35

Policy Options for Environmentally Sound Technology

*Purushottam Khanna and Vijay Kulkarni**

I. Introduction

The emergence and acceptance of the concept of sustainable development in recent years has brought in the general realization that societal perceptions must shift towards ecological determinism so as to achieve qualitative growth within the limits of ecosystem's carrying capacity. The carrying capacity based planning process, innovative technologies for enhanced material and energy effectivity of production and consumption, structural economic change towards less resource- intensive sectors, and preventive environmental management through increasingly interventionist policies are some of the strategies for reconciling developmental goals with ecological capabilities.

This paper analyzes the existing and future environmental issues emanating from developmental objectives and policies in various economic sectors in India and suggests an agenda for action, with focus on environmentally sound technology, to ensure discernible positive movement towards the overall aspirational goal of sustainable development.

* National Environmental Engineering Research Institute, Nagpur (Maharashtra) India.

1. Patil J., *Agriculture and the Eighth Plan*, Yojana, Agriculture, (Independence Day special) vol. 37 : 14&15, 16-21 (August 15, 1993).
2. GOI, *National Land Use : Policy Outline and Action Points*, National Land Use and Conservation Board, (Ministry of Agriculture, New Delhi), (1988).
3. *Fertilizer Statistics*, The Fertilizer Association of India, New Delhi, pp. I-105, II-60, III-31, 32, 90 (1991-92).

II. Environmental perspective of economic sector

Population

India accounts of 2.2 percent of the global land and 16 percent of the world population. The country's population has nearly doubled in the four decades of its independence and is estimated to reach the billion mark by the year 2000 AD. While there has been a decline in average birth and death rates and increase in life expectancy, the country is far from a demographic transition to population equilibrium.

Food, Agriculture and Forestry

India witnessed a record production of 180.3 million tonnes of food grains in 1992-93 [1] and, with continued development efforts in agriculture sector, it is estimated that the country will be able to meet the demand of 240 million tonnes by the year 2000 AD[2].

Despite heavy reliance on irrigation, high-yielding varieties and fertilizers; Indian agriculture is witnessing the familiar phenomenon of diminishing returns. A recent study reveals that the inputs to agriculture increased at a rate of 10.5 percent per annum between 1980-90, whereas the yields increased at only 3.7 percent per annum[3].

The consumption of fertilizers in the country has increased from almost a negligible figure in 1950-51 to 70.7 kg per hectare in 1991-92[3]. The country uses nearly 100,000 tonnes of pesticides annually and almost 70 percent of this is contributed by compounds banned or severely restricted in

the developed countries.

India presently has 143 million hectares of arable land of which 80 million hectares suffer from varying degrees of soil degradation[4]. Further, as per latest satellite data, the country is losing 1.3 million hectares of forests a year[5]. The major causes of deforestation in the country are the increasing demands for fuelwood, grazing land and timber; raw material for paper industry; and the construction of large multipurpose dams.

On an average, the country loses 6000 million tonnes of top soil per year through water erosion which, in terms of NPK alone, constitutes an annual loss of Rs.12000 million. The total area subjected to periodical floods has increased by 100 percent in the past 10 years .

Energy

India's per capita consumption of commercial energy at 226 kg oil replacement units is only one-sixth of the world average[6]. The energy intensity of growth, on the other hand, is extremely high while energy efficiency remains low. With one unit input of energy, India produces only half of what is produced in the developed countries. Further, for 1 percent growth in GNP, the country requires 2.02 percent energy growth.

The energy policy has always laid emphasis in expansion of capacity. Subsidized prices, which even fail to cover the costs, have discouraged energy saving and technological innovations. Some of the power stations in the country operate at efficiencies of barely 25 to 30 percent. The loss of energy in electricity transmission/transmission is nearly 23 percent[7].

Another significant aspect of energy scenario is that cooking energy constitutes nearly half the energy used in the country, of which almost 90 percent comes from non-commercial sources such as firewood, cowdung and crop wastes.

Increased reliance on coal is the single major cause of air pollution and land spoliation in the country. Despite regulatory measures, the levels of air pollution in many regions have far exceeded permissible concentrations resulting in increased health risks and larger environmental threats such as global warming and acid deposition.

The combustion of non-commercial fuels as a source of cooking energy in the country has resulted in excessive exposure to indoor air pollution while depriving the soil of important nutrients that would otherwise be recycled through biomass decay.

More than 80 percent of the hydroelectric potential in India still remains untapped primarily due to adverse environmental consequences of large-scale hydropower development such as deforestation, undesirable change in riverine ecology, and massive displacement of human communities.

Biomethanation, which is an energy efficient and environmentally compatible process and could provide five times the energy yielded by combustion of non-commercial fuel sources, has been exploited only for substrates such as cowdung. The potential for biogas generation from other substrates largely remains untapped.

Industry

India has established a well diversified industrial structure with a sizable capacity in basic and heavy industry. The share of value addition to the GDP by the manufacturing

4. *The Price of Forests,* Proceedings of a Seminar on the Economics of the Sustainable Use of Forest Resources, Centre for Science and Environment, 176, 188, (1992).
5. GOI, *The State of Forest Report,* Forest Survey of India, Ministry of Environment & Forest, Dehra Dun, (1987).
6. *Tata Energy Data Directory and Year Book,* TERI (New Delhi) 3 107, (1990-91).
7. *Ibid.*

sector is expected to rise from 15.03 [8] in 1989-90 to 20 percent by the year 2000 AD with an average annual growth rate of 8 percent. The expansion in industry sector, however, has been towards capital and energy intensive sectors which are also the most polluting.

Nearly 50 percent of the total industrial output in monetary terms is contributed by over 2 million small scale industries which also account for 60 to 65 percent of the total industrial pollution [9]. Further, the use of toxic chemicals in industry has grown phenomenally. As per estimations of OECD derived from correlation between hazardous waste generation and economic activity, nearly 0.4 million tonne of hazardous waste was produced in the country in 1989. Only about 50 percent of the large/medium scale industries have provided complete/partial emission/effluent control systems and many of these do not achieve stipulated standards.

III. Health and human settlements

Inadequate shelter and basic amenities, lack of access to clean water in adequate quantities, poor sanitation, environmental pollution, and resource depletion are some of the major problems of human settlements that continue to pose insurmountable health and environmental risks in urban as well as rural areas. Nearly one-third of the total urban population in India lives in slums. In order to deal with the problems of shelter, the Ministry of Urban Development has recently formulated the National Housing Policy.

The National Commission on Urbanization built a case in 1988 for dispersal of urban centres and identified 329 settlements as Generators of Economics Momentum (GEM) to bring about a dispersed urbanization pattern. The Commission also identified 49 Special Priority Urbanization Regions (SPUR) on the basis of their potential for socio-economic development. Similar attempt was made in the VI Plan period by initiating a programme on Integrated Development of Small and Medium Towns (IDSMT). These programmes, however, have largely failed in meeting their objectives due to multiplicity of agencies, and absence of an integrated approach to the problem.

The largest single cause of infant mortality in India has been digestive disorders that are closely related to water supply, hygiene and malnutrition.

The growth of vehicular traffic has posed a veritable nightmare not only on the roads, but also in the atmosphere. From merely 0.3 million in 1950, the number of vehicles in the country increased to 19.3 [10] millions in 1990. Automobile emissions in Bombay and Delhi account for nearly 70 percent of carbon monoxide, 50 percent of hydrocarbons, and 30 to 40 percent of particulates in the atmosphere.

IV. Sustainable development

Sustainable development is a process in which the exploitation of resources, the direction of investments, the orientation of technological development, and the institutional changes are all made consistent with future as well as present needs.

(1) Premises and preconditioning

The concept of sustainable development has following underlying premises:

- *Symbiotic* relationship between *consumer* human race and *producer* natural systems

8. *Handbook of Statistics,* 1989, Confederation to Indian Industry, (New Delhi) pp. 370 (1989).
9. Nyati K.P., *Environmental Pollution Problems and their Management in Small Scale and Non-Regulated Industries,* Conference on Environment and Industry, Forum on Industry and Environment, (New Delhi) (1988).
10. *Handbook of Statistics,* Confederation of Indian Industry, (New Delhi) 282 (1992).

- *Compatibility* between ecology and economics

The following enlarged constitutional preconditions must be satisfied while working for the goal of sustainable development:

- Equity and social justice;
- Endogenous choices;
- Economic efficiency; and
- Ecologic harmony.

(2) Agenda for sustainable development

The concept of sustainable development is closely linked to the carrying capacity of ecosystem. Accordingly, the underlying correlation between population, poverty and pollution must be analysed against the backdrop of ecosystem's capacity to provide supportive capacity for development, and assimilative capacity for maintenance of acceptable quality of environment. With these preconditions, following agenda for sustainable development ensues:

- Carrying capacity based developmental planning process;
- Preventive environmental policy
- Structural changes in economy; and
- Enlarged role of environmental impact & risk assessment, and environmental audit.

(3) Carrying capacity based developmental planning process

Developmental planning in most countries has been traditionally based on the concept of minimum needs in which the planning priorities and activity targets are established to meet certain basic minimum needs of poorest sections of population. This approach, if anything, has led to greater inequality in the societies of developing countries as it overlooks the basic requirement of availability of resources that form the building blocks in developmental process. In contrast, the developmental planning process based on regional carrying capacity takes cognizance of the fact that the ecosystem, with its biotic and abiotic components, provides the basic resources that support production-consumption activities, and assimilates the residues produced during the course of these activities.

Sustainable development calls for trade-offs between the desired production-consumption levels through the exploitation of supportive capacity and environmental quality within the assimilative capacity of regional ecosystems. The utilization of carrying capacity, thus, requires a series of adjustments to reconcile competing aspirations in developmental process. This shift in developmental planning process also brings out the fact that analytical models could be used to answer technological questions whereas value judgments must be made in societal and political domains for devising pragmatic developmental and environmental strategies.

Given certain inputs of human and natural resources, the carrying capacity based planning process uses a systems approach to estimate the changes in carrying capacity indicators. The differentials between realized and desired carrying capacity are overcome through a combination of institutional, informational and attitudinal strategies aimed at changes in the exogenous driving forces, systems structure, and the aspirations and tolerances that determine the level of desired carrying capacity.

An ideal approach to the validation of the concept of regional carrying capacity based developmental planning process will be hierarchical through the stages of village, district, region, nation and globe in keeping with existing political and administrative boundaries. It is obvious that the success of this approach depends entirely on planner's

participation in the process and its acceptance by administrative and political jurisdictions.

V. Preventive environmental policy

Preventive environmental policy (PEP) is directed towards the conditions that gives rise to environmental problems and anticipatory actions to readjust these conditions so as to prevent potential environmental damage. It must be recognized that preventive strategies cannot avoid future environmental damage totally, but can, at best, limit it more effectively than the reactive policy.

Adoption of preventive strategies does not make reactive strategies superfluous as environmental backlogs must be cleared and unforeseen problems dealt with. Pragmatically speaking, the preventive and reactive approaches complement each other and that is how the legislative, administrative, institutional and policy formulations must be devised.

Identification and implementation of environmentally sound technologies warrant evaluation of various feasible options based on economic, environmental and social considerations. While the decisions at the industry level are guided by the economic analysis of resources conserved, pollution control costs avoided, and costs incurred on new technologies; Government at the national level must include analysis for the benefits to society, impacts on environmental quality, as also stock and quality of natural resource base.

The methodologies for technology assessment relate to two different and yet interlinked stages in the overall process of conversion of raw materials into finished products, viz. manufacturing process and residue/waste management.

VI. Structural economic change

Structural change involves large scale technological substitution towards environmentally-benign technologies such as:

- *Cleaner technologies* of industrial production
- *Recycle and reuse technologies* for end-of-pipe treatment
- *Biotechnology* for substitution of non-renewable with renewable resource base
- *Integrated technologies* that minimize cross-media transfer of pollutants thus minimizing overall pollution-induced risks in all environmental components

These are three broad groups of resources upon which economic activity is based, viz. non-renewable resources, renewable resources, and information. The sectors of economy that deal with non-renewable resources are environmentally the most problematic. Restructuring of the economy by substituting environmentally harmful branches with equally productive but environmentally compatible ones could form an important strategy in environmental policy.

Structural change aims at raising the levels of both ecologic and economic efficiency by increasing material and energy effectivity in production and consumption in order to minimize the expense on environmental protection while keeping the cost of natural resource exploitation within acceptable limits. It involves restructuring of economy based on ecological principles. A few examples of structural change are presented hereunder:

(1) Manufacturing sector

Transition to production processed which save or recycle raw materials and energy, substitution of ecologically harmful to harmonious products, application of biotechnology for substitution of non-renewable resource base, carrying capacity based plan-

ning of industrial estates, ecological grouping of industries.

(2) Agriculture sector

Eco-cultivation and biotechnological improvements, promotion of organic manures and biocides, development of land-use plans compatible with species and ecosystem types.

(3) Energy sector

Rational use of primary energy, greater use of regenerative energy sources, decentralization of supply, improvement in combustion processes.

(4) Construction industry

Use of renewable and environmentally compatible building materials, saving of land and energy, labour-intensive designs.

(5) Transport sector

Reduction in the specific energy consumption of motor vehicles, reduction in total number of motored kilometers, provision of efficient public transport system.

Structural changes in economy could be brought about by delinking of economic growth from the consumption of ecologically significant resources.

The analysis of Indian economy between 1970 and 1989 exhibits a marked structural deterioration with negative environmental effects. The energy-intensity of economic growth has increased substantially. This trend could be reversed only through structural economic change based on the tenets of ecology.

VII. Role of environmental impact and risk assessment and environmental audit

Environmental Impact & Risk Assessment and Environmental Audit (EIRA & EA) are potentially the most valuable, inter- disciplinary, objective decision-making tools with respect to alternate routes for development, process technologies, and project sites. These provide an anticipatory mechanism which establishes quantitative values for parameters that indicate the quality of the environment and natural systems before, during and after the proposed developmental activity, thus allowing measures ensuring environmental compatibility with economic efficacy.

EIRA & EA could form a major instrument for the assessment of developmental activities in the context of regional carrying capacity, provided the conceptual framework is extended to the cumulative assessment of policies, plans and projects on a regional basis.

EIRA & EA should ideally be undertaken at the policy and planning levels as the environmental consequences of projects often arise due to higher-level decisions. Policy EIRA & EA, however, are viewed as extremely complex, largely due to the fact that the potential range of alternatives to achieve a desired goal can be almost unlimited. This problem may be resolved through a hierarchical approach in which the number of alternatives are reduced by defining the problem in terms of a series of choices.

The most appropriate stage for implementing EIRA & EA is at the level of district planning, since at this stage a reasonable number of alternatives are available to the developer. The assessment of regional supportive and assimilative capacities during formulation of development plans cold greatly reduce the requirement for project level EIRA & EA.

Most ecological problems are the cumulative result of environmental and social impacts of human activity in the region. Planning for sustainable development in the context of ecosystems carrying capacity thus

requires systematic identification, quantification, and management of cumulative trends in significant environmental variables on a regional basis. Functional planning regions need to be identified based on ecological criteria such as climate, vegetation patterns, and soil classification; and airshed and watershed boundaries rather than political jurisdictions.

VIII. Priority areas of environmental action

The analyses of economic sectors in India apropos the agenda for sustainable development leads to following conclusions:

- Aspirational goal of Sustainable Development demands no less than environmental reorientation of entire developmental process;
- There is a need for introduction of a right mix of preventive and curative approaches in environmental policy;
- Administrative structures and institutions need to be redesigned accordingly; and
- Priority areas of environmental action at policy, plan & programme levels need to be tackled on an urgent basis.

The priority areas of environmental action at the policy, plan and programme levels are presented in Appendix.

IX. Conclusion

Environmental management in present day context warrants a dynamic policy framework in which the time lag between problem awareness, technological solution and remedial action is minimized through a combination of four strategies, viz.

- anticipation and prevention of environmental problems that may arise as a consequence of decisions taken within various sectors of the economy;
- restoration of environmental quality wherever necessary;
- structural changes in economy; and
- inter-policy coordination.

Policy-makers faced with long-term environmental problems often argue that they cannot afford to worry about the remote and abstract when surrounded by the immediate and concrete. The problems which overwhelm us today are precisely those which, through a similar approach, we failed to solve decades ago. (Dr. Mostafa K. Tolba, Former Executive Director, UNEP).

Acknowledgment

The substance presented in this chapter has been derived from a number of national and international publications. The authors are responsible merely for the interpretation of available literature to highlight the emerging role of environmentally sound technology in sustainable development.

Appendix

Priority areas of environmental action

	Policy level	Plan level	Programme level
1.	Carrying capacity based developmental process	Supportive capacity based developmental planning	Development and implementation of village /district/regional/national sustainability model
		Assimilative capacity based environmental management	Assimilative capacity based location of developmental projects
			Establishment of Centre for Studies on Policy Issues
2.	Preventive environmental intervention	Introduction of environmentally benign technologies and services in various economic sectors	R&D and implementation of cleaner technologies of production and recycle & reuse technologies for end-of-the pipe treatment in industry
			Use of renewable resources in energy sector
			Greater use of biotechnology and ecocultivation in agriculture sector
			Use of fuel efficient engines in transport sector
			Use of renewable and environmentally compatible building materials in construction sector
			Establishment of Centre for Studies on Cleaner Technologies of production
		Structural change towards less resource and energy-intensive sectors of economy	Substitution of non-renewable with renewable resource base in manufacturing sector, use of biofertilizer and biocides in agriculture, use of non-conventional sources in energy sector
			Expansion of tertiary sector of economy

	Policy level	Plan level	Programme level
		Conservation of raw material and energy resources	Environmental audit including resource and energy audits of developmental activities
			Development of resource and energy efficient systems
		Application of EIA in sectoral decision making	Development of sectoral guidelines for environmental review
			R&D on screening & scoping and computer-aided EIA methodologies
			Preparation of model studies on EMP and DMP
			Development of objective criteria for delineation of environmentally sensitive areas
			Establishment of autonomous National Environmental Impact Assessment Agency
		Inter-sector policy coordination	Review of sectoral plans from environmental considerations
			Creation of infrastructure within MEF for inter-policy coordination
			Creation of environmental cells in various Ministries
3.	Measurement of qualitative growth	Development of indicators of qualitative growth	Development of National Ecologic-Economic Database (NEED)
			Development of concept of Gross Ecologic Product (GEP)
4.	Restoration of environmental quality	Assimilative capacity based environmental standards	Assessment of regional assimilative capacity and formulation of location specific standards
			Implementation of environmental assimilative capacity based standards

Policy level	Plan level	Programme level
		Formulation of standards for industrial sludges
	Operationalization of polluter pays principle	Introduction of effluent tax
		Introduction of resource cess for industry
		Implementation of standards based on resource consumption and production capacity
	Damage-cost functions and cross- media analysis as basis for environmental quality standards	Development of damage-cost functions and concomittant environmental standards
		Analysis of cross-media pollution transfer for integrated pollution control
	Legislative and fiscal measures to induce waste utilization	Collation of information on nature, volume, location and accessibility of wastes, economically viable technologies for waste utilization and potential market for recoverable materials
		Development of stabilized market support for recovered materials
	Integrated landuse planning	Apportionment of land for meeting competitive sectoral demands
		Integration of physical and environmental planning concepts for devising national/regional/district/town land use plans
		Establishment of Centre for Studies on Land Environment
	Reclamation of degraded lands and restoration of fragile ecosystems	R&D and implementation of technologies for reclamation of mining lands, water bodies, wetlands, and catchment areas

Policy level	Plan level	Programme level
		R&D and implementation of technologies for restoration and enhanced utilization of forests, mangroves, wetlands, island and coastal ecosystems, arid and semi-arid zones
	Development of wastelands	Identification of wastelands
		R&D and implementation of technologies for development of wastelands
	Ecosystem-compatible and need-based afforestation	Vegetation mapping of the country
		Development of afforestation plans to meet demands for forest based products particularly for rural poor
5. Information, education and training	Use of integrated ecologic-economic database for sectoral decision making	Creation of nodal agency for establishment of National Ecologic-Economic Database (NEED)
	Human resource development for environmental management	Introduction of environmental subjects in curricula of schools and colleges
		Introduction of specialized graduate and post-graduate programmes on environment
		Continuing education of professionals
		Extension of employment guarantee scheme to environmental restoration programmes
	Awareness building for enlightened public participation in environmental decision making	Development of mass communication techniques

Policy level	Plan level	Programme level
		Development of centralized facility for acquisition, documentation, storage and dissemination of environmental education material in form of Environmental Resource Centre

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