities deficient in infrastructural services such as water supply, sewerage and solid waste management. Various efforts have been made to evolve a strategy for improvement in water supply and sanitation. However, sanitation was limited mostly to disposal of human excreta while solid waste management did not receive adequate attention. The continuing urbanisation due to various factors like demographic and economic changes, industrialisation, increase in density of population as also aerial expansion of urban centres, is exerting immense pressure on the existing municipal waste management services. At the start of this century, it will be appropriate to assess the prevailing situation, estimate the future scenario, identify the problems and develop a strategy for improvement to outline appropriate course of actions.

SITUATION ANALYSIS

Municipal Solid Waste (MSW) Management is a part of public health and sanitation, and is entrusted to the municipal government for execution. Presently the systems are assuming larger importance due to population explosion in municipal areas, legal intervention, emergence of newer technologies and rising public awareness towards cleanliness.

Except in the metropolitan cities, solid waste management is the responsibility of a health officer who is assisted by the engineering department in the transportation work. The activity is mostly labour intensive, and 2-3 workers are provided per 1000 residents served. The municipal agencies spend 5-25% of their budget on solid waste management, which is Rs. 75-250 per capita per year. Normally a city of 1 million population spends around Rs. 10 crores for this activity. Inspite of this expenditure, services are not provided to the desired level.

The quantity of solid waste varies with the size of the population of an urban centre and ranges between 0.2 to 0.5 kg/capita/day. On an average a city, having a population of 1 million has to handle about 250-350 tonnes of solid waste every day. The waste mainly consists of a large organic fraction (30-40%), ash and fine earth (30-40%), paper (3 to 6%), plastic, glass and metals (each less than 1%). Paper is recycled on a priority basis followed by plastic, glass and metals. The carbon to nitrogen ratio ranges between 20 to 30 and the lower calorific value ranges between 800 and 1000 kcal/kg. The community bin system of collection is commonly used and bins of various non-standard designs are provided and are often unsatisfactory.

The waste from the community bins is collected by varied types of transport vehicles ranging from bullock carts to compactors. Municipal agencies use their own vehicles for solid waste transportation. However, in some cities they are hired from private contractors. Manual composting is carried out in smaller urban centres. Although in 1980's mechanical composting plants were set up in 10 cities, presently, only one plant out of them continues to be in operation. Over the years a few more plants have been set up. Incineration has not been successful due to the low calorific value of the solid waste. Waste is disposed of in low-lying areas without taking any precautions and without any operational control. Solid waste workers handle the waste without any protective equipment and are prone to infection.

FUTURE SCENARIO

The urban population of 285 million is concentrated in a few large cities and 32 metropolitan cities are accounting for 35.4% of the urban population that is expected to reach 341 million by 2010 (Census of India, 2001). The waste quantities are estimated to increase from 46 million tonnes in 2001 to 65 million tonnes in 2010.

The waste characteristics are expected to change due to urbanisation, increased commercialisation and standard of living. The present trend indicates that the paper and plastics content will increase while the organic content will decrease. The ash and earth content is also expected to decrease mainly due to an increase in the paved surface. Although the organic content is expected to decrease, the material will still be amenable to biodegradation and the calorific value will continue to be unsuitable for incineration.

In keeping with the present practices and estimates of waste generation around 90% of the generated wastes are landfilled requiring around 1200 ha. of land every year (with an average depth of 3 m). Due to rapid urbanisation, prevailing land use regulations and competing demands for available land, it is desirable that adequate land be earmarked at the planning stage itself for solid waste disposal. The larger quantities of solid waste produced and higher degree of urbanisation will necessitate better managernent involving a higher level of expenditure on manpower and equipment.

SHORTCOMINGS ASSOCIATED WITH THE SYSTEM

Solid waste management systems are existing in most of the urban centres since last few decades. However, these systems have yet to emerge as a well organised practice. Some of the major shortcomings are described as below.

IRREGULAR REMOVAL OF SOLID WASTE FROM THE CITY AREA: Solid waste deposited at various collection points is not removed at regular intervals. Similarly a number of roads and open areas are not swept regularly. Many of the city areas, especially newly expanded areas may not be provided with collection service. This results in the accumulation of solid wastes in the form of heaps in many areas. At times, the accumulated waste is pushed inside the drains and sewer lines thereby blockinq ' them.

SOLID WASTE DISPOSAL: The prevailing method of open dumping is a major source of environmental pollution as presented in Figure 1 (NEERI Report, 2002). Moreover, it has become increasingly difficult to identify new sites for disposal due to public opposition, scarcity and high cost of land.

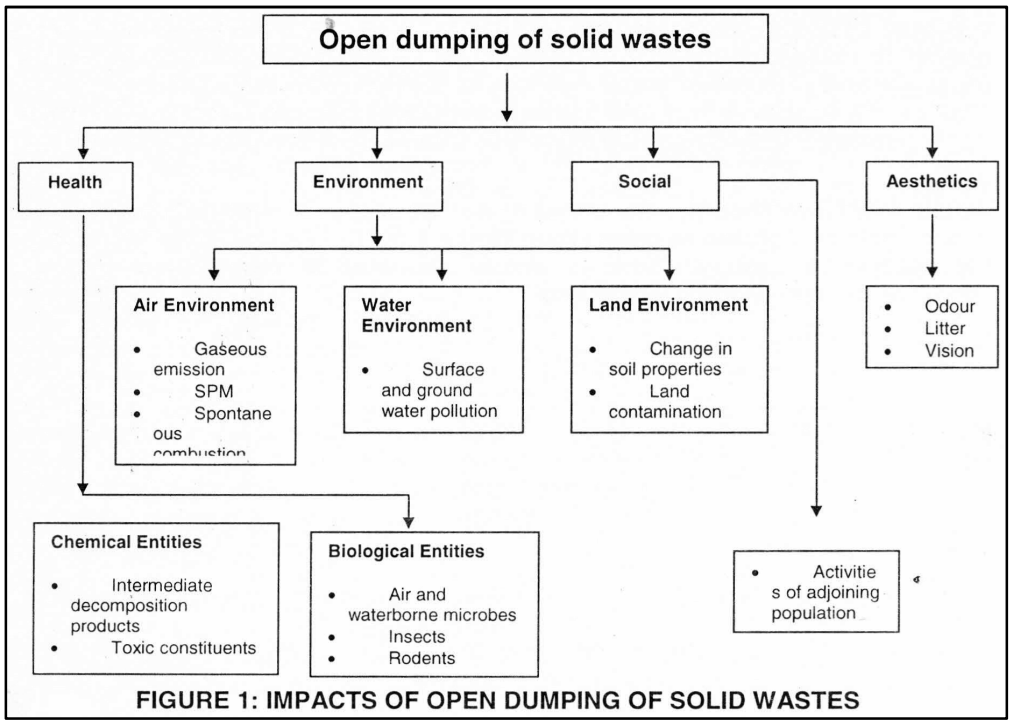

FIGURE 1: IMPACTS OF OPEN DUMPING OF SOLID WASTES

UNDER UTILISATION OF RECYCLING POTENTIAL: A large proportion of MSW consists of degradable organic matter which should be processed to utilise its recycling potential and reduce organic load on landfilling. However, the appropriate material or energy recovery systems are yet to be established in our country.

PROBLEM OF PLASTIC WASTE MATERIAL: Since last few years, plastic materials have become a part of every day life. The plastic wastes, especially used as packaging material, that too thin plastic bags, have become a nuisance in MSW management. Wind blown thin plastics are observed in every nook and corner. These bags are not recyclable and rejected by the waste pickers. Inspite of govt. ban on thin plastic bags, its use is not completely restricted. .

LEGAL PROVISION

In 1996 a PIL (Public Interest Litigation WP 888/96) was filed in the Supreme Court demanding hygienic and ecofriendly waste management in class I cities (having population more than 100,000) and provision of adequate sites for processing and disposal. The committee appointed by the court in 1999 recommended source separation of 'wet' biodegradables and' dry' recyclables with daily doorstep collection of 'wet' waste for composting and 'dry' waste left to the informal sector. The report also addressed a host of administrative, fiscal and legal issues.

Further Ministry of Environment & Forests, Government of India promulgated Municipal Solid Waste (Handling and Management) Rules in Sept. 2000. The salient features of these rules are presented in Table 1. It could be seen that the rules are oriented towards environmental protection and municipal agencies are trying to implement them as per their capability. However, presently its effect is not very conspicuous.

TABLE 1
SALIENT FEATURES OF MUNICIPAL SOLID WASTES (MANAGEMENT AND HANDLING) RULES, 2000

Schedule No.	Schedule Name	Contents
I	Implementation	1. Setting up and monitoring of processing and disposal facilities (By 31.12.2003 or earlier) 2. Improvement of existing landfill site (By 31.12.2001 or earlier) 3. Identification of landfill site for further use (By 31.12.2002 or earlier)
II	Management of municipal solid waste	Regulations related to storage, collection, transportation, processing and disposal which include mainly 1. Segregation of waste at source 2. Creating storage facilities devoid of unhygienic and insanitary conditions 3. Organizing house to house collection of municipal solid waste 4. Use of covered transportation vehicles 5. Adopting biological processing for biodegradable and landfilling for non-biodegradable
III	Specification for landfill site	1. Selection of landfill site based on examination of environmental issues, location and life of site 2. Providing facilities at landfill site 3. Specifications for designing of site to prevent pollution problems as leachate generation and collection 4. Groundwater quality monitoring 5. Ambient air quality monitoring 6. Plantation at landfill site to provide vegetative cover over the completed site 7. Post-closure care of site for long term monitoring 8. Location specific methods for hilly areas
IV	Standards for composting, treated leachate and incineration	1. Waste processing based on state-of-the-art technology 2. Designing of compost plant following the compost quality specifications 3. Disposal of waste following standards for treated leachate 4. Practicing incineration following operating and emission standards

FACTORS RESPONSIBLE FOR POOR PERFORMANCE

RAPIDLY INCREASING AREAS TO BE SERVED AND QUANTITY OF WASTE: The solid waste quantities generated in urban centres are increasing due to the rise in the population and increase in the per capita waste generation rate. The increasing solid waste quantities and the areas to be served strain the existing solid waste management system.

INADEQUATE RESOURCES: While allocating resources including finance, solid waste management is assigned with a low priority resulting in inadequate provision of funds. Often there is a common budget for collection and treatment of sewage and solid waste management and the later receives a minor share of the funds. The inadequacy of human resource is mainly due to the absence of suitably trained staff.

INAPPROPRIATE TECHNOLOGY: The equipment and machinery presently used in the system are usually that which have been developed for general purpose or that which have been adopted from other industry. This results in underutilization of existing' resources and lowering of the efficiency. A few attempts have been made to borrow the technology developed in other countries like highly mechanised compost plants, incinerator-cum-power plants, compactor vehicles etc. However, these attempts have met with little success, since, the solid waste characteristics and local conditions in India are much different from those for which the technology is developed.

DISPROPORTIONATELY HIGH COST OF MANPOWER : Mostly out of the total expenditure, around 90% is accounted for manpower of which major portion is utilized for collection. Since citizens tend to throw the waste on the adjoining road and outside the bin, the work of the collection staff is increased. Hence, the cost of collection increases considerably.

SOCIETAL AND MANAGEMENT APATHY: The operational efficiency of solid waste management depends upon the active participation of both the municipal agency and the citizens. Since the social status of solid waste management is low, there is a strong apathy towards it, which can be seen from the uncollected waste in many areas and the deterioration of aesthetic and environmental quality at the uncontrolled disposal sites.

LOW EFFICIENCY OF THE SYSTEM: The current solid waste management system is unplanned and is operated in an unscientific way. Neither the work norms are specified nor the work of collection staff appropriately supervised. The vehicles are poorly maintained and no schedule is observed for preventive maintenance. Due to shortage of financial resources, the vehicles are often used beyond their economical life resulting in inefficient operation. Further, there is no coordination of activities between different components of the system. The cumulative effect of all these factors is an inefficient solid waste management system.

INTEGRATED APPROACH FOR SYSTEM'S BETTERMENT

Solid waste management has been an essentially a large material handling system scattered over the entire city area for solid waste collection and transportation to its outskirts for processing and disposal. Moreover, the system provides the service to the public, employees a sizable number of manpower and requires a large number of resources in the form of vehicle and machinery. Over the years, it has been realised that it is necessary to design the system as a whole rather than individual component systems that may result into sub-optimal solutions. Hence, the concept of integrated solid waste management system has come into vogue when all the component systems are considered simultaneously and accordingly the systems are planned and executed. The system configuration so obtained facilitated the compatibility of the components to each other thereby improving the performance considerably. The integrated solid waste management (ISWM) has also been defined as the selection and application of suitable techniques, technologies and management programme to achieve specific objective and goals. (Tchobanoglous, 1993).

However, author is of the opinion that MSW management is not just a technological system facilitating handling and disposal of MSW but deals with many other factors Povering socio-economic conditions and operating environment in municipal government.

Against this backdrop, the system could be improved through an integrated approach covering many other issues than technological system as presented in Figure 2 and are discussed below.

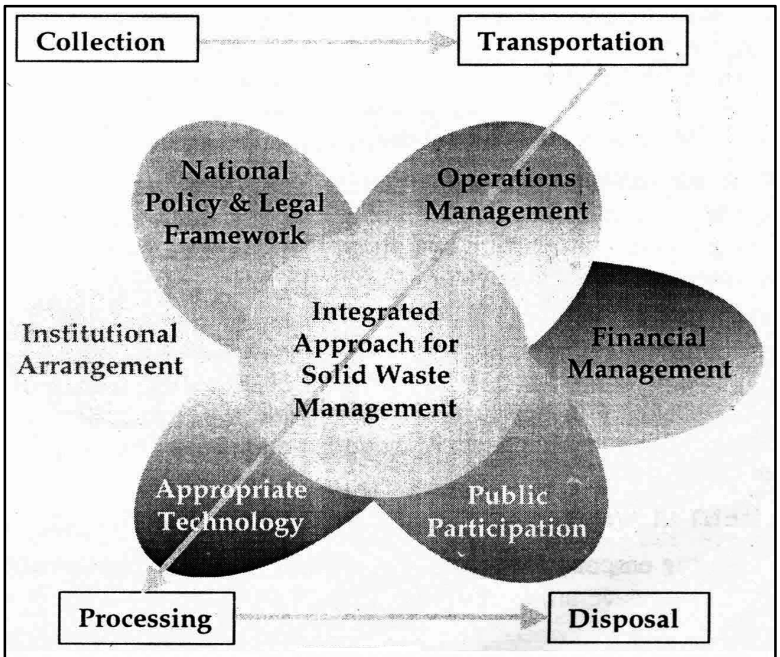

Figure 1 : Integrated Solid Waste Management System

INSTITUTIONAL ARRANGEMENT: MSW management is a municipal responsibility and thus becomes an essential part of local government. The central government and state government have also a role to play in it as far as the financial and institutional support is concerned. Further, in order to improve the efficiency of the system, private sector participation should also become an integral part of the system. Thus, appropriate institutional arrangement has to be worked out by identifying the role of all the agencies in the system.

APPROPRIATE TECHNOLOGY: ISWM has to be designed in accordance with waste characteristics and quantities generated, and prevailing operating conditions. Various handling equipments like vehicles for transportation, machinery for processing and disposal have to be appropriately designed in accordance with the waste characteristics, for example the waste generated in the industrialised countries is having a low density necessitating the requirement of compactors. Further, in case of developing countries when the waste is of low calorific value, thermal processing may not be of worth relevance.

OPERATIONS MANAGEMENT: Basically, the operational systems consist of material handling and treatment wherein the waste generated from different sources are collected, transported, processed and disposed of on day to day through week to week basis. The procedures and practices for each component system need to be defined clearly and there has to be an in-built mechanism to monitor and control the operation.

FINANCIAL MANAGEMENT: ISWM is a large, ongoing vital system requiring resources in the form of manpower, vehicle, machinery and land. The system would necessarily need finance for the capital investment and recurring expenditure. This is a critical issue in developing countries, where a number of municipal agencies attribute the low standard of the system to financial weakness of the agency.

PUBLIC PARTICIPATION AND AWARENESS: ISWM is meant for public and without their cooperation, the system cannot be operated or maintained appropriately. Hence it is necessary to make the public aware about the ISWM through continuous persuasion to seek their participation in the system.

POLICY AND LEGAL FRAME WORK: Every nation should have a policy on ISWM covering various aspects such as cleanliness, maintenance of public health standards, preservation of environmental quality, provision of sustained source of finance and so on. It is also necessary to have a legal framework in keeping the national policy. The legal framework should necessarily include guidelines for effective enforcement mechanism.

IMPROVEMENT PLAN

In keeping with the proposed integrated approach the following action plan is proposed.

INSTITUTIONAL ISSUES

- Identification of nodal Ministry at Central and State level
- Creation of independent MSW management department at municipal level
- Preparation of strategic long term plan to develop and maintain ISWM system
- Establishment of research, development and training facility at the national level
- Formulation of policy for private sector participation
- Institutionalization of activities of informal sector

TECHNOLOGICAL ISSUES

- Design and development of appropriate technology addressing
  - Waste minimisation and waste avoidance technologies
  - Source specific collection system
  - Location specific transportation system
  - Market specific processing technology
  - Site specific landfilling technology
- Development of PC based Management Information (MIS) System

PUBLIC PARTICIPATION AND AWARENESS

- Mounting sustained education and awareness campaigns using all sources of media such as T.V., Radio networks, newspapers, etc.
- Introduction of relevant topics in the school curricula
- Source separation schemes through NGO's and CSO's
- Complaints cell at ward level
- Community participation in decision making and monitoring

FINANCIAL ISSUES

- Increased allocation of funds from municipal budget
- Developing tariff structure on 'no profit no loss' basis
- Tax exemption for MSW related activities
- Financial support from central and state govt. to augment the municipal resources
- Charge recovery system for specific occupation groups

POLICY AND LEGAL ISSUES

- Formulation of national policy for ISWM
- National policy based legal structure to promote ISWM system
- Prohibition of mixing of hazardous industrial waste and infectious solid waste with

MSW

- Identification of citizen's responsibility towards the system
- Simple and transparent enforcement mechanism

CONCLUSION

Solid waste management is a vital, ongoing and large public service system which needs to be efficiently provided to the community to maintain aesthetic and public health standards. Municipal agencies will have to plan and execute the system in keeping with the increasing urban areas and population. At the start of the century, there has to be a systematic effort in the improvement in various factors like institutional arrangement, financial provisions, appropriate technology, operations management, human resource development, public participation and awareness, and policy and legal framework for an ISWM system.

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Industry and Sustainable Development

Dr A G Bhole

INTRODUCTION:

The process of industrialization describes the transition from a 'society initially based' on agriculture to one now based on industry. Modem industrialization is often dated as having its origins in the industrial revolution, on the contrary environmental pollution can be traced to manufacturing in ancient times. Mechanization and automation and now computerization have brought remarkable industrial revolution in recent decades.

This dramatic modernization in the industrial world resulted in increase in productivity, lower costs for manufactured products and usually an increase in the standard of living. However this development has its dark side also. Industries dump their process waste materials into the water, air and land. Most of the industries normally cluster together near or in cities. Their discharges have cumulative effects relatively on a small area. The rapid growth in production also increased the demand for energy, raw materials, and natural resources, often taxing their supply and causing environmental damage due to resource-extraction processes. Typically, industries have a culture to use only the virgin materials because of the expense and complexity of renovating recycled materials into usable quality for manufacturing new products. Therefore, there is often no market for the materials in a product after it has served its useful purpose and it is discarded into "a landfill, creating more pollution. Recently this practice has begun to change. Areas that could previously assimilate the industrial wastes can no longer handle them causing environmental degradation. In some cases, the environmental threats can be reduced by more efficient utilization of resources by industry and by better design of products so that they can be more easily recycled after use.

Indiscriminate use of virgin resources in manufacturing and subsequent inadequate treatment of waste would not provide the resource sustainability and environmental quality as required. This gave rise to a new approach which emphasized minimising the use of harmful or over exploited resources and eliminating or minimising waste production at the industry or source. This philosophy is gaining momentum now. This can be called as sustainable development.

Professor R. K. Ham of the University of Wisconsirl defines 'Sustainable' as an action or process that can continue indefinitely. No resources are used to extinction or faster than they are naturally replenished. Sustainable development is the development with no degradation of land, water or air by wastes. But this is not feasible hence the regulatory authorities generally allow some degradation to levels deemed to be acceptable.

Sustainable development is basically environmentally and economically sustainable. Environmental sustainability reduces overall environmental burdens by optimizing both consumption of resources and generation of wastes and emissions. Economic sustainability means that the over all costs are acceptable to both public as well as government. Sustainable development meets the needs of the present without compromising the ability of future generations to meet their own needs (Gro Harlem Brundtland, former Prime Minister of Norway)

The EPA defines pollution prevention as the use of materials, processes, or practices that reduce or eliminate the creation of pollutants or wastes at the source. It includes practices that reduce the use of hazardous materials, energy, water or other resources and practices that protect natural resources through conservation or more efficient use' This definition also explains sustainable development. It is concerned with activities that range from product changes to process changes to changes in the methods of operation.

The word sustainable has its origin in the Latin word, 'subtenir' meaning 'to hold up' or 'to support from below'. A community must be supported from below - by its inhabitants.

Sustainability can be described as follows:

Safe
Universally accepted
Stable
Technology that benefits all antipollution
Improvement in quality of life

Non-toxic
Awareness
Beautiful
Indigenous material, technology and knowledge.
Least cost production.
Income
Total quality
Youth
(Source: Olaitan Ojuroye, Nigeria)

Since 1972 a number of conferences were held for the cause of Sustainable Development. Summery of these conferences is given in Table 1.

ISO: The International Organisation of Standards at Geneva has prepared a number of guidelines called as ISO useful for government, public, organisations including industries.

Certification of ISOs like 9000, 9001, 14000 series for industries take care of sustainable development.

ISO 9000 : It is a certification awarded by one of many independent auditors attesting that the industry/ organization has met with quality management requirements determined by ISO 9000. It is a frame work for showing customers how products are produced and tested and how records are kept and defects fixed.

ISO (9001:2000) : It is the revised ISO for international quality management system standards. They require the industry (organization) to identify the processes needed for the quality management system and their application throughout the industry. This has to be followed by determining the sequence and interaction of these processes and the criteria and methods to ensure that both the operation and control of these processes are effective. It then requires the organization to ensure the availability of resources and information necessary to support the operation and monitoring of these processes. The most important aspect is to monitor, measure and analyse these processes and implement actions necessary to achieve planned results and continual improvement of these processes.

The ISO 14000 series (14000 to 14044) : They are international standards brought out by international consensus for environment management and are becoming the key components for sustainable development. This is because of the goals set by ISO 14000 such as:

- Conservation of natural resources.
- Reduction and abatement of waste and emissions ..
- Efficiency in operation by use of best available technology
- Continuous improvement in environmental performance, and
- Compliance to national and international environmental laws and conventions

Note that ISO 14000 is not so document oriented as is ISO 9000. It also does not specify performance of pollutant levels since it is the job of environmental legislation.

IS 14001 : It deals with environmental policy, planning, implementation and operation, checking and corrective action, management review, management responsibility, quality system, control review; handling storage packing preservation and delivery of products.

CONVENTIONAL ENERGY:

The raw materials required for a industry should be replenishable and low cost and should not get exhausted, similarly the use of energy should be minimal from a suitable source. Although theoretically this appears to be O.K., the materials like coal, ores of different metals and other materials required for any product are bound to deplete sooner or later. For example the coal required for a coal fired thermal power station will exhaust after some period of years though the period may be pretty long. The amount of fossil fuels (like oil, gas, coal, peat etc.) is presently enormous but these resources are not equitably distributed around the world. Most of the coal deposits are of low quality containing large amount of sulphur or other contaminants that can create severe air pollution problems when burned. The coal reserves in the world will last' only for about 200 years at the present rate of consumption. The available mining techniques are unable to economically recover many of the coal reserves. So the actual availability of coal will be much less than 200 years. Thus a major shortage of coal will be felt possibly within the next century. Hence we cannot count on coal as a major supplier of energy in the future. Air pollution (by particulate matters, trace metals, gases like sulphur dioxide, unburned hydrocarbons etc.) coupled with the impact of coal burning on

global warming, large quantity of fly ash, the environment degradation caused by mining, the impacts on natural waters because of acid mine drainage and the health effects on the miners who contact black-lung disease are the major issues which control the use of coal. But in India major source of energy is from coal fired thermal power stations.

Another major source of energy is hydroelectric power in India. Nature has endowed India with a huge potential for hydro electric development. The likely impacts of hydro projects on environment can be as listed below:

i) submergence of land below water
ii) displacement of project affected people
iii) reservoir induced seismicity
iv) soil erosion and sedimentation
v) aquatic life
vi) flora and fauna
vii) deforestation
viii) green house effect.

The environment impacts of hydro electric power stations are less compared to coal fired thermal powerstations, and hence should be preferred wherever possible.

Nuclear power is the third source of energy in India. The boiling water reactors (BWR) and the pressurised water reactors (PWR) are two major types of nuclear power stations. Low pressure reactors were thought to be relatively safe, but the Chernobyl reactor though based on low pressure technique, showed that it is not a safe technique. Management of the radioactive wastes is a major serious problem. Until 1970, most countries dumped their low level radioactive wastes in the oceans. This has now essentially ceased. Most low-level nuclear wastes are now stored in tanks or buried underground. But now of more concern to the nuclear power industry is to find an answer for what to do with the spent fuel assemblies from the reactors. These high-level wastes are currently being stored under water at the power plants because there are as yet no acceptable disposable sites available. The need for a safe disposal site is becoming critical. In addition to the spent fuel cores, the safe decommission, dismantle and dispose of the highly radioactive buildings and reactors from phased out power plants has become a difficult task. This is unfortunate because nuclear energy is much less polluting than other forms of energy.

RENEWABLE ENERGY:

Renewable energy is normally generated from sources, which do not deplete, such as

i) Hydro power
ii) Energy from ocean
iii) Solar energy
iv) Wind energy
v) Energy from biomass
vi) Natural gas

STRONG POINTS

- Potential unlimited / perennial.
- Environmentally friendly.
- Favoured option for sustainable development.
- Favoured option for ensuring equitable distribution of benefits.
- Based on natural recycled resource.
- Devices are modular in sizes.
- Less lead time, quicker implementation.
- Easy to install, 'Stand alone' systems.
- Fuel transportation cost is absent.
- Cost of other inputs is considerably low including cost of operation and maintenance.

TABLE 1 : SUMMARY OF CONFERENCES SO FAR HELD FOR SUSTAINABLE DEVELOPMENT

1972 The United Nations Stockholm Conference	The agenda of the United Nations Conference held in Stockholm was the human environment, and it expressed concern with the global spread of environmental damage. This led to the establishment of Environmental Protection Agencies in a number of countries. the remedial steps taken were aimed at controlling the extent of environmental damage by setting limits or by requiring restoration of environmental equality. However such an approach neither took a holistic approach to the environment nor integrated the environment and development.
1980 The World Conservation Strategy	The International Union of Nature and Natural Resources (IUCN) published its World Conservation Strategy (WCS). The strategy defined development as "the modification of the biosphere and the application of human, financial, living and non-living resources to satisfy human needs and improve the quality of human life." The WCS said that conservation is a process which must be applied "cross-sectorally", and not be seen as a separate" activity sector in its own right," if the fullest sustainable benefits are to be derived from the resource base. The WCS also calls for anticipatory environmental policies and national accounting systems which will include nonmonetary indicators of success in conservation.
1980 A Programme for Survival	The independent Commission on International Development issues published a report, A Programme for Survival, calling for a reassessment of the notion of development as well as a new economic relationship between the richer North and the poorer South.
1982 The United Nations World Charter for Nature at Nairobi	The United Natrions published its World Charter for Nature, which adopted the principle that every form of life is unique and should be respected, regardless of its value to humankind. It also called for respect for our dependence on natural resources and control of exploitation of them: "Ecosystems and organisms shall be managed to achieve and maintain optimal sustainable productivity."
1986 The IUCN Ottawa Conference on Environment and Development	The IUCN followed up the World Conservation Strategy with the Ottawa Conference on Conservation and Development Sustainable development, the "emerging paradigm", is derived from two closely related paradigms of conservation: that nature should be conserved, which is "reaction against the laissez-faire from the moral injunction to act as steward, and responding to warmings expressed in publications such as Silent Spring and Limits to Growth.
1992 U.N.Conference on Environment & Development at Rio de Janeiro	On June 3,1992, this conference began in Rio de Janeriro, Brazil. It brought to gether diplomats, politicians and experts on environment and development from 172 (out of 178) member States of U.N. It was the conf for NGOs also. This was the 3rd Conf. Of United Nations. The first was in 1972 and the second in 1982. The Rio Declaration consists of a preamble and 27 articles reflecting general principles of Agenda 21.
1995, World Summit for Social Development at Copenhagen	This Summit acknowledged that people are at the centre of our concerns for Sustainable development and that they are entitled to a healthy and productive life for sustainable development and that they are entitled to a healthy and productive life in harmony with the environment. It also mentioned that equality and equity between women and men is a priority.

WEAK POINTS

- Energy is available seasonally and intermittently
- Normally it is low density energy, requiring larger space.
- more labour is required
- Capital cost is much more.

1 Hydro power

World wide estimated potential is 20,000 billion units per year out of which 10,000 billion units per year is economically feasible. Of this only 27.5% has been utilized so far. India's hydro power potential is estimated at 84000 MW Around 16% of this potential has been tapped so far through 20,000 MW of installed capacity.

Small hydro power plants: In India 'small hydro' covers station capacity upto 15 MW and potential for the same is estimated to be around 15000 MW. So far 533 MW of 'small hydro capacity has been installed and another 450 MW is under construction. Mini hydro plants on canal drops, dam toe and run-of-river sites are quite feasible. Offers for over 450 MW have been received from private sector. For hilly regions, decentralized generation and distribution is more suitable and hence needs more attention.

i. Micro hydro plants: They are still of smaller capacity compared to small hydro power plants and are also useful for hilly regions and hence gaining significant importance.

2 Energy from ocean

Ocean energy is derived by :

i. thermal gradients.
ii. Waves.
iii. tides.

i. Thermal gradients.

A temperature difference of about 200C between warm surface waters and deep cold waters at around 2 km in tropical oceans is sufficient to generate electric power. Essentially it consists of evaporating a working fluid such as ammonia or fresno by the use of a heat exchanger which drives a turbine generator to produce electricity. Indian ocean has a potential to generate 50,000 MW.

ii. Wave energy.

Sea waves piled up by the wind, continuously rise up and down. Oscillating water column plants have been developed to capture the wave energy. At present, 500 KW of grid connected power generating capacity is operating world over. A demonstration unit of 150 KW was installed by Kerla State Electricity Board in 1993 at Kovalam Beach.

iii. Tidal Power

The earth's gravitational pull generates oscillating oceanic tides which keeps billions of cubic meter of water in movement. The potential energy of tides is estimated at 3000 MW. About l/3rd of this power is dissiplated in shallow seas. Presently about 300 MW of tidal plants are under operation in France, Canada, Russia and China. In India, the sites are in the Gulf of Kutch, Cambay, and Sunderbans with average tides of 3 to 7m height and a cumulative power potential of nearly 10,000 MW.

3 Solar energy

One method of using solar energy is to heat oil to very high temperatures, the oil is then used to produce steam to be used in a conventional electric generator.

Another method is use of photo voltaic cells. Solar energy is captured and converted directly to electric current by separating electrons from their parent atoms and accelerating them across an electro static barier. In some cases they have been used successfully for power houses. Cost of power generation is still prohibitive for large applications, but it is coming down. The solar energy capture efficiencies have already increased from 1%, 25 years back to about 10%, but as long as cost and size of photovoltaic cells and storage batteries do not come down significantly, solar energy will probably play only a minor role.

4 Wind energy

Wind energy or wind power has been used for thousands of years to run mills and pump water. In recent years it has been used to run electrical generators. Presently there are thousands of wind generators in U.S.A., Europe etc. Netherlands and Denmark are synonymous with wind mills. In India wind mills are installed at various places, where S wind is available almost round the year. Bajaj Auto Ltd. has invested 300 crores of rupees for wind energy which is used to run their industries. Wind power will continue to increase but it may be hardly 3 to 4% of total energy required.

5 Energy from biomass

Bio energy from anaerobic digestion of organic matter and anaerobic composting of solid waste is gaining significant importance. The gas generated has been used to operate turbine engines, internal combustion engines, gas engines etc. At present biomass energy is successful on a local basis but I feel its potential for large scale use is still far off.

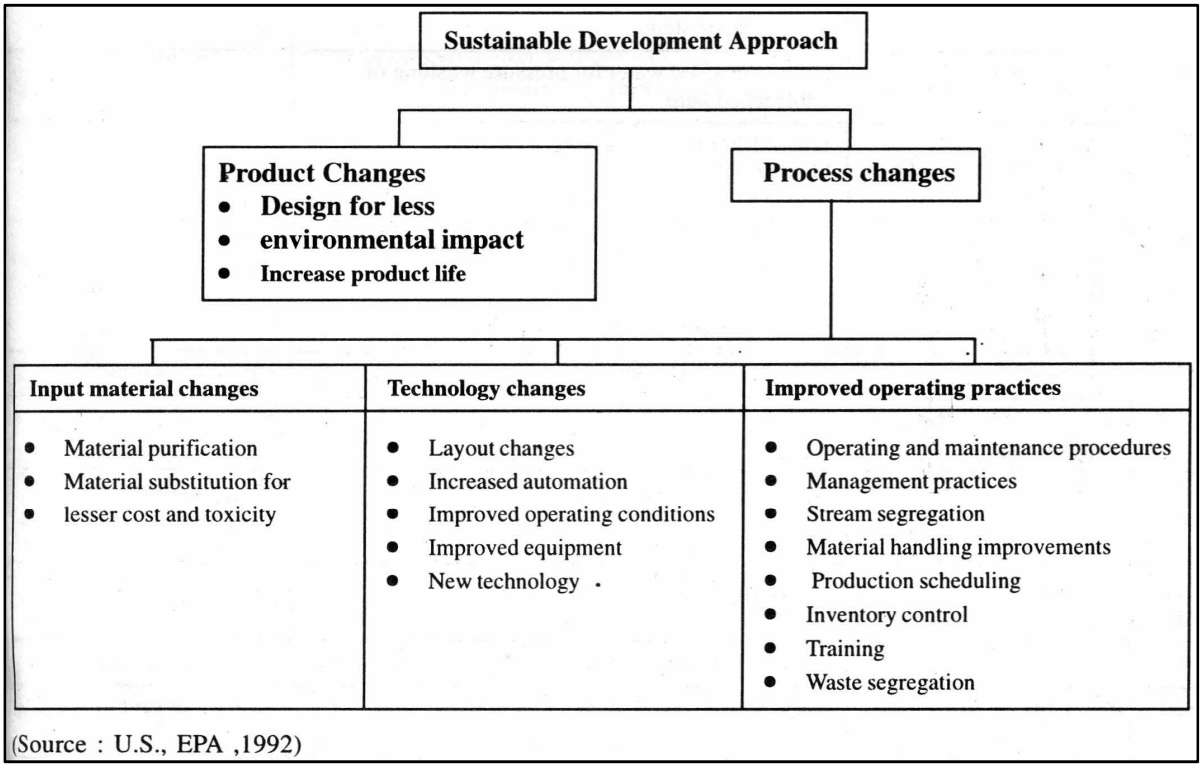
6 Natural gas

It is a sustainable source of energy and hence should be utilised to the maximum possible extent. A large number of thermal power stations in most of the states in North - East part of India use natural gas as energy source for thermal power stations. Namrup thermal power station in Assam is generating power with the help of natural gas since 1965.

PROCESS AND PRODUCT CHANGE:

Process and product change is infact a continuous process which is going on for last so many decades. The process of improvement in the product is basically user oriented. Cost effectiveness is also another factor that governs the production criteria. Of late, environment sustainability has been given weightage but not which is due. It requires serious planning and action in this direction as per ISO 14000.

Methodical approach for sustainable development of industry is given in the following chart.



(Source : U.S., EPA ,1992)

Some examples of process modification are given in Table 2

TABLE 2 - AVENUES FOR WATER RECYCLE THROUGH PROCESS MODIFICATION

50	Process	Modification	Remarks
Textile	Mercerizing	Counter-current flow pattern	20% water saving over conventional process
	Dyeing	Replace running washes by static washes Reuse of bathing or wetting water for naptholating	
	Printing	Reuse of blanket washing water for same purpose	
	Washing of printed cloth	Counter-current washing	60% water saving over open soaper
	Desizing	use of kier liquors used for peroxide treatment of bleached cloth	
	Cooling water	Reuse through closed system	
Metal Plating	Rinsing	Counter-current flow of water in rinse tank Use of solenoid valves, controlled by conductivity bridges determining dissolved solids concentration in rinse tanks, instead of open tap system	10% water saving
Pulp & Paper	Pulp washing	Use of decanted water for pressure washing of unbleached pulp	
	Bleaching	Use of filtrate back water for preparing bleaching water Use of alkali extraction stage filtrate as makeup water	
	Washing of bleached Pulp	Use of back water from acid treated pulp for washing bleached pulp Use of hypochlorite bleaching stage excess filtrate in washing chlorinated pulp	
	Screening	Use of pulp dryer white water	20% water saving
	Dilution of bleached stock at hypo-stage	Use of pulp dryer white	10% water saving
Steel Rolling Mills	Cooling	Recycle in closed system	66% water saving
Distillery Soap &	Cooling	Recycle in closed system	84% water saving
Detergent	Cooling	Recycle in closed system	66% water saving
Thermal Power	Cooling	Recycle in closed system	75% water saving

(Source : Khanna and Kaul, Jour IAEM, Oct.1996)

INDUSTRIAL POLLUTION:

As regards industrial pollution, it should be prevented or reduced at the source whenever feasible; pollution that cannot be prevented should be recycled in an environmentally safe manner, whenever feasible; pollution that cannot be prevented or recycled should be treated in an environmentally safe manner whenever feasible; and disposal or release into the environment should be employed only as a last resort and should be conducted in an environmentally safe manner.

a) Waster Water :

As regards industrial waste water treatment is concerned, primary treatment such as screening, flow equalization, mixing, primary sedimentation, flotation, granular filtration, gas stripping of volatile organic compounds etc. are included.

Biological or secondary treatment has two options, aerobic or anaerobic followed by treatment of excess sludge. Aerobic processes have options such as activated sludge process, aerated lagoons, aerobic digester, trickling filters, rotating biological contacters, packed bed reactors etc. anaerobic processes have options such as anaerobic filter, expanded bed, upflow anaerobic sludge blanket, anaerobic digester etc.

Some of the above mentioned conventional treatment options are low cost, easy to maintain and also produce energy through methane and carbon dioxide, and hence sustainable. These processes are basically anaerobic such as

i) anaerobic filters ii) U.A.S.B. iii) anaerobic digester.

Apart from the above mentioned conventional treatment options, there are various natural treatment systems as mentioned below, which are low cost and require operation and maintenance almost next to nil and hence are self sustainable.

i) Oxidation pond ii) Facultative ponds in cold climate iii) Facultative ponds in warm climate

iv) Controlled discharge ponds v) Partial mix aerated ponds vi) Secondary hyacinath ponds

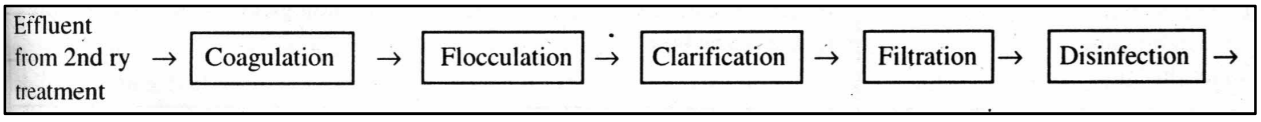
vii) Advanced Secondary hyacinath ponds viii) Tertiary hyacinath ponds ix) Constructed wetlands

x) Overland flow xi) Slow rate systems xii) Rapid infiltration systems

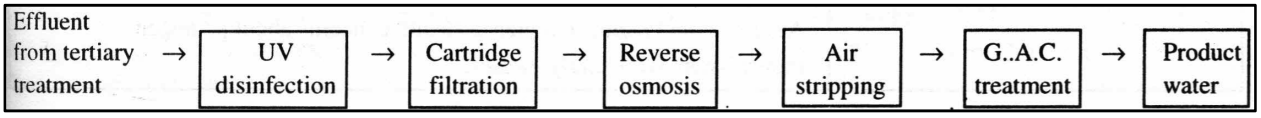
The conventional primary and secondary treatment is rarely able to achieve the required effluent standards and hence further tertiary treatment is required, either singly or in combination. The various options for tertiary treatment are

i) Flocculation and sedimentation
ii) Granular - medium filtration.
iii) Microscreening / filtration
iv) Chlorination/ozonation.
v) Ion exchange process
vi) Adsorption.
vii) Reverse Osmosis
viii) Eletrodialysis.
ix) Distillation.

The conventional tertiary treatment is indicated in the following block diagram



The treated effluent can be used for secondary purposes but if the waste water is to be reused for potable purposes then further treatment shown in the following flow diagram will be required



Although the tertiary treatment can treat the effluent to the desired degree but unfortunately it is not sustainable to the industrialist because of cost involvement.

The zero discharge should be the goal of every industry but if it is not possible then .the effluent could be reused depending upon the degree of treatment of the waste water as shown in Table 3.

B) AIR POLLUTION :

Industries emit air pollutants which can be classified into two categories, primary and secondary.

Typical primary pollutants are carbon monoxide, hydro carbons, sulphur dioxide, nitrogen compounds and particulate matters. Secondary pollutants are photochemical oxidants and atmospheric acids.

The SO_2 and NOx can react with water vapour in atmosphere in the presence of oxidizing agents (ozone, hydrogen peroxide, hydroxyl ions) to form sulphuric and nitric acids. Acid rains are very corrosive and can attack many materials including limestone, marble, metals etc. Acid rains are toxic to many trees and plants. Use of low- sulphur coal or improving sulphur recovery process at coal combustion facilities or reducing the amount of coal needed, can reduce SO_2.

TABLE 3: CATEGORIES OF INDUSTRIAL WASTEWATER REUSE AND POTENTIAL CONSTRAINTS

Wastewater reuse categories	Potential constraints
Agricultural irrigation Crop irrigation Commercial nurseries Landscape irrigation Park School yard Freeway median Golf course Cemetery Greenbelt Residential	Surface and groundwater pollution if not properly managed Marketability of crops and public acceptance Effect of water quality, particularly salts, on soils and crops Public health concerns related to pathogens (bacteria, viruses and parasites) Use area control including buffer zone. May result in high user costs
Industrial recycling and reuse Cooling Boiler feed Process water Heavy construction	Constituents in reclaimed wastewater related to scaling, corrosion, biological growth, and fouling Public health concerns, particularly aerosol transmission of pathogens in cooling water
Groundwater recharge Groundwater replenishment Salt water intrusion control Subsidence control	Organic chemicals in reclaimed wastewater and their toxicological effects. Total dissolved solids, nitrates, and pathogens in reclaimed wastewater
Recreational/ environmental uses Lakes and ponds Marsh enhancement Streamflow augmentation Fisheries Snowmaking	Health concerns of bacteria and viruses Eutrophication due to N and P in receiving water Toxicity to aquatic life
Nonpotable urban uses Fire protection Air conditioning Toilet flushing	Public health concerns on pathogens transmitted by aerosols Effects of water quality on scaling, corrosion, biological growth, and fouling Cross-connection.
Potable reuse Blending in water supply reservoir Pipe to pipe water supply	Constituents in reclaimed wastewater, especially trace organic chemicals and their toxicological effects Aesthetics and public acceptance Health concerns about pathogen transmission, particularly viruses.

(Source: Metcalf & Eddy, 3rd Edition)

Carbon dioxide is the gas generally responsible for global warming because it is added to the atmosphere in large quantities. But other gases such as methane, nitrous oxide, chlorofluorocarbons (CFCs) and other trace gases also playa role, though insignificant in concentration. In fact these gases trap heat much better than CO_2 e.g. methane traps 20 to 30 times and CFC traps 20,000 times more than CO_2. Highly industrialized nations such as USA, Europe etc are mostly responsible for global warming. According to WHO report about 160,000 people die every year from side effects of global warming. This number could be almost doubled by 2020. This year about 15000 people died in France because of heat wave. Children of third world are most affected by global warming.

CO_2 gas is also mainly responsible for Green House effect. The heat becomes trapped in the presence of CO_2 in the upper atmosphere. The infrared portion of sun's radiation is mostly absorbed by CO_2. CO_2 also traps the infrared heat radiation emitted by earth's surface and reemit back towards earth surface. CO_2 also is transparent to visible light. This results in increase in temperature. Contribution of CO_2 for global warming is 57% while those of CFC, CH4, and NOx are 25, 72, and 6% respectively.

Production of CFC in large quantities by western countries is mainly responsible for depletion of ozone in the stratosphere. In 1989 in the 'Montreal Protocol on Substances that deplete the Ozone Layer' 81 nations agreed to phase out all the CFCs by the year 2000. Research is on to find a suitable replacement for CFC as a refrigerant for refrigerators, air conditioners, industrial cooling units etc. Presently hydro chloro fluroro carbon (HCFC) is under trial to replace CFC.

C) SOLID WASTE MANAGEMENT:

In olden days solid waste was just dumped in depressions on vacant land or was burned. However as the societies developed, people became aware of simple land disposal problems such as air pollution, odour nuisance, health hazards, surface and ground water pollution. Safer and more efficient disposal practices were needed. This led to the use of sanitary landfill, composting, incineration and subsequently resource recovery and energy recovery. Sanitary Landfill generates mainly methane and carbon dioxide which in turn generate energy. The residual decomposed solids are good as manure. Sanitary landfill, a common method, requires proper leachate sealants such as polymers, synthetic membrances, liners etc. to avoid ground water pollution by leachates. Proper drainage through perforated pipes, collection and treatment of leachates is very necessary. The landfill site should be atleast 0.5 m away from the habitats, with a 500 m wide buffer zone around it. The energy derived in sanitary landfill method can be used locally only.

Vermicomposting is gaining importance because of higher manure value at atmost negligible higher cost.

As regards incinerator, it should contain two chambers, one primary and another secondary. Its stack height should be as prescribed (normally 30 m) and should satisfy emission standards (SPM-150 mg/Nm^3, NOx - 450 mg/Nm^3, HCI-50 mg/ Nm^3)

Fly ash is one of the major solid waste generated by industries mainly by thermal power stations. Fly ash though results after burning of coal, still remains a burning problem. It has been used for manufacture of pozzolana cement, in cement mortar, in concrete, for moulded concrete bricks and RCC materials, for construction of highways and even runways, also along with soil for plantation of specific trees etc. but the quantity of fly ash generated is many more folds compared to the quantity utilized. Hence there is a need to find out a sustainable solution for its utility and disposal. ESP for removing fly ash in TPS needs further research to improve its efficiency.

Disposal of plastics is still a severe problem. Sustainable disposal of plastics is the need of the day. Biodegradable plastic needs to replace presently used plastic. Efforts are also made to derive product like petrol after treating the plastic but it is still under experimental stage.

D) NOISE POLLUTION:

The modern technology for achieving greater productivity necessarily deals with greater speeds, higher fluid pressures and velocities and more powerful machinery. This creates the undesirable noise pollution in industry resulting interference in communication, hearing impairment, irritability, annoyance, high blood pressure etc. It-also affects productivity. Sound level below 60 dB is supposed to be below 'Speech Interference Level' (SIL).

Measures to control noise in industry

i. Administrative control in the form of 'worker rotation' is an effective control method. In this case worker is not exposed to high noise level for a long period beyond permissible limits.

ii. Engineering Control

a Suppression of noise at source - Noise can be minimised by proper design, proper location, proper installation, proper and regular operation and maintenance of machineries.

b Path control : The important paths of noise transmission from a source includes a structure which supports the entire machinery producing noise; surface and panels attached to the source; cables, conduits, belts, wires, ducts, pipes etc; and fluids flowing through or surrounding the source.

Sound absorption, sound insulation and vibration control are the important parameters to control noise. Sound absorption materials which are generally light-weight, porous or fibrous are recommended. Thermo-coal sheet lining or drapes along wall surface and carpets are typical materials.

Vibration control is possible through isolation. Free space is ideal insulator.

For path control of noise, acoustic enclosures, noise barriers or mufflers/ silencers are recommended.

A FRAMEWORK FOR SUSTAINABLE DEVELOPMENT:

The sustainable development at local national and international level is mentioned in the tabular form in Table No.4 as shown below.

TABLE 4 : A FRAMEWORK FOR SUSTAINABLE GROWTH AND DEVELOPMENT

	Development paradigm					
	Local Development		National Development		International Development	
Strategic function	**Regionally sustainable economic growth**	**Ecodeveop-ment**	**Sustainable economic growth**	**Sustainable development**	**Development of supportive economic environment**	**Global sustainable development**
Assessment	Integrated regional (monetary) accounting	Environment statistics Regional (physical) resource accounting, Statistical ecology	Integrated environmental economic accounting	Environment statistics Natural (physical) resource accounting National development reports	International (comparative) environmental accounting	International (integrated) databases, statistical compendia and reporting
Research and analysis	Modeling Spatial disparities and growth	Modelng ecodevelop-ment	Integrated micro-meso and macro-economic analysis and modeling Modeling carrying capacity Development of ecotechniques	Models of integrated (physical) planning and development	International and global economic/ enviornmental analysis and integrated modeling	International (physical) modeling of global environmental concerns and their socioeconomic implications
Planning and politics	Regional planning and policies of sustainable economic growth	Ecodevelopment planning and administration (decentralized planning and strategies)	Reorientation of macroeconomic policies towards sustainability Policies of structural change Economic (dis) incentives for microeconomic planning & management	Integrated (physical) planning and project formulation Demographic policies on population, resources, environment, and development Programs of human needs satisfaction	International strategies of sustainable economic growth	International standards for sustainable development International strategies and conventions (e.g. Agenda 21)
Support	Extension service technical assistance (for local-level projects) public awareness building and participation (support to organizations)		Public awareness building and participation Programs and projects of education, training and public information Institution building and environmental law/regulations Technical cooperation, including transfer (import) of environmentally sound technology and capacity building		Promotion of sustainable growth amd development at international and global levels Multilateral support for international (global) sustainable development International institution building (e.g. UNCSD)	

CONCLUSIONS:

i. Optimal use of raw materials, energy and water along with minimal generation of waste, its recycle, recovery and reuse should be aimed at.

ii. Proper schedule of operation and maintenance of the industry needs to be prepared and followed meticulously. Spare parts of machinery wherever required, have to be always ready in the stores

iii. Certification of ISO 9000, 9001 and 14000 series should be aimed at by all industries.

iv. The teeth of judiciary should be more sharpened for strict implementation of laws.

v. Population growth has to be checked at any cost. Increase in population increases the demand which in turn increases the pressure on social and economic structure ultimately resulting in degradation of the environment.

vi. Corruption is another bottle neck for sustainable development. Corrupt practices create an atmosphere of unaccountability and a distorted decision making process which is harmful to social, economic and environmental conditions.

Considerations of GHG Emissions and Rapid Depletion of Mineral Resources in Developing Countries

Prof S P Banerjee

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1. HISTORYOF MINERAL USEAND WORLD PRODUCTION OF MINERALS

The earliest human civilizations arose in river valleys in different parts of the world. Although mankind progressed successively from Stone Age to Copper Age, Bronze Age and Iron Age, the exact period of such progression were different in different geographical locations. In Indus valley, copper and bronze were in use by 3500 BC and 2000 BC respectively and Iron Age started around 1200 Be. Gold and silver ornaments have been used for many centuries before their use as coins started around 600 Be. However, significant and large scale use of metals and fuels started only after the advent of the industrial revolution in the 18th century. The world population was still at a relatively low figure, estimated at only one Billion in the year 1800. However, the population doubled to two Billions by the year 1930 (i.e. in 130 years) and again doubled to four Billion by the year 1974 (i.e., in 44 years). The technological inventions of the 19th and the 20th centuries have helped man to greatly improve his standard of living and modify his life style based on the use of automobiles and electrical appliances. As a combined result of population growth and increased living standard, the demand for metals and minerals has continued to grow as can be seen from Table 1 in which the world production of a few selected minerals and metals for the years 1900, 1950, 1990 and 2000 are given. The use of aluminium, nickel, chromium (component of stainless steel) and petroleum (required by automobiles) were very low in 1900. For the other minerals and metals, the consumption in the period 1900 to 1950 increased by a ratio varying from 1.9 to 4.8. The most significant part, however, is that the growth in mineral consumption continued in the 1950 - 2000 period as can be seen from the last column of Table 1 where the ratio of production in 2000 to that of 1950 is seen to vary from 1.6 to 16.5.

Table 1: World Consumption of selected minerals and metals (in Mt or as specified)

	1900	1950	Ratio b/a	1990	2000	Ratio e/b
	a	b	c	d	e	f
coal	1000*	1700	1.7	3300	4700	2.8
Iron and steel	65	190	2.9	770	848	4.5
Lead	0.749	1.64	2.2	3.37	3.1	1.9
Zinc	0.479	1.97	4.1	7.18	8.79	4.4
Copper	0.495	2.38	4.8	9.2	13.2	5.5
Tin	0.09	0.172	1.9	0.22	0.28	1.6
Bauxite	0.09	8.18	91	113	135	16.5
Chromium	0.0165	0.72	44	3.95	4.68	6.5
Nickel	0.012	0.145	12	0.97	1.27	8.8
Gold (t)	386	879	2.3	2180	2590	2.9
Silver(t)	5400	6320	1.2	16600	18400	2.9
Petroleum (BB)	0.15	6	40	21	23	3,8
Cement		133		1043	1650	12.4
Rock phosphate	8.15	23.4	2.9	162	133	5.7

2. MINERAL RESOURCEDEPLETION AND LIMITS TO GROWTH

1960scan be considered as the starting period of global environmental movement. Concerns were raised in this decade about the indiscriminate use of pesticides, acid rain, large scale deforestation and deterioration in air and water qualities in different parts of the world. At the same time many groups started worrying that the very large scale use of metals, minerals and fuels to support a profligate living style of a burgeoning population was not sustainable with the finite known mineral resources of the world. The Club of Rome's 1972 publication aptly titled 'Limits to Growth' is the most famous report of this kind. Based on the then known reserves of minerals and consumption trends, the report predicted exhaustion of many minerals in the world within a span of 50 years but

more specifically some minerals like mercury (1985), tin (1987), crude oil (1992), copper (1993), lead (1993), and natural gas (1994) were supposed to have got exhausted earlier (the figures in brackets indicating the projected year of exhaustion). However, discovery of new deposits and improvement in mining, mineral processing and metallurgical technology have pushed back the spectre of mineral exhaustion by a few decades. Nevertheless the threat is real as can be seen from the periodical shooting up of oil prices (or the oil shocks) that the world is experiencing since the 1970s.

3. GLOBAL WARMING AND KYOTO PROTOCOL

Another issue that is relevant to putting a curb on human consumption of minerals is the spectre of global warming caused by the increasing level of green house gases (GHG) in the atmosphere. Carbon dioxide is the principal green house gas and burning of fossil fuels is the main cause of its emission into the atmosphere and besides the fossil fuel burning power stations, the transportation and other industrial sectors also contribute to this emission. The C02 concentration in the atmosphere was only 280 ppm in 1860 but has crossed the 370 ppm mark now. The earth is hotter now than it has been in the past 2000 years. At the Rio Earth Summit in 1992, a Climate treaty (UNFCCC) was signed by over 150 nations to reduce GHG emission so that the GHG concentrations in the atmosphere stabilize at a level not too harmful for the climate system. The climate treaty took into account the wide disparity in per capita GHG emission (mainly carbon dioxide emission) between the developed and the developing countries (Table 2). It didn't set any binding emission limit for any country but only required the developed countries to adopt national policies so that their GHG emissions return to 1990 levels. After lengthy negotiations spanning over two years, an Action Plan, known as the Kyoto Protocol was agreed upon by 38 of the developed countries (Annexure I countries) in 1997. It set binding requirements of curbing GHG emission for the developed countries so that an overall reduction of just over 5%takes place in their 1990 GHG emission levels by 2008- 2012. However, the Kyoto Protocol has not been ratified as yet by such major emitters as USA and Russia and hence the Protocol has not achieved binding status as yet. In the mean time the carbon dioxide level in the atmosphere is continuing to rise and the spectre of global warming is looming nearer. The corrective steps would have to be more drastic now than what would have been the case if the Protocol came into force in 1997 or 1998.

Table 2: Per Capita (t) and Total CO2 emission in Mt in selected countries

Country	1980 (Mt)	1990 (Mt)	2000 (Mt)	Per capita (t)
USA	4754	5011	5819	19.8
Australia	200	265	358	18.0
Canada	460	477	576	14.2
Russia		2022 (1992)	1543	9.9
Germany	1067	993	838	9.6
UK	617	600	555	9.5
Japan	958	990	1183	9.4
Italy	379	415	449	7.4
France	499	374	407	6.2
China	1445	2262	3017	2.2
Brazil	191	253	338	1.8
India	303	593	996	1.0
World	18636	21638	23891	4.0

4. CARBONTAXAND CHANGINGFUELMIX FORPOWERGENERATION

As a corrective step, a very heavy dose of carbon tax is likely to be mandated by the U.N. body on climate change. Hopefully, this will give a competitive edge to the renewable sources of energy such as hydel and solar power. But there are problems of submergence, destruction of habitats and involuntary displacement associated with hydel power development. The cost of electricity generated from solar power is still very high and as a result its share in global electricity production is miniscule. Hence for the foreseeable future the world will have to depend on fossil fuels to meet the energy needs. The imposition of carbon tax would not only make energy much costlier but also significantly distort the energy supply pattern followed in different countries. With globalizations of economy in most countries, every industry has to be competitive in the international arena. Many mines and metal industries are major consumers of energy. The bulk of primary energy supply in many developing countries such as China and India are obtained from burning coal. Power station coal with its high ash content and large carbon dioxide production on burning is a greater polluter than oil which leaves no ash, and natural gas (NG) is the best fossil fuel from environmental point of view as it produces the least amount of CO_2. The developed countries anticipating

Kyoto restrictions and with a desire to protect their air quality are gradually switching over to NG based power generation. Inevitably a demand supply imbalance is cropping up and the price of NG is going up in recent years. Different fuel mix used by the world for electricity generation in the year 2000 and as projected by IEA for the year 2020 is given in Table 3. It shows that the relative share of natural gas alone will go up in the next two decades, the share of all other sources will decline. The present known reserves of NG is estimated to last for 60 years only. With economist David Ricardo's "scarcity rent" concept coming into play, the cost of natural gas and consequently the cost of electricity produced from its burning are likely to be much higher in future than it is now.

Table 3: Fuel mix for Electricity production in the world in 2000 and 2020

	2000	2020
Hydro and renewable	17.6 %	13.4%
Nuclear	16.2%	11.1%
Natural Gas	20.2%	33.8%
Oil	9.1%	6.0%
coal	36.9%	35.7%
Total Electricity Production	16 TWh	25 TWh

5. TOTAL EMISSIONFROMA COUNTRY

The total atmospheric emission for a country depends on a number of factors, namely the technology of its energy production, the energy intensity of its economy, the standard of living of its citizens and the population of the country, F. E. Vest et al of Alstom have related these factors into an equation in one of their recent papers presented at an energy conference (WA Energy Conference, Perth 2003):

$$\text{Total Emission} = \underset{\text{I}}{\frac{Pollutant}{Energy}} \times \underset{\text{II}}{\frac{Energy}{GNP}} \times \underset{\text{III}}{\frac{GNP}{Capita}} \underset{\text{IV}}{\text{Population}}$$

The first term is related to the type of fuel used and the technology of power plants and industries, their burners and pollution control mechanisms, the second term reflects the energy intensity of the economy, the third to the standard of living of the people and the fourth term is the number of heads in the country. In a populous LDC like India the values of I, II and IV are high but still the total emission is not too high because of a very low GNP per capita. The developed countries are trying to reduce their share of total emission by a reduction in I and II factors. The switch over to natural gas fuel has already been mentioned. Along with Flue Gas Desulphurisation for control of SO_2 a lot of attention is being paid these days to NOx control. The earlier technique of using water at the burners to keep the flame temperature low as an effort for reduction of NOx emission is now discarded for its deleterious effect on efficiency of energy conversion and replaced by low NOx producing dry burners. The fuel efficiencies at power stations are being raised by using better burners and better turbine designs and using co-generation where possible. The LDCs may not be able to switch away from coal fuel at present but should try to use the modern design of boilers, at least for the new plants. Efforts should also be made to reduce the energy intensity of the economy.

6. MINING AND THE METAL INDUSTRIES SECTOR

Coming to the mining and metal industries sectors, the greatest impact on GHG emission is obtained by improving energy efficiency and reducing the energy intensity of each operation. We can use the Canadian experience as an example of what can be achieved in this regard. Canada is a major mining country with the mining and smelting sector contributing 4% of its GDP and producing minerals valued at $27 Billion in 1998. In 1997, the mining sub-sector - the metal mining and non-ferrous smelting and refining- together accounted for 6.3% of total industrial energy consumed in Canada and about 5.7%of direct industrial CO_2 emission. According to the Mining Association of Canada, in 1990-97 period metal mining as a whole decreased its energy consumption by 10.1% and reduced CO_2 emissions by 4.2%. A notable development in the Canadian smelting and refining sector in the late 1990s has been the capture and conversion of waste heat in the form of steam, a clean and efficient form of energy. Sometimes the application of stringent environmental pollution laws can result in closure of industries, as was the case with many coke oven plants in USA in the 1990s and cement plants in the North European countries. Development of new technologies on the other hand can have big impact on control of future emissions. For example, if the hydrogen and fuel cell based cars find wide application, pollution from the transportation sector will get much reduced. A positive

way by which the coal mining industry can contribute to the reduction of GHG is by using the unworkable coal seams or the mining voids for sequestering CO_2 for which R&D work is going on. .

7. CONCLUDING REMARKS

The Kyoto Protocol does not put any obligation on the developing countries to achieve a target of GHG reduction by a given year. Even then India is under pressure from some developed countries, notably the USA, to take steps for reducing GHG emissions. If the step is achieved through increased energy efficiency in the mines and plants, it is a welcome step but if it requires a reduction in the use of the indigenous high-ash coal or going slow on construction of new power stations, it can't be accepted. India's per capita electricity consumption of 470 kWh is abysmally poor when compared with the world average of approximately 2200 kWh. India has a vast unemployment problem with the labour supply growing at an estimated 2.4% per year. In the short term employment generation, which requires a low cost of energy, should be our priority. In the long term population control and a greater use of renewable energy resources should be the objective of our planners. Thus the developing countries may have to adopt a slightly different approach to the global warming problem than that adopted by the developed countries.

Rain Water Harvesting, Conservation and Management Strategies for Urban and Rural Sectors

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1. Introduction

Water is essential for all life and used in many different ways, It is also a part of the larger ecosystem in which the reproduction of the bio diversity depends. Fresh water scarcity is not limited to the arid climate regions only, but in areas with good supply the access of safe water is becoming critical problem. Lack of water is caused by low water storage capacity, low infiltration, larger inter annual and annual fluctuations of precipitation (due to monsoonic rains) and high evaporation demand.

The term water harvesting was probably used first by Geddes of the University of Sydney. He defined as the collection and storage of any form of water either runoff or creek flow for irrigation use. Meyer's of USDA, USA has defined it as the practice of collecting water from an area treated to increase runoff from rainfall. Recently Currier, USA has defined it as the process of collecting natural precipitation from prepared watershed for beneficial use. Nowadays water harvesting has become a general term for collecting and storing runoff water or creek flow ,resulting from rain in soil profile and reservoirs both over surface/under surface. Previously this was used for arid and semi arid areas, but recently their use has been extended to sub humid and humid regions too. In India water harvesting means utilizing the erratic monsoon rain for raising good crops in dry tracks and conserve the excess runoff water for drinking and for recharging purposes.

2. History of Rain Water Harvesting

Water harvesting like many techniques in use today is not new. It is practiced as early as 4500 B.C. by the people of Ur and also latest by the Nabateans and other people of the Middle east. While the early water harvesting techniques used natural materials, 20th century technology has made it possible to use artificial means for increasing runoff from precipitation.

Evenari and his colleagues of Israel have described water harvesting system in the Negve desert. The system involved clearing hill sides to smooth the soil and increase runoff and then building contour ditches to collect the water and carry it to low lying fields where the water was used to irrigate crops, By the time of the Roman Empire, these runoff farms had evolved into relatively sophisticated systems.

The next significant development was the construction of roaded catchments as described by the public works Department of Western Australia in 1956. They are so called because the soil is graded into ditches. These ditches convey the collected water to a storage reservoir. Lauritzan, USA has done pioneering work in evaluating plastic and artificial rubber membranes for the construction of catchments and reservoirs during 1950's. In 1959,Mayer of water conservation laboratory, USA began to investigate materials that caused soil to become hydrophobic or water repellent. Then gradually expanded to include sprayable asphalt compounds, plastic and metal films bounded to the soil compaction and dispersion and asphalt fiber glass membranes. Early 1960, research programmes in water harvesting were also initiated in Israel by Hillal and at the University of Arizana by Gluff. Hillal's work related primarily to soil smoothing and runoff farming. Cluff has done a considerable amount of work on the use of soil sealing with sodium salt and on ground covered with plastic membranes.

Water harvesting was practiced more than 1000 years back in South India, by way of construction of irrigation tank, ooranis, temple tanks, farm ponds etc, but the research in India on this subject is of recent one. Work is taken up at ICRISAT, Hyderabad, Central arid Zone Research Institute, Jodhpur, Central Research Institute for dryland Agriculture (CRIDA), Hyderabad, State Agricultural Universities and other dry land research centers throughout India.

In Pakistan, in the mountainous and dry province of Balukhistan, bunds are constructed across the slopes to force the runoff to infiltrate. In China, with its vast population is actively promoting rain and stream water harvesting. One very old but still common flood diversion technique is called 'Warping' (harvesting water as well as sediment).

When water harvesting technique are used for runoff farming, the storage reservoir will be soil itself, but when the water is to be used for livestock, supplementary irrigation or human consumption, a storage facility of some kind will have to be produced. In countries where land is abundant, water harvesting involves; harvesting or reaping the entire rainwater, store it and utilize it for various purposes. In India, it is not possible to use the land area only to harvest water and hence water harvesting means use the rain water at the place where it falls to the maximum and the excess water is collected and again reused in the same area. Therefore the meaning of water harvesting is different in different area countries. The methods explained above are used for both agriculture and to increase the ground water availability.

The water harvesting for household and for recharging purposes are also in existence for long years in the world. During rainy days, the people in the villages used to collect the roof water in the vessels and use the same for household purposes including drinking. In South East Asian countries people used to collect the roof water (thatched roof by providing gutters) by placing 4 big earthern drums in 4 corners of their houses. They use this water for all household purposes and if it is exhausted only they will go for well water. The main building of the Agricultural College at Coimbatore was constructed 100 years ago and they have collected all the roof water by pipes and stored in a big underground masonry storage tanks by the sides of the building. These rainwater are used for all labs, which require pure and good quality of water. In the same way the rainwater falling on the terrace in all the building constructed subsequently are collected and stored in the underground masonry tanks Even the surface water flowing in the Nalla's in the campus are also diverted by providing obstructions, to the open wells to recharge ground water.

Hence Rainwater harvesting is as old as civilization and practiced continuously in different ways for different purposes in the world The only thing is that it has not been done systematically in all places, Need has come to harvest the rainwater including roof water to solve the water problems everywhere not only in the arid but also in the humid region.

3. Need for Rain Water Harvesting

Water is a becoming a scarce commodity and it is considered as a liquid gold in this part of the country (especially in Coimbatore, Erode, Salem Districts of Tamil Nadu). The demand of water is also increasing day by day not only for Agriculture, but also for household and Industrial purposes. It is estimated that water need for drinking and other municipal uses will be increased from 3.3 MHm to 7.00 MHm in 2020/25. Similarly the demand of water for industries will be increased by 4 fold i.e. from 3.0 MHm ti 12.00 MHm during this period At the same time more area should be brought under irrigation to feed the escalating population of the country, which also needs more water. But we are not going to get one litre more water than we get at present though the demand is alarming.

The perennial rivers are becoming dry and ground water table is depleting in most of the areas. In Coimbatore, the depletion is about 30-50m in the last 30-40 years. Country is facing floods and drought in the same year in many states. This is because, no concrete action was taken to conserve, harvest and manage the rain water efficiently.

The rainfall is abundant in the world and also in India. But it is not evenly distributed in all places. India being the monsoonic country, the rain falls only for 3 to 4 months in a year with high intensity, which results more runoff and soil erosion. Total rain occurs only in about 100 hours out of 8760 hours in a year. It also erratic and fails once in 3 or 4 years. This is very common in many parts of the country.

The availability of water in the world, in India and in Tamil Nadu is given below with rainfall.

Places	Rainfall in mm	Population	Availability of Water/Person/Yr $M^3/P/Year$
World	840	6 Billion	700
India	1150	1.0 Billion	2200
Tamil Nadu	925	62.5 Million	750

If the availability of water is 1700 M3/p/y, there will be occasional water stress, and if it is less than 1000 M3/p/y, it is under water scarcity condition. Though India is not under water stress conditions but Tamil Nadu state is already under water scarcity condition, but there is no need for panic since it is possible to manage this condition as in the

case of Israel where the availability is only about 450 M3/p/y, by means of water harvesting, water conservation and water management.

Water scarcity / stress is not limited to the arid regions; only but also occurring in high rainfall areas also. Chirapunj i gets more than 11,000 mm of average annual rainfall but face drinking water problem before monsoon commences whereas in Ralegoan Siddhi, in Maharastra there is no water scarcity problem though the annual average rainfall is only about 450mm. Hence to mitigate water problem / drought etc, there is an urgent need to follow our ancestral way of water harvesting and the latest technologies adopted in Soil and water conservation measures on watershed basis including roof water harvesting etc which are described in detail below.

The Theme paper on Water vision 2050 of India, prepared by Indian Water Resources Society (IWRS) has indicated that a storage of 60 MHm is necessary to meet the demand of water for irrigation, drinking and other purposes. But the present live storage of all reservoirs put together is equivalent of about 17.5 MHm which is less than 10% of the annual flow in the rivers in the country. The projects underconstruction (7.5 MHm) and those contemplated (13 MHm) are added, it comes only 37.50 MHm and hence we have to go a long way in water harvesting to build up storage structures in order to store about 60 MHm.

More than 75% of the areas comes under hard rock in Tamil Nadu. Further the porosity of the rock is only about 3%. The natural recharge of rainwater in this region is only about 8 -12%, which is very minimal. Therefore there is an urgent need to take up the artificial recharge of the rain for which water harvesting and water conservation structures are to be build up in large scale. The rainfall in coastal area is more than 1200 mm (Chennai) still; drinking water is a problem in almost every year. This is because the entire rainwater is collected in masonry drains (from houses, streets/roads etc) are taken to the sea instead of taking into the ground water aquifers or in surface reservoirs by pumping if need be. The ground water available can be used during summer and make the aquifer empty so that the rainwater can be put into the aquifers during rainy period by suitable water harvesting measures.

All the above details indicate the need for water harvesting measures in urban and rural area for the use of Agriculture, drinking and other purposes.

4. Methods of Water Harvesting in Rural and Urban Areas

There are different / various system of water harvesting depending upon the source of water supply and places as classified below.

a) In situ Rainwater harvesting

- Bunding and terracing.
- Vegetative / stone contour barriers.
- Contour trenching.
- Contour stone walls.
- Contour farming.
- Micro catchments.
- Tie ridging methods
- Farm ponds.

b) Direct surface runoff harvesting

- Roof water collection
- Dug out ponds / storage tanks
- Tankas
- Kundis
- Ooranis
- Temple tanks
- Diversion bunds
- Water spreading

c) Stream flow / runoff harvesting

- Nalla bunding

• Gully control structures
• Check dams - Temporary

Permanent

• Silt detension tanks
• Percolation ponds

d) Sub surface flow harvesting

• Sub surface dams
• Diaphragm dams

e) Micro catchment's / watershed

• Inter terrace / inter plot water harvesting
• Conservation bench terrace

1) Runoff inducement by surface treatment

• Roaded catchments
• Use of cover materials - Aluminum foils, Plastic sheet, bentonite, Rubber, etc
• Using chemicals for water proofing, water repellent etc. to get more run off water. A comprehensive watershed development on watershed basis including water harvesting structures are given in the figure I.

5. Plan of Action for Rainwater Harvesting

As stated early, rainwater harvesting is as old as civilization and is practiced in many countries including India from time immemorable. But government and people remember this only when water is not available even for drinking purposes. There is no use of spending huge sum of money when we notice the water scarcity for drinking, industry and agriculture. These activities / structure should be taken / constructed before the rainy season so that the rain water which goes as runoff outside the sub watershed / city limits can be collected and used directly or by recharging into the ground. Government is undertaking the wasteland / watershed development programs, but not done in a comprehensive / integrated manner / holistic saturating the watershed in all water harvesting measures. Hence there is a need to take up watershed development programmes - mainly water harvesting measures in a scientific and systematic manner.

The government of Tamil Nadu has laid condition that in any building construction, water harvesting work should be included and executed, but in practice, it is not perfect. The authorities concerned should monitor the programme so that the drinking water problem can be solved in all municipalities / corporation without any difficulty to some extent.

To sum up the following types of Water Harvesting System for different uses can be implemented in different parts of the country.

No	Region	Types of Water	Use
1	Arid plains	Artificial catchments to capture rainfall (tankas or kundis in Rajasthan)	Drinking
		Tanks or talabs in Rajasthan to capture surface runoff	Drinking and irrigation
		Embankments / obstructions across drainage / Nalla to capture surface runoff	Irrigation water & also for recharging
2	Semi Arid places	Tanks I Ponds/Eri to capture surface runoff and also chains of tanks called cascade.	Irrigation water and drinking water through recharge of ground water
3	Flood plains	Mud embankment which may be breached during the floods.	Irrigation water and drinking water through recharging ground water
4	Hill and Mountain region	Diverted stream flows Jammu, M.P., Maharastra	Irrigation water

6. Case Study in Water Harvesting

There are numerous case studies available in water harvesting both in Rural and Urban sectors. In Rural areas it is Soil and Water conservation measures taken on watershed basis to conserve and augment ground water. In the urban sector, it is mostly roof water harvesting for direct use and recharging the ground water and also collecting of surface runoff from pavements / roads and recharging it into the ground through recharge pits or using abandoned / existing wells. The following are the places where rain water / roof water harvesting has been implemented in a successful manner.

1. Rural areas

a. Ralegoan Siddhi in Maharastra state

b. Lakshman Nagar and Varisai Nadu in Theni Dt., Tamil Nadu.

c. Alankulam Taluk in Tirunelveli Dt., Tamil Nadu.

d. Aravari watershed in Alwar Dt., of Rajasthan:

e. Maheshwaram watershed in Andhra Pradesh.

f. Kapilnalla watershed in Karnataka

2. Urban Sectors

Mostly the roof water harvesting measures are taken up.

a. India

i. Tamil Nadu Agricultural University, Coimbatore, all main buildings.

ii. PRICOL, Periyanaickenpalayam (Industry Building), Coimbatore

iii. TWAD Board / office and PWD office at Chennai.

iv. Numerous Apartment buildings in Chennai.

v. Sundaram and Clayton Ltd, Padi, Chennai - (Industry buildings)

vi. TVS training schoool at Vanagaran, Chennai

vii. Rastrapathi Bhavan, Delhi.

viii. Center ofiscience and environment building at Delhi.

ix. Institute of economic growth, New Delhi.

b. Foreign Countries

I. Thailand - Many houses including thatched houses in villages.

II. Japan - office complex.

III. Germany - office buildings.

IV. Singapore - office buildings.

Rules and regulations have been framed for Rain Water Harvesting in all corporation, municipalities and panchayat unions in Tamil Nadu. The Gujarat government has issued a general resolution for the effort that no new construction would be allowed- if it does not have provision for rooftop rainwater harvesting. This would be valid in all 143 municipalities and 6 urban development authorities in the state. It is heartening to note that Confederation of Indian Industries (CII) and Federation of Indian Chambers of Commerce and Industries (FICCI) have taken action to implement the rain water harvesting to their Industry premises.

If the above measures are implemented in Rural and Urban areas, the drought in rural areas and drinking water problem in Urban and Rural population can be solved to some extent. The people, NGO, and Government should joint together and implement the rain water harvesting in a big way in all places in the years to come to solve water scarcity problem in the country.

7. Conclusions

It is very important to make water everybody's business. It means a role for everybody with respect to water. Every household and community has to become involved in the provision of water and in the protection of water resources. Make water the subject of a people's movement. It means the empowerment of our Urban and Rural community, i.e., to manage their own affairs with the state playing a critical supportive role.

Further involving people will give the people greater ownership over the water project including watershed development, Soil and Water conservation and water harvesting will go a long way towards reducing misuse of government funds. It will also develop the ownership (own water supply systems), they will also take good care of them. In this way it is possible to solve water problems facing the county in the 21st century.

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Challenges of Sustainable Environmental Health in Developing Countries

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ABSTRACT

One of the greatest failures of the last fifty years has been the failure to lay the foundation stones of public health in the developing world - hygiene, sanitation and water supply. It is a failure that today deprives hundreds of millions not only of health but of productivity. It is a failure that undermines the normal mental and physical growth of rising generations. It is a failure that pollutes fresh water resources with faecal matter on a massive scale. It is a failure that condemns more than a billion people to live with a daily environmental crisis of squalor, smells, and diseases. And it is a failure that holds back the development of people and of nations. Despite significant progress made in the economic & industrial development, the demographic and environmental health scenario continues to be a cause of serious concern in the developing countries particularly in those of Sub-Saharan Africa and South East Asia. The traditional problems of water and air-borne infections combine with malnutrition and poor environmental sanitation to form a vicious cycle which is increasing the burden of diseases beyond the capacity of the existing health infrastructure and jeopardizing the productivity of society. Today, while the urban population of these countries faces the development and environmental degradation, concurrently the rural population continues to suffer lack of sanitation and safe drinking water, malnutrition and ecological insecurity.

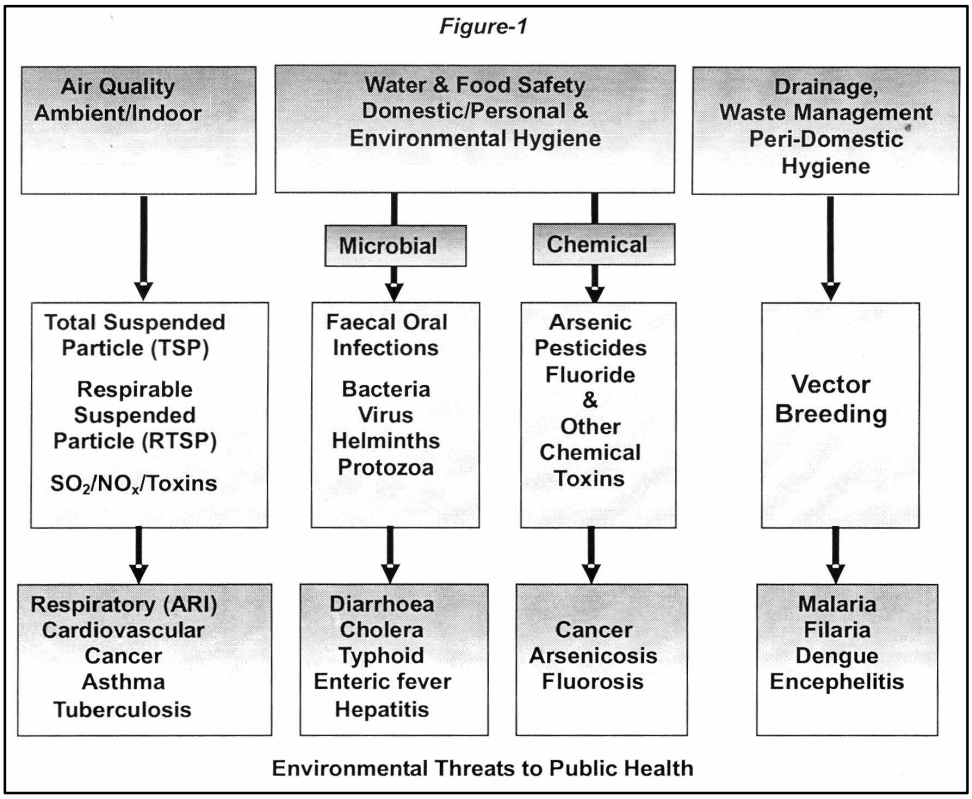
INTRODUCTION

World Health Assembly 1998 Alma Ata adapted four key strategies for attaining health for all. One of these key strategies was "Promoting healthy lifestyles and reducing risk factors to human health that arise from environmental, economic, social and behavioral causes. If the agenda has remained unfinished by a wide margin, the primary reason could be found in our failure to develop an enabling policy for promoting a hygienic environment conducive to healthful living. Environmental services such as community water supply, sanitation, control of air and water pollution, waste disposal, personal and domestic hygiene along with nutrition and health education are central to the concept of preventive and social medicine and they are the key pillars of primary health care. An estimated 60-80% of all diseases and over 1/3rd of deaths in the developing countries are caused by environment related factors, and on an average as much as 1/10th of each person's productive time is sacrificed to environment related diseases.

In most of the developing countries of Asia and Africa the Health authorities are struggling to maintain balance between the competing priorities of curing diseases, containing epidemic along with promoting environmental and preventive health. The heavy and critical burden of diseases caused by environmental factors, is putting tremendous pressure on the health infrastructure, which can hardly cope up with the same.

ENVIRONMENTAL THREATS TO PUBLIC HEALTH

The Figure below summarizes the major environmental threats to community health in the developing countries like pollution of ambient and indoor air, chemical and microbial contamination of water, soil and food and lack of sanitation, hygiene, drainage and waste management.



The faecal-oral infections caused by bacteria, virus, helminthes and protozoa attributable to unsafe water and lack of sanitation are causing huge burden of infectious diseases like diarrhoea, cholera, typhoid, enteric fever, hepatitis and critically high infant mortality. Pollution of ambient air in the urban environment and indoor air pollution are causing acute respiratory infections (ARI) along with cardio-vascular diseases, asthma and lung cancer. This is also abating tuberculosis which has already assumed critical proportions because of poverty and malnutrition. Another emerging environmental health to community health is posed by contamination of soil and water sources by pesticides and heavy metals like Arsenic, Fluoride etc. Inadequate drainage and improper solid waste management are creating conditions conducive to vector breeding giving rise to vector borne diseases like malaria, filarial, dengue, encephelitis etc.

ENVIRONMENTAL POLLUTION IN URBAN AREAS: A CRITICAL HEALTH CONCERN

Data in respect of non-communicable diseases related to environmental pollution and lifestyle are scanty. Cardiovascular diseases and cancer are on the increase in urban and industrial areas and psychological and neurological sickness due to high noise pollution is also causing concern. Both ambient air pollution and indoor and workplace environment are responsible for increasing respiratory episodes, asthma and acute respiratory infection. Though it would be difficult to project the exact burden of environmental and lifestyle-related non-communicable diseases, they may become one of the major public health problems in the developing countries, unless adequate measures are taken to arrest the environmental degradation of urban and industrial areas. The Table-1 depicts Annual health incidence and health costs due to ambient air pollution levels exceeding WHO guidelines in 36 Indian cities (using data from1991-1992).

Urban air today is a deadly cocktail of pollutants, thanks to the geometric growth of automobile vehicles on road and extremely inadequate emission control. Tiny respirable particulates (PM 10), exacerbate cardiac and respiratory problems; even at very low levels of exposure in the short run. These trigger cancer in the long term.

Carbon monoxide impairs the oxygen carrying capacity of the blood. Sulphur-dioxide is associated with increased mortality and hospital admissions associated with respiratory and cardiac symptoms. Nitrogen oxides increase the susceptibility of respiratory systems and impair immune responses. To these we should add a range of air toxins including volatile organic compounds and polycyclic aromatic hydrocarbons. Figure 2 depicts the annual average levels of SPM in the ambient air of 36 Indian cities. Both in terms of total suspended particulate matter (TSPM) and fine respirable suspended particulate matter (RSPM) major Indian cities are critically contaminated. According to a

WHO estimate of the 500000 deaths caused per year globally due to exposure to particulate pollution, 20% occur in India. Figure-3 depicts WHO estimates on excess deaths due to particulate matter in ambient air across various regions in the world. It could be seen that China, India and Central Eastern Europe are the most affected regions.

Table-1

	Physical impacts	Cost valuation (US$ millions)
Premature deaths	40,351	170-1615
Hospital admissions and sickness requiring medical treatment	19,800,000	25-50
Minor sickness (including restricted activity days and respiratory symptom days)	1,201,300,000	322-437
Total		517-2102

Figure-2

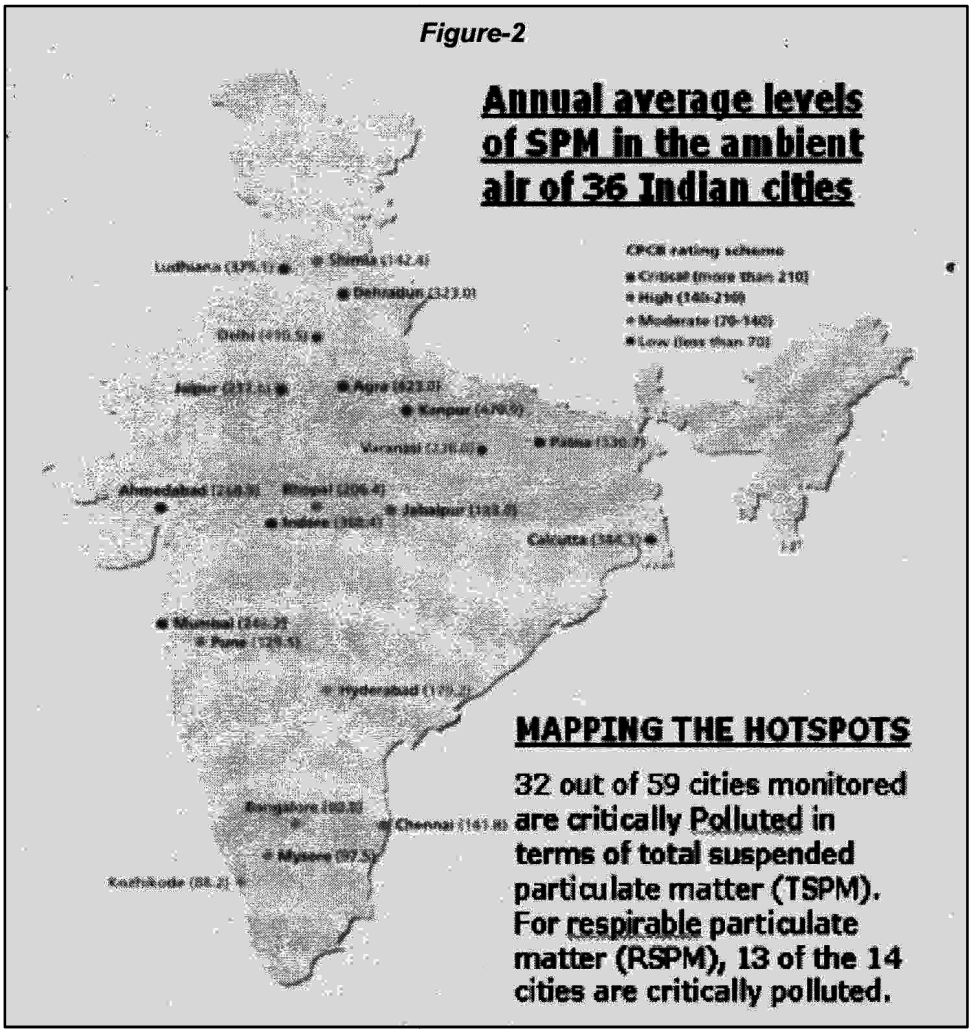


Figure-3

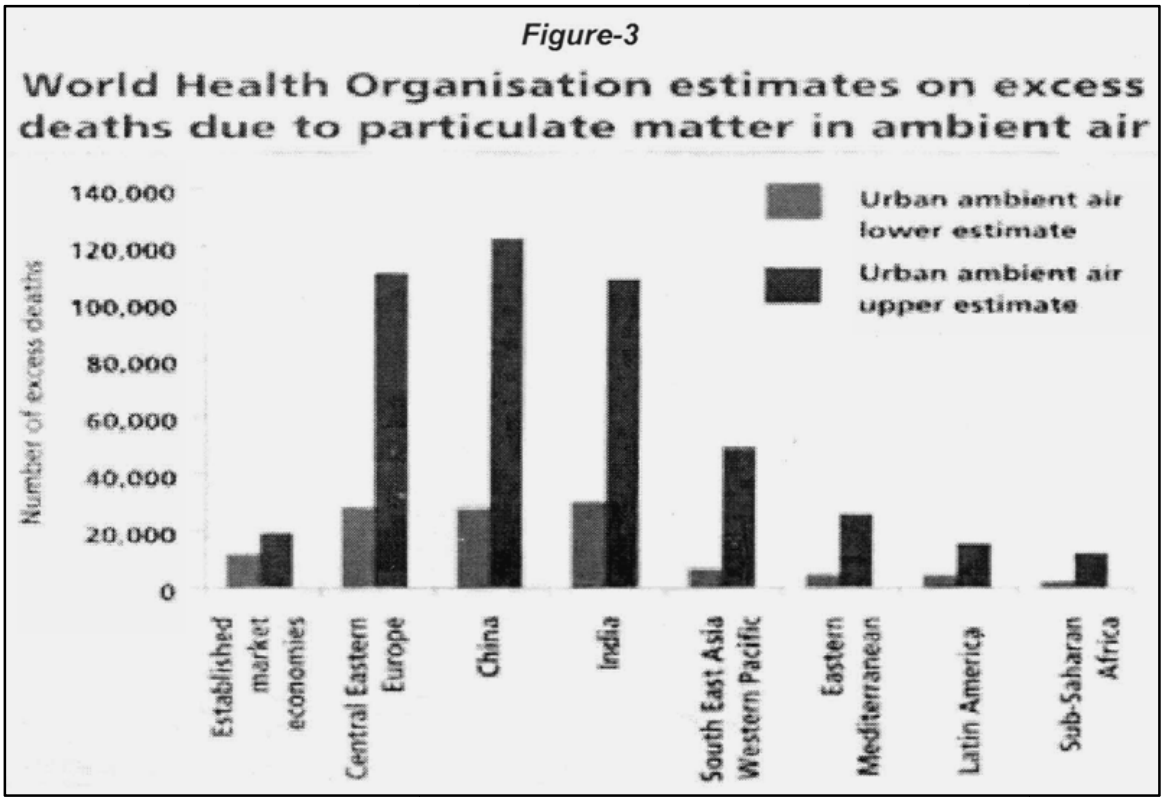


Figure-5 depicts average SPM levels in the ambient air at the major traffic intersections in Kolkata. Impact on the pedestrians and those working roadside including the traffic policeman could be extremely serious. It could be stated that the present rate of growth of automobile transport is not environmentally sustainable unless stricter emission control and traffic management regulations are enforced. Figure 4 depicts the rising trends of Bronchial asthma and Bronchiolitis cases at a New Delhi Hospital.

Figure-4

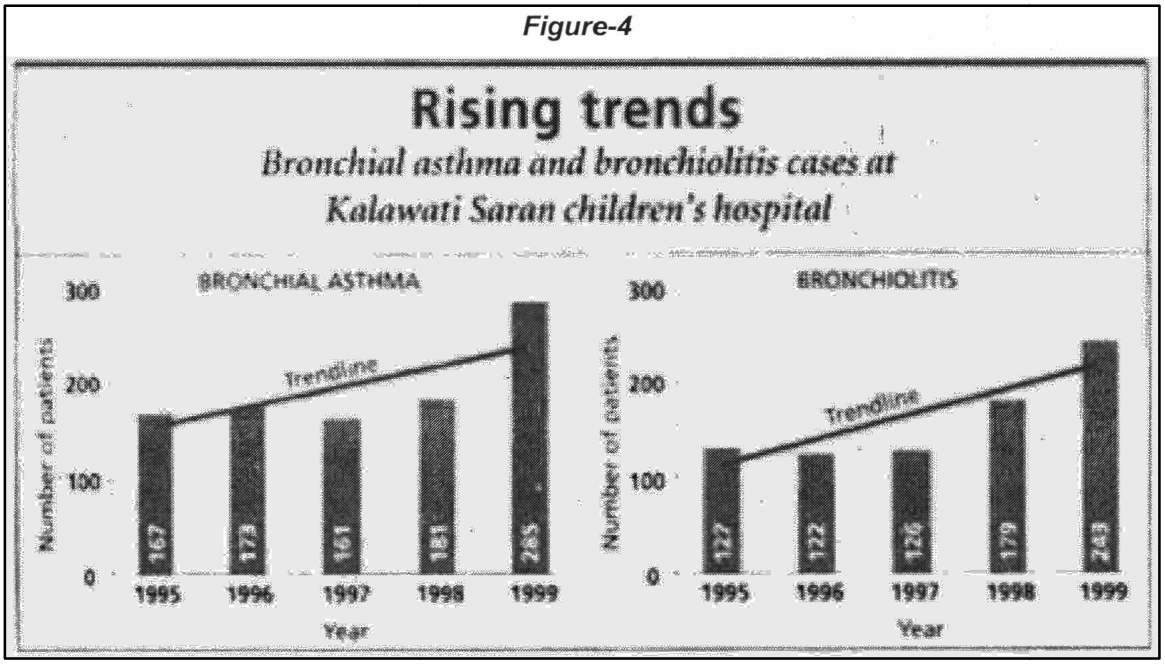
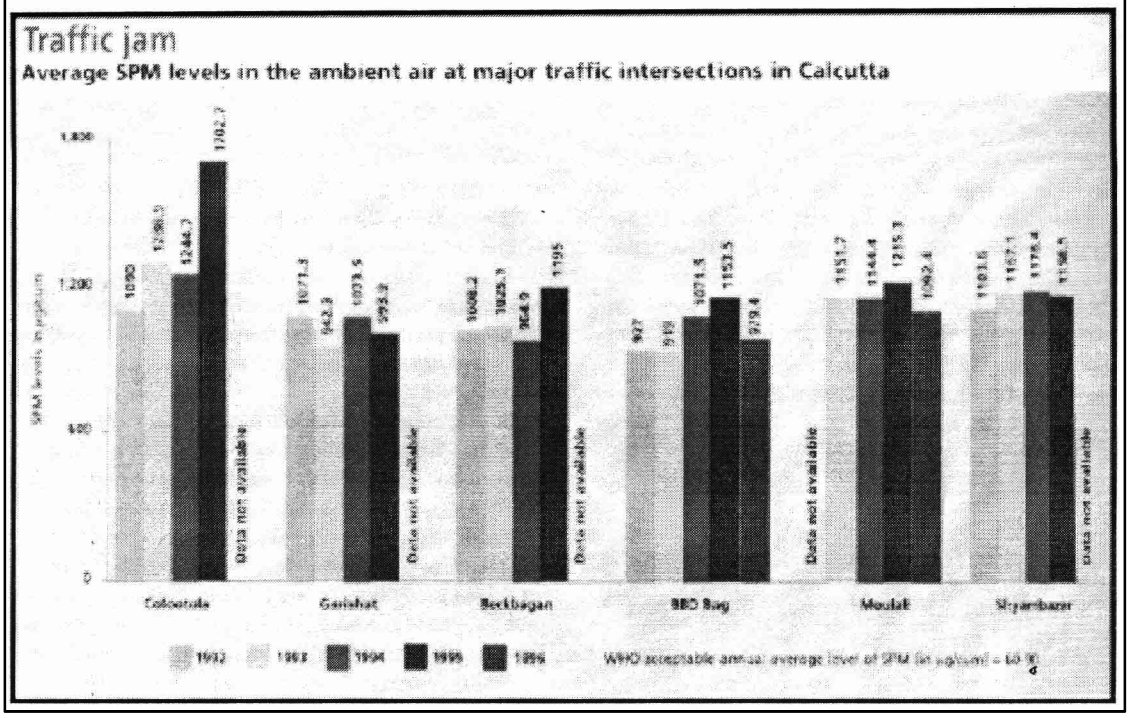


Figure-5



INDOOR AIR POLLUTION: A CRITICAL ENVIRONMENTAL PROBLEM IN THE DEVELOPING COUNTRIES

Concentration of particles found indoors often exceeds the levels found outdoors, particularly in the ill-ventilated homes of the rural poor and urban slums. Experts have identified six major categories of ill-health which can be attributed to exposures indoors.

- Acute respiratory infections in young children
- Adverse pregnancy outcomes (low birth-weight, stillbirth or neonatal death) for women exposed during pregnancy
- Lung Cancer
- Chronic lung ailments (bronchitis or asthma) and associated heart maladies
- Diseases of the eyes
- Increase in the severity of coronary artery disease
- 4.3 Million Children fall prey to ARI every year.

WATER AND SANITATION RELATED DISEASE BURDEN IN THE DEVELOPING COUNTRIES

Despite substantial improvement in water and sanitation coverage, both mortality and morbidity figures, indicate a significant burden of communicable diseases derived from water, sanitation and other environment factors. The Figure-6 depicts the infectious disease burden in the year 2000 in different regions in terms of disability adjusted life years (DALY) per 1000 persons. Burden of select infectious diseases in the developing countries are shown in Table-2. Estimates of morbidity and mortality of water and sanitation related diseases in the South East Asian region countries are shown in Table-3.

Regional child mortality and select determinants are depicted in Table-4. It could be seen that India and Sub-Saharan Africa are among the worst affected regions. Lack of access to sanitation, female illiteracy and unsafe water are the three critical factors behind high child mortality in these countries. The Table-5 indicates the estimated preventable child deaths that could be achieved through various environmental interventions. It is pertinent to note that more than 4 million child deaths in the developing countries could be prevented by implementing 100% access to safe water & sanitation along with immunization and female literacy.

Figure-6
Infectious diseases burden in the year 2000 in different region in terms of disability adjsted life years (DALY) per 1000 persons.

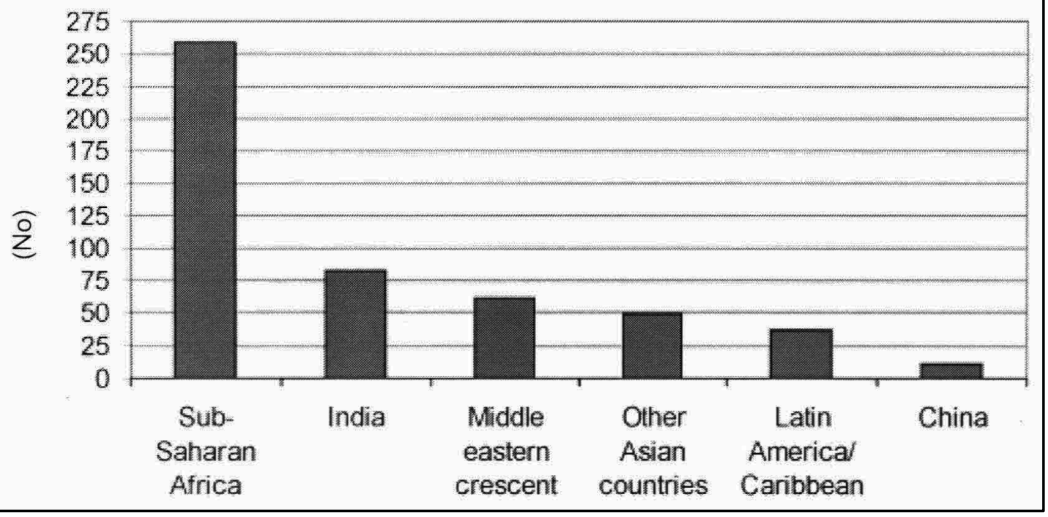


Table 2
Burden of select infectious diseases in the developing countries.

Diarrhoea	**4 billion cases per year. 2.2 million deaths**
Intestinal nematode infections	Infect about about 500 million people.
Schistosomiasis	About 200 million are infected. 20 million suffer severe consequences.
Trachoma	About 6 million are blind from trachoma

Table-3
Estimates of morbidity and mortality of water-related diseases in SEAR countries (late 1990s)

Diseases	Morbidity (episodes/year or) people infected)	Mortality (deaths/year)
Diarrhoeal episodes	0.7 to 3.7 episodes per child less than 5 years of age	
Malaria	3,100,000	NA
Dengue Fever	400,000	8,000
Hepatitis	NA	28,000
Lymphatic Filariasis	60,000,000 (people infected)	-

Table-4
Regional Child Mortality & Select Determinants

	India	China	Other Asian countries	Latin America/ Caribbean	Middle Eastern Crescent	Sub-Saharan Africa
Child mortality-under 5 (per 1000 live births) in 1999	90	37	65	38	92	166
Access to improved water source in 200 (% of total population)	88%	75%	78%	85%	83%	54%
Access to sanitation in 2000 (% of total population)	31%	38%	66%	78%	76%	54%
Female illiteracy in 2000 (% of 15-24 year olds)	35%	4%	20%	6%	31%	27%
Immunization 1996 -97 (% of infants <12 months)	81	96	90	87	79	55

Table-5

	India	China	Other Asian countries	Middle Eastern Crescent	Sub-Saharan Africa	Latin America/ Caribbean	Total
Increase child immunization to 100%	110	5	30	85	525	15	770
Increase female literacy to 100% (age 15-24 year)	460	15	135	280	615	15	1520
Provide safe water to 100% of the population	90	60	90	90	700	20	1050
Provide safe sanitation to 100% of the population	570	150	115	105	565	25	1530
Provide safe water and sanitation to 100% of the population	635	200	195	185	1165	45	2425
Increase immunization and female literacy and water and sanitation to 100%	1030	215	330	495	1910	70	4050

THE KILLER VECTORS IN URBAN AND RURAL ENVIRONMENT

Vector-borne diseases like Malaria, Filaria, Dengue, Kala-azar, encephalitis etc are adding significant disease burden in the developing countries. Unhealthy living conditions, lack of drainage and solid waste management are the primary factors for vector breeding. In India, it has been a century of research and implementation of Malaria control strategies. It was a major killer during the 40s and 50s. Concerted efforts by the Government after independence and intensive use of insecticides brought down the incidence to a few thousand cases per year by 1960. But since then, there has been a steady resurgence particularly of urban malaria. Today, it is more than 2 million cases per year. Excessive reliance on insecticides has damaged the environment and yet could not protect public health in the long run. Faulty urban planning and lack of peri-domestic and home hygiene are to be blamed for the resurgence of urban malaria. A long term and sustainable approach is required for the control of vector-borne diseases in the developing countries. Bio-environmental control strategy which is based on vector biology and ecology could be the most cost effective and sustainable measure for vector control.

CHEMICAL TOXICANTS IN WATER, SOIL AND FOOD CHAIN: EMERGING HEALTH CONCERN IN THE DEVELOPING COUNTRIES

The WHO Guideline for drinking water quality set guideline values for some 100 distinct chemicals. Not all of them occur in significant concentrations in all the countries or with significant frequency. The public health significance also varies from country to country. As such, in developing a national risk management strategy for chemicals in water and environment, care should be taken to consider all social, health, economic, cultural and ecological issues. While, we must ensure that resources are not unnecessary diverted towards monitoring substance of relatively minor health importance, there is absolutely no way that we can compromise on the issue of health risk while setting national standards and standards for monitoring and surveillance of water sources, food and soil. Among the chemicals & heavy metals, which are posing serious threats to the health of the community, Arsenic, Fluoride and pesticides are emerging as the most critical health concerns in some countries of Asia and Africa.

PESTICIDES AND HEAVY METALS IN THE ENVIRONMENT

Data in respect of pesticide residues and toxic heavy metals in the environment is rather inadequate for a rational and scientific assessment of environmental health impact. However, despite limitation of available data, the points of grave public health concern for the developing countries are:

(i) Residues of pesticides contribute significantly to contamination of food, water, soil, animal products and human milk and tissues.

(ii) The ubiquitous presence of DOT and HCH in the environment.

(iii) High body burden of DOT and HCH in the general population, and the possible risk of breast cancer among women, and

(iv) Widespread contamination of bovine milk and baby feeds with hard-to-degrade organochlorine pesticides.

(v) Consuming vegetable contaminated with heavy metals and pesticides could lower a child's intelligence.

WHO ESTIMATED IN 1991 THAT AROUND 25 MILLION FARM WORKERS IN THE DEVELOPING COUNTRIES ARE LIKELY TO SUFFER PESTICIDE POISONING IN EACH YEAR

The increasing use of chemicals and pesticides in agriculture, industries and commerce as well as in public health and medical care services poses serious risk for human and the environment. The WHO publication on health situation in South East Asian countries has reported a number of cases of pesticides poisoning in Bangladesh, India, Indonesia, Myanmar, Nepal and Thailand, affecting large number of people. The present level of management of hazardous chemical industries including bio-medical wastes from hospitals is a serious health concern in the region. Though a number of regulations and legislation have been enacted in recent years in India and other countries, enforcement of the same is poor. There is an urgent need to strengthen national capabilities for ensuring sound management of chemicals and hazardous wastes.

In surveys conducted by Indian Council of Medical Research, out of total 13,000 samples of wheat, rice, spices, pulses, vegetables, fruits etc tested between 1968- 1998, 54% were found to be contaminated and it is apprehended that the daily intake of pesticides like HCH, Aldrin, DOT might be exceeding ADI (Acceptable Daily Intake) significantly.

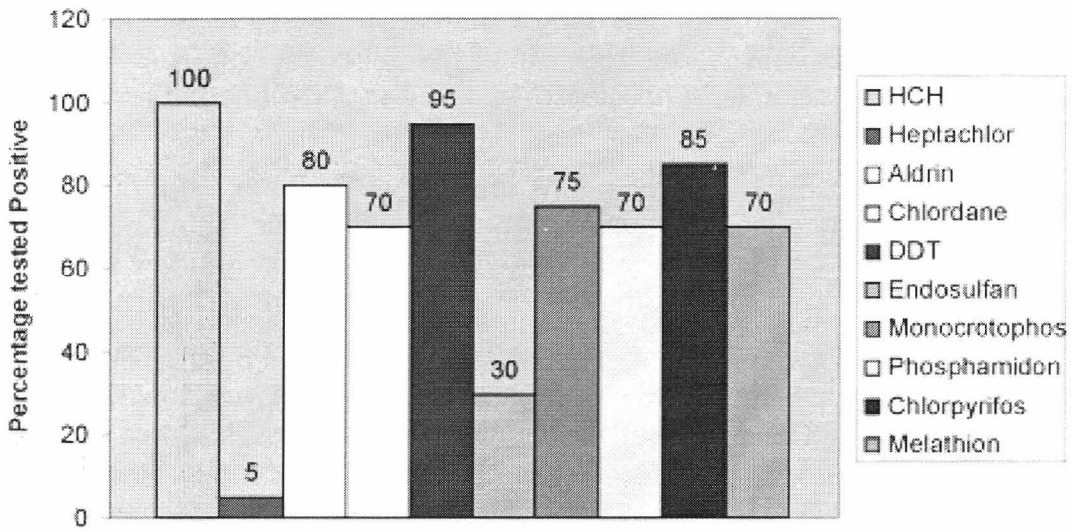
Table-6 depicts the levels of pesticides in some common vegetables in the rural areas of Punjab in India. A random sample survey in a few villages of Punjab State in India indicated high level of pesticides among the agricultural farmers. (Figure-7).

Table-6

The Toxins in Food Pesticide levels in two blocks in Punjab

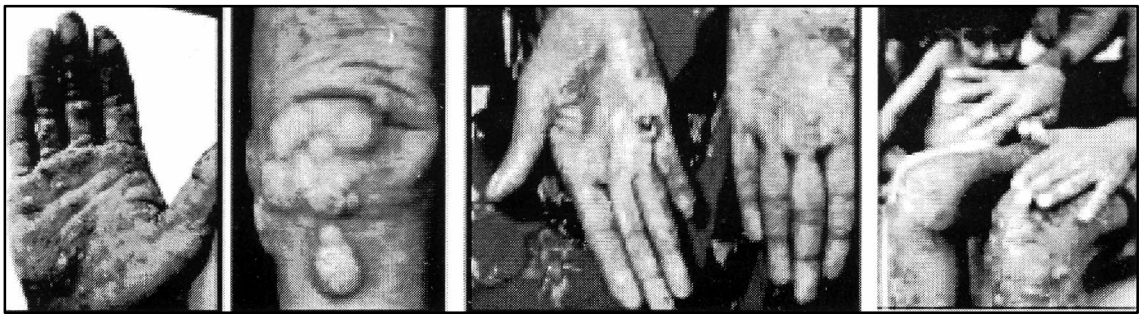
Type of sample	Talwandi Sabo	Chamkaur Sahib
Vegetable	Cauliflower	Cabbage
Heptachlor	0.015 ppm	0.009 ppm
Chlorpyrifos	0.00333 ppm	0.001 ppm
Alpha endosulphan	0.0027 ppm	Absent
	Carrot	Ghia (Bottle gourd)
Aldrin	0.0013 ppm	Absent
Ethion	1.68 ppm	Absent

Figure-7



ARSENIC & FLOURIDE IN GROUNDWATER, THE NEW MENACE IN SOUTHEAST ASIA

The excess of naturally-occurring harmful inorganics like arsenic and fluoride in groundwater is a major health concern in the South-East Asia Region (SEAR). Drinking arsenic rich water over a long period is unsafe, as it is a documented carcinogen. Almost 50 million people in Bangladesh are at risk of drinking water with arsenic contamination above 50 micrograms per litre. The same figure for West Bengal in India would be between 5-12 million. The most commonly reported, symptoms of chronic arsenic poisoning include hyperpigmentation and keratosis. Skin cancer and internal cancer can also occur. The estimated risk of excess lifetime skin cancer in Bangladesh at the present arsenic contamination level is put at 3754000 (0.29% of the population) Situation in India and other South Asian countries are likely to be similar. A scientific epidemiological assessment of the extent and magnitude of the problem in Bangladesh and India has not yet been made.



The problem of arsenic in groundwater has also been reported from other SEAR countries, such as Myanmar, Nepal, Thailand, China, Vietnam, and Cambodia. The critical concerns for governments and other sector partners in the affected countries are:

(i) Restricting the people from drinking arsenic-contaminated water;

(ii) Providing alternative sources of arsenic free source drinking water;

(iii) Informing the people about the health risk associated with drinking arsenic contaminated water, and

(iv) Providing medical relief, by way of training medical practitioners serving either in government systems or outside.

In India, 20 out of 35 states are affected by high level of fluoride in groundwater and 66 million people are at risk of fluorosis. Six million children below the age of 14 are suffering from skeletal fluorosis. Fluoride problems have also been reported from China, Bangladesh, Thailand and many other countries. Like arsenic, in the case of fluoride too, the most important control measure is to provide alternative safe source of water or fluoride contaminated water must be treated.

NEW MILLENNIUM: OLD MALADIES

In India, according to a World bank report, the total costs in terms of health and productivity impact of lack of safe water and sanitation and environmental degradation, add up to a total of US$ 9.7 billion per year i.e 4.5% of the GDP of the country at 1992 values. The health impact of water and air pollution and lack of sanitation account for 73% of the total damage. Unfortunately, the health sector, which bears the burden of the activities of sectors like urban & rural development, industry etc, does not have adequate institutional capacity or infrastructure for monitoring the environmental health impact of the same. As such, it can do little advocacy for protecting and promoting environmental health.

We are at the threshold of a new millennium, yet the maladies of the old system and institutions inherited from the colonial past still continue. Among these maladies following could be identified in many of the developing countries.

- Market economy based medical education with curative and hospital care bias.
- Neglect of preventive, promotive, environmental health.
- Lack of a holistic and community based approach to disease control.
- Health Policy stands in isolation from the Non-Medical and socio-ecological Determinants of Health
- Lack of epidemiological, environmental and ecological surveillance.
- Inadequate and ineffective advocacy on the part of health on key policy matters related to environment, industry, nutrition, education, gender etc.

APPROACH FOR 21 ST CENTURY

ENVIRONMENT & HEALTH: THE CRITICAL COALITION

As a first step towards formulation of a radically different Public Health Approach in the 21 st century we need an in-depth socio-ecological and epidemiological analysis of national health programmes. Only on the basis of a rational and scientific epidemiological, ecological and demographic understanding of the existing situation, we would be able to add the much needed and much talked about, ecological and social dimension to our health system. Provision of an environment conducive to healthful & hygienic living condition would remain the most essential & critical factor for health promotion. Policies and programmes of the environment-related sectors need to be smoothly

interfaced with the policies and programmes of the health sector, in order to reduce the health risk to the citizens and the consequential disease burden.

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Sanitation for Rural India — Challenges and Strategies

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Esteemed dignitaries, colleagues and friends,

'Sanitation is more important than political independence', thus said the Mahatma, Mohandas Karam Chand Gandhi, in 1925, while fighting for India's independence. Almost a century later, the whole world joins him in thinking alike.

We all know that lack of sanitation facilities and poor hygiene cause millions of poor people to die every year from preventable diseases. Globally, this amounts to more than 3 million deaths per year, two thirds of which are caused by diarrhoea alone. Of these, 90 percent are children under 5 years of age, mostly in developing countries. About 88 percent of the diarrhoeal diseases are attributed to unsafe water supply, inadequate sanitation and personal hygiene- 'Besides, more than 133 million people suffer from high intensity intestinal helminth infections leading to cognitive impairment, dysentery and anaemia.

What is Sanitation?

Derived from the Latin word Sanitas, which means health, sanitation is the hygienic means of promoting health through prevention of human contact with the hazards of wastes. Hazards can be physical, microbiological, biological or chemical agents of disease. Wastes that can cause health problems are human and animal faeces, domestic wastewater, solid wastes, and industrial and agricultural wastes. Prevention can be by using engineering solutions like sewerage and wastewater treatment, simple technologies like latrines and septic tanks, or evert by personal hygiene practices like simple hand washing with soap.

Status in Rural India

Lack of adequate sanitation is a pressing challenge in both rural and urban India. Sanitation related diseases take a heavy toll of lives, especially of children below five. Every day, an estimated 1,000 children under five die in the country because of diarrhoea. Prevalence of child undernutrition in India, the highest in the world at 47 per centl, is aggravated by the prevalence of diarrheal disease (at 22 per cent2). Studies suggest that it affects child development and undermines educational achievement. Sanitation related illnesses drain productivity and income, ultimately perpetuating poverty. Inadequate sanitation facility force households into the indignity of open defecation, an acute problem especially for women and young girls. One of its major consequences is education drop-out by young girls and teenage women, particularly at puberty.

According to Census 2001, roughly 72 per cent of India's population lived in villages. Estimates indicate that though there is a trend towards fast urbanisation, at least 67 percent of India's population will still continue to live in villages beyond 2015. And therefore rural sanitation will continue to be a major sector demanding due attention of the governments, related institutions and the public at large.

The responsibility for provision of sanitation facilities in India primarily rests with the local governments of the respective areas. The local government in an urban area is the Urban Local Body (ULB), i.e., the Municipal Corporation, Municipality or the Notified Area Council, while it is the Gram Panchayat in a rural area. The State and Central Governments act as facilitators through enabling policies, budgetary support and capacity development. 'The day everyone of us gets a toilet to use, I shall know our country has reached the pinnacle of progress', said by Jawaharlal Nehru, the first Prime Minister of India in the early years of independence, is indicative of the concern of the Government towards sanitation.

The plan periods however were characterized by relatively negligible investments in the sector till the 6th Five Year Plan lasting 1980-85, during which the International Drinking Water Supply and Sanitation Decade 1980-1990was launched (in 1980).In 1986,the Government of India initiated the country's first nation-wide sanitation program, viz., the Central Rural Sanitation Program (CRSP)with an investment of more than Rs. 6 billion. Household pour-flush toilets were provided on hardware subsidies with a view to generate demand, which however failed miserably.

Despite construction of over 9 million toilets, rural sanitation grew at just 1 per cent annually in the 1990s. By 20013, only 22 per cent of rural households had access to a toilet.

The Sector Reforms

The relatively poor performance of the CRSP was a lesson learnt. The program proved that mere provision of sanitary facilities neither helps increased coverage nor the usage. It came with a strong message that attention to total sanitation must be given in order to attain sustainable sanitation. Accordingly, the program was restructured and launched as Total Sanitation Campaign (TSC) with a paradigm shift from focus on infrastructure to that on behaviour changes. Key features of TSC include a community led approach with emphasis on hygiene behaviour, school and institutional sanitation, solid and liquid waste management, environmental sanitation, Information, Education and Communication (IEC), capital incentives only for households below poverty line (BPL post construction and usage, flexible menu of cost-effective and appropriate technology options based on consumer preferences, development of supply chain to meet the demand stimulated, fiscal incentive like Nirmal Gram Puraskar (NGP) etc.

Reports say that more than 59 million individual household latrines have already been constructed against a massive target of 119.83 million in rural India, taking the figure of around 22 per cent in 2001 to around 50 per cent today. Reports further add that more than 0.93 million school toilets, 17,000 sanitary complexes for women and 0.29 million pre-school or Anganwadi toilets have been constructed by now.

On the other hand however, a rough evaluation study5 indicates that more than a quarter of the toilets are not being used. The reasons attributed are inadequate awareness, water scarcity, poor construction standards, and standardized toilet designs. Similarly, the reasons attributed to lower levels of use of school and institutional toilet are inadequate awareness, inadequate numbers and capacities of toilets, common toilets for boys and girls, water scarcity, poor construction standards, improper and unsafe location, child unfriendly designs, poor maintenance, locking up of toilets by teachers for their exclusive use.

Scaling Up through Integration and Convergence

Creation of awareness is a much talked about phenomenon today. As we know it is aimed at changing attitudes. Change of attitude is aimed at changing human behaviour and then change of habits. But habits die hard. Change of habits is a change of culture. In other words, a sanitation program is a cultural revolution by itself. And bringing in a cultural revolution is easily said than done. It needs a multi-pronged approach to uproot the old bad habits in all people in a community to replace them with new good ones. Besides, it needs a minimum reasonable time to make the changes sustainable.

Integrating and converging sanitation programs with other initiatives of the Government and other bodies have proved to achieve results faster. There are many other social sector flagship programs implemented parallel to sanitation programs like TSC, viz., the Rajiv Gandhi Drinking Water Mission (RGDWM),the National Rural Health Mission (NRHM), the Sarva Shiksha Abhiyan (SSA), the Mid Day Meal Scheme, Integrated Child Development Services (ICDS), Swarnjayanti Gram Swarozgar Yojana (SGSY),National Rural Employment Guarantee Ad (NREGA), Backward Regions Grant Fund (BRGF) Program, 12th Finance Commission (TFC) etc., each of which has some commonality with the other. Most of these programs are implemented' through the same district-level institutions and many of the activities are complementary, such as community mobilization, IEC campaigns, capacity development etc. and these could be well integrated with the TSC to its best advantage.

TSC should be integrated with ARWSP in ensuring water supply in all school toilets. The maintenance of these toilets should be integrated with the Students Health & Hygiene Committees, Balsansads and School Cabinets under health and education programs. The Mid-day Meal Scheme should be integrated for creating awareness amongst children and workers on health and hygiene activities with specific focus on hand washing before preparation of and taking meals as well on adequate cleaning of utensils, grains and vegetables. TSC should be integrated with ICDS in providing water and sanitation facilities to Anganwadi Centres along with health and hygiene education activities. The Communication and Capacity Development Units (CCDUs) under TSC and Udisha Training Centres and Regional Anganwadi Workers Training Centers (AWTCs) under ICDS should undertake joint training programs to achieve better sanitation, health and hygiene in Anganwad is as well as in the village communities.

Successful convergence is possible between National Rural Health Mission and Water and Sanitation Missions at various levels through joint training programs for functionaries of both NRHM and TSC. Convergence is possible with SGSY through training of women masons under SGSY for TSC works, linking bank loans under SGSY to help

Self Help Groups (SHGs) to set-up Rural Sanitary Marts. Convergence is also possible with NREGA, BRGF and 12th Finance Commission for Solid Waste Management by use of TSC funds on capital costs of technologies.

Women and Children as Prime Movers

In much of the developing world including India, women and girls pay the heaviest price for poor sanitation. There are many reasons, beyond health repercussions, for why sanitation is a priority issue for women and girls. First, in many cultures, the only time available for women or girls to defecate, if they don't have a latrine, is after dark. Apart from the discomfort caused by the long wait, this sometimes causes serious illness. Second, there is also a risk of harassment and assault apart from that of snake and scorpion bite during the night-time walk to and from the communal defecation fields. Third, the lack of safe, separate and private sanitation and washing facilities in schools is one of the main factors preventing girls from attending school, particularly when menstruating. Fourth, the health and lives of more than half the world's children are constantly threatened by environmental hazards as they get sick through contact with excreta in their environment. Caring for sick children adds to the already heavy workload of women and girls. Fifth, many pregnant women have sanitation-related hookworm infections that pose a considerable health burden in developing societies. Sixth, about the indignity of open defecation, the less said the better.

On the other hand, women and girls, as managers at the household level, are traditionally responsible for domestic water supply and sanitation, and maintaining a hygienic home environment in Indian communities. As a corollary, a sanitised India without the full participation of women is implausible. There could probably be no better method of professing sanitation than with the direct involvement of women at all levels and at all stages, Women understand the need of everybody in the house and are better planners than men. They are better campaigners and once involved, change the culture of the entire community towards using toilets. Their involvement in construction of toilets and management of Rural Sanitary Marts (RSMs) makes the programs more result oriented. They are probably the best change agents for sanitation that could be available on earth.

Children similarly have proven themselves to be most successful ambassadors of any activity for a society. The newest trend is to best use their profound hidden capacity in propagating the messages of sanitation among family members, the neighbourhood and the surrounding to change the community and the environment as a whole.

Role of NGOs

Sanitation programs cannot probably be successful without the active participation of Non Government Organisations. They have a very wide role to play in the system beginning from the IEC activities to setting up of Production Centres or Rural Sanitary Marts, providing necessary support for construction, and to ensuring that toilets constructed are actually used. Dedicated NGOs, through their experience and skill, can motivate the communities in an easier and better

manner than others to attain a sustainable change in the community sanitation status.

Private Initiatives

Private initiatives play a major role in achievement of household and institutional sanitation coverage. Under the TSC, Above Poverty Line (APL) households are expected to build household toilets without any household incentives. To date, more than 27 million APL household toilets have been constructed; mostly with private initiatives, as compared to 32 million BPL household toilets6, mostly with Government and other support. In addition, the private sector is predominantly involved in the supply of sanitary materials and services, and to an increasing extent in maintenance.

Role of Media

The topic of sanitation is not a regular feature in mainstream news media, unless there is sensational news such as a disaster linked to sanitation or its lack thereof. However, all types of media, be it print, radio or television, have an important and integral role to play in this revolution at all levels, be it national, state or sub-state, as they are the main channel to communicate with the target audiences.

Changing Trends in Career Options

After John Snow and Edwin Chadwick discovered in early 19th century that lethal cholera was spread by water, sanitation became and continues to remain the most important medical invention of the world. More interestingly, water supply and sanitation, mostly handled by engineers the world over, are medical interventions and have posed a challenge more to the engineers than to the people in the medical profession.

Ironically, even as the water and sanitation sector is so very important to human life, there has always been an undersupply of professionals to this sector. This is more so in the recent times, when the trend in professionals is an expectation for high salary packages in the beginning of the careers, which the private companies and Multi National Companies (MNCs) rare able to meet. Thus there is always a diversion of trained professionals from good engineering colleges towards private companies and the MNCs, leaving only those passing out of C medium-level engineering colleges to join the water and sanitation sector, mostly controlled by the Government. In addition, inadequate career counselling before joining or while doing engineering is another major reason for good students not opting for this sector as a career.

The Challenge Ahead

Target 10 under Goal 7 of the Millennium Development Goals (MDGs) is to halve, by 2015, the number of people without sustainable access to safe drinking .water and safe sanitation. Although the MDGs were formulated in 2000, the baseline has been set as 1990. At current rates of progress with about 50% coverage already made, India will not only meet the sanitation MDG, but will exceed it, by covering more than 90% by 2012.

Mera Bharat Mahan! Our claim to these nice sounding feel-good words is certainly worth it, when we take into account its legions of software programmers, counts of, call centres, piles of nuclear bombs and dozens of space expeditions. But when one fingers at more than half of shining India's population still defecating in the open leaving about a lakh of tons of faeces every day to pollute more than 75 percent of the country's , surface waters to cause more than. a crore cases of diarrhoea, 7 lakh cases of typhoid and 1.5 lakh cases of viral hepatitis every year, one feels shrunk on the peerless status of the most disturbing crisis for incredible India today, possibly calling for a sanitation emergency.

It is encouraging that we have a strong political will in India today with a focussed proactive look towards sanitation with committed financial resources. With a multi-pronged attack on all related elements, with local bodies and civil societies taking the lead; with priority support from the administration at all levels, with women engaged as change agents and children as health ambassadors, with effective involvement of Self Help Groups, and above all with an enabling environment around, I am confident that our much desired open-defecation-free sanitised rural India will be reality in the very near future.

Thank you very much for giving me this opportunity of being amongst 'you to' share my feelings on such an important ongoing revolution in the country.

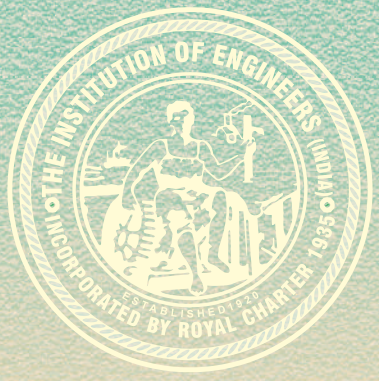
About Environmental Engineering Division Board

The Institution of Engineers (India) established the Public Health Engineering Division in the year 1962 and thereafter, it was renamed as Environmental Engineering Division. This Division consists of quite a large number of corporate members from Government, Public, Private sectors, Academia and R&D Organizations. Various types of technical activities organized by the Environmental Engineering Division include All India Seminars, All India Workshops, Lectures, Panel Discussions etc., which are held at various State/Local Centres of the Institution. Apart from these, National Convention of Environmental Engineers, an apex activity of the Division, is also organized each year on a particular theme approved by the Council of the Institution. In the National Convention, several technical sessions are arranged on the basis of different sub-themes along with a Memorial Lecture in the memory of '**N V Modak**', the eminent Environmental Engineer of the country, which is delivered by the experts in this field.

Due to multi-level activities related to this engineering discipline, this Division covers different sub-areas such as:

- Green Power
- Abetment and Mitigation of Water, Air & Noise Pollution
- Cost Effective and Emerging Effluent Treatment Technologies
- Waste to Energy Technology
- Recycle and Reuse of Wastewater
- Clean Development Mechanism
- Environment Impact Assessment and Environment Management Plan for different Engineering Sectors
- Challenges and Issues in Urban Water Conservation
- Urban Sewerage System through Trenchless and Microtunelling Technology
- Green House Gases and their Adverse Effect on Environment
- Hazardous Waste Management
- Green Technology
- Coal to Methanol

In order to promote the research and developmental work in the field of Environmental Engineering, the Institution also publishes **Journal of The Institution of Engineers (India): Series A** in collaboration with Springer, which is an internationally peer reviewed and Scopus-indexed journal. The journal is published quarterly and serves the national and international engineering community through dissemination of scientific knowledge on practical engineering and design methodologies pertaining to Civil, Environmental, Agricultural, and Architectural Engineering.



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