Professor S.C. Pandeya
(Born January 1, 1929)

J Indian bot Soc Vol 74 (1995) 1-8

ENVIRONMENTAL MANAGEMENT*

S.C. PANDEYA
13, 14, Pragatipuram, P.O. Dayalbagh, Agra - 282 005 India

At the outset, I wish to express my hearty gratitude to honourable members of Executive Council of the esteemed Indian Botanical Society for kindly unanimously electing me as its President for the year 1994-95.

I am greatly obliged to my teacher Professor R. Misra, father of Ecology in India, for kind blessing and guidance, I have always received. I bow to him in reverence and pray for his very long fruitful life.

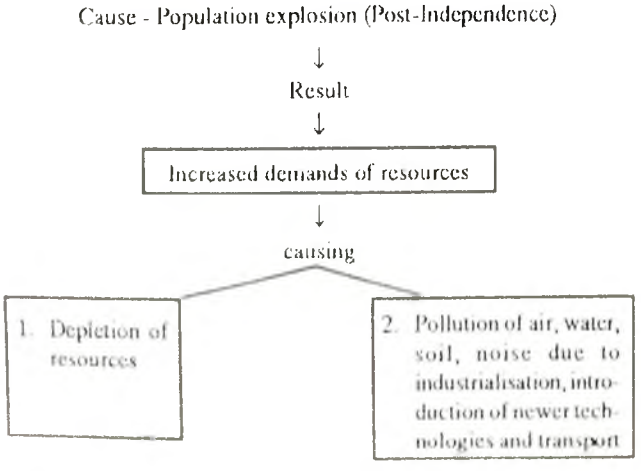
Ladies and Gentlement, I wish to present a conceptual and philosophised talk on "ENVIRONMENTAL MANAGEMENT". I also wish to take advantage of this For}m to establish Environmental Management as a separate subject under Applied Ecology with pin pointed Aim of Better Human Environment. I shall divide my talk in two aspects:

I Holistic Approach in understanding structure and functions of Environment (or Nature)

II Our Environmental Problems and Concepts in Environmental Management.

You will kindly agree with me that our natural resources are fast dwindling. Vegetational cover, species diversity and some important species are in the state of concern.

The basic issue of environment



More than 200 years ago, British economist Thomas Malthus sounded the first alarm on the issue of population growth and its impact on resource depletion. While the impending food shortage predicted by Malthus never materialized, the theory did set off and widened to cover environmental degradation in terms of air, water and soil pollution, ozone depletion, global warming and others (Kirwin in *Our Planet*, Vol. 6, No. 3, 1994). 'Everyone sees the *population-environment* interaction as a complex and dynamic set of relationsips, and some aspects of human technology and institutions are mediating these relationships', say the authors of *Population-Environment Dynamics*, published in 1993.

Basic Data of India

Geographical Area	-	328 mill ha
Human Population	-	Near 1000 mill; Consumption : 200 mill t yr^{-1}
Livestock	-	400 mill; Consump. 1,600 mill t y^{-1}
Potentially Available :		
Food	-	Near adequate
Fodder	-	900 mill t yr^{-1} (Inclusive of farm residue and forest grazing resource) - *inadequate*
Energy	-	Highly inadequate

Resulting into :

- More land commissioned for Agriculture, hence depletion of forests from 16% in 1947 to 9% (ISRO 1990 figure)
- Overgrazing and degradation of land, decreasing carrying capacity and causing floods
- Energy crises - further depletion of forests, dams and inundation of forests for hydroelectricity
- Intensive agriculture - energy cost of input more than production; open irrigation canals - causing floods and changing country's climate, pollution of air, water, soil

* Presidential address delivered at the 17th Annual Conference of Indian Botanical Society held at Punjab University, Chandigarh, October 21-23, 1994.

- Industrialisation-pollution of air, water and soil; health hazards
- Limitation of space, more colonization causing depletion of usable land, slums - pollution and health hazards due to unhygienic conditions

Hence - Our environmental concerns, priority issues

Resource Management
- Depletion of renewable resources
  - Primary Production & biomass
  - Plant and Animal species
  - Soil
  - Water
- Depletion of non-renewable resources
  - Minerals & fossil fuel

Human settlement
  - Land use and tenure
  - Housing, water supply, sanitation
  - Transportation & urban dilemma
- Pollution and waste management
  - Air, water, soil, noise
  - Hazardous waste
  - Public health & environmental diseases

The environmental problems

Forest - fixing level of use, afforestation, dams and inundation, management of river catchment, AOE studi•s.

Grazing Lands/Rangeland optimum level of grazing resource use (at carrying capacity), development of degraded lands with people participation, method to combat desertification.

Aquatic ecosystems Optimal sustainable use of lakes, rivers and oceans

Agroecosystems sustainable agriculture, optimization of use of irrigation, fertilizers, weedicide, insecticide and mechanization; screening crops commensurate with local environment, Net Primary production of crops to equalise Potential Primary Produce.

Pollution of air, water, soil & noise : Inventroy of causes and journey (spread) of pollutants, extent of damage and methods of abatement, enforcement of laws

I. Holistic Approach in understanding structure and functions of Environment

It is realised that nature functions as one 'whole'. Environment is another word for 'nature' (Stockholm Conference on Better Human Environment 1972). Total Environment can be visualised as of three components or subenvironments for better understanding, namely,

(i) *Physical sub-environment* : Constituting all climatic variables and geomorphology (Driving veriables); and soil and water as substrate and microclimate (Abiotic State Variables)

(ii) *Biological sub-environment* : Comprising all plants, all animals, including man as an animal, and micro-organisms (Biotic State Variables)

(iii) *Socio-cultural sub-environment* : Cultural heritage, social customs, religion, economic status, level of education, politics, and crime.

The three subenvironments (or components) are completely integrated to constitute total environment or nature.

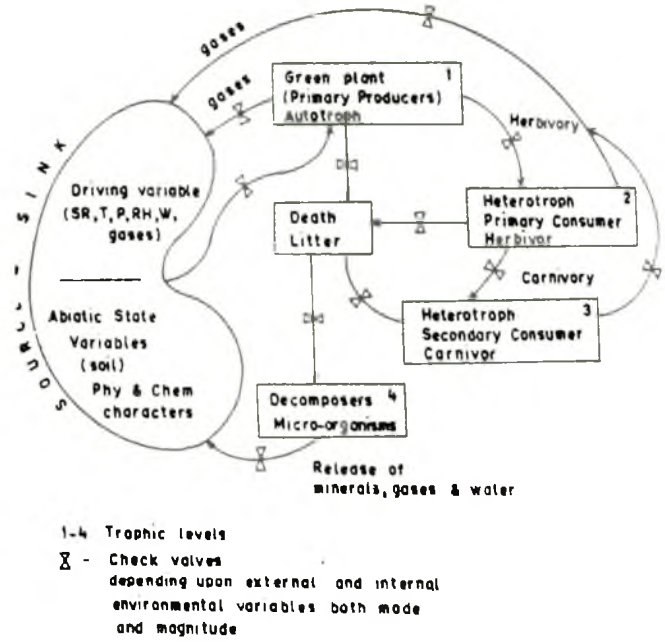


Figure 1. Box and Arrow Diagram for Ecosystem Functions

Ecosystem is defined as the functional study unit of nature or total environment, since it includes both organisms and abiotic environment. An ecosystem has **six basic characters,** namely (abstracted from Odum 1971):

(a) Structure and composition - diversity patterns in time and space
(b) Clear trophic levels and food chains
(c) Flow of energy - energy circuits (hence self-sustained)

(d) Nutrient cycling - biogeochemical cycles
(e) Development and evolution
(f) Self-regulation-controls (Cybernetics)

Fig. 1. is Box and Arrow Diagram of functioning of an ecosystem.

Structure and functions of an ecosystem are the sum total effect of the total environment. When not disturbed by any outside agency, primary producers in an ecosystem fix solar energy in the form of organic matter. This can be called as potential production. Potential production, as also its eonsumers (secondary production) oscillate in time depending upon variations in the magnitude of the physical environment. An ecosystem can be used, e.g., for grazing, cutting of wood, for game, etc., within the lower and upper limits of its range of recovery. The two limits are called as lower and upper limits of negative feedback. Any ecosystem can be used within these two limits. If overused, i.e., below the lower region of negative feedback or too much of subsidy is added for increasing the production beyond the upper limit of negative feedback, The system collapses bringing about undersirable change. This may cause irreparable damage to an ecosystem. The Zone between the two limits named above, is the *region of sustainable development* (the homeostatic platform) - Fig. 2.

We have had several experiences in this country of ill conceived short-sighted gains. Construction of large dams, Ganga Action Plan, Indira Gandhi Canal in Rajasthan, irrational application of fertilisers, pesticides, weedicides, The Taj Mahal. etc., are some of the

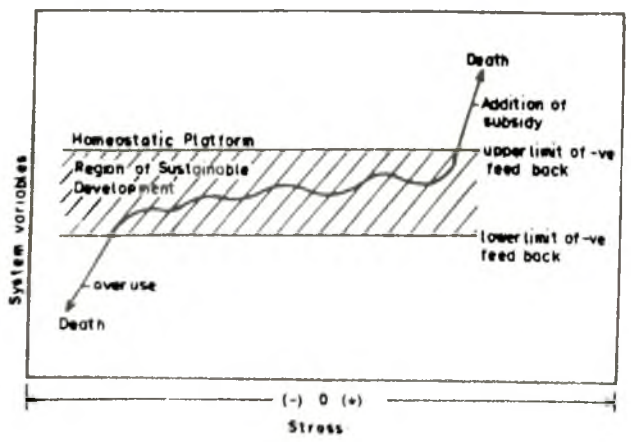


Figure 2. Homeostatic Platform. The region of sustainable development and use of the resources is between lower and upper limits of the negative feed back.

examples of planning without understanding the holistic functions of nature. This is the concept of *ecological back-lashes* or *ecological boomerangs.*

We may define ecological backlash as an unrealised (although it can well be predicted in system context) determental consequence of environmental modification which cancels out the projected gain or, as is too often the case, actually creates more problems than it solves. When this happens, it is a double tragedy since not only is the energy spent in remaking the lost land scape, but additional energy must then be spent to correct all the new problems created. Increase in agricultural production, that is, so called "green revolution", has resulted chiefly from the industrialization of agriculture, involving large fuel energy subsidies, sophisticated chemical control, and highly domesticated plant varieties. Maximizing for yield without regard to other consequences is producing very serious backlashes. For example, to double the crop yield, it requires a tenfold increase in fertilizer, pesticides, and horse power (Fig. 3).

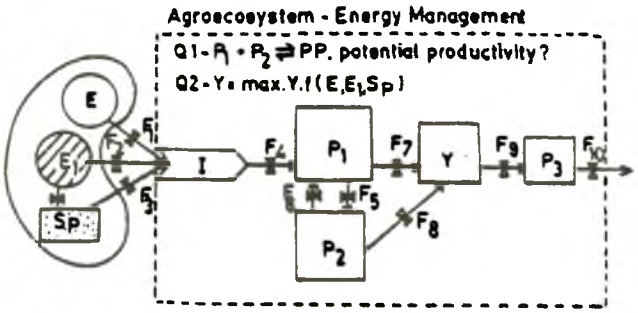


Figure 3. E - Driving Variables - Solar Energy, FORCING FUNCTION: E_1 - Outside FORCING FUNCTION (auxiliary power - agri. subsidy): S_p - Abiotic State Variable - soil - PROPERTY: F - FLOWS: I - INTERACTIONS : P_1 - PROPERTY - biotic state variable - aboveground primary production: P_2 - Y - PROPERTY - belowground primary production: PROPERTY - yield for man and herbage for his bovine; P_3 - PROPERTY - man and his bovine; - check valve as to themode and magnitude of the FLOW.

II. Our Environmental Problems and concept and principles of Environmental Management

Environmental Management is a human activity to moderate conflict between Ecology and economy, or to seek compromise between requirements of the laws of flow and turnover in an ecosystem and the human society. If we were only to respect ecology (as many naturalists and conservationists and even 'Environmentalists' are doing, human society would not survive and vice-versa, if we were only to think of economy,

environment would be desolated and as a result, human society would also go to ruin.

Hence, the concept and principle of environmental management are to find out *optimum sustainable* relations between the environment and the human society (of which man is *a part*), and to keep them within their flexibility.

(In this context, under certain conditions, we may even decide that the best management of a given ecosystem is to do nothing and leave it under its cybernetics along time scale.)

Hence, we have to develop procedures for the evaluation of environmental consequences of spatially distributed activities. The strategy is to develop integrated analyses of cultural and natural systems. The primary objective of regional environmental analysis is to aid decision makers and managers as they try to cope with existing problems. Such an effort should (modified from McCarthy *et al.* 1974) :

(i) *forecast* and simulate future changes - the science of System Analysis and Modelling
(ii) *evaluate* the consequences of alternate plan
(iii) *determine* the *optimal* solution to the problem, and
(iv) *provide* the user with information and computational tools so that he can develop solution keeping the totality of environment in view

To develop these capabilities within a total management concept requires that many *complex issues* be considered *simultaneously,* like : economic alternatives, environmental effects, political processes, etc. For such a comprehensive effort to be successful, following set of *capabilities* is required:

(i) a multidiscplinary team that be structured so that each issue may be attacked individually, yet the solutions be combined
(ii) *integration* of each area of expertise so that the models developed in each area may interact and effect one another as happens in the real world
(iii) *research methodologies* that are common be used by all members of the team

The multidisciplinary team be made up of *five basic components :*

Basic Components	**Primary Functions**
Socioeconomic	Socioeconomic analysis must be capable of making base-line and conditional forecasts of aggregate regional activity in terms of population and employment.
Land allocation	Land-allocation analysis must be able to spatially allocate the predictions of land-use changes
Sociopolitical/policy	The sociopolitical/policy analysis must develop management strategies in response to fiscal impact and public reaction
Natural systems	Cultural-systems analysis must be capable of predicting the effects of patterns of change on the regional environment
Cultural systems	Cultural-system analysis must be able to predict the consequence of alternatives to man, his welfare, and institutions

System Ecology or System Analysis (modified from UNESCO 1972) Though we think of "models" in terms of equations and computer, they can be defined more generally as any physical or abstract representation of the structure and function of *real system.* Picture and verbal models are generally used in ecological understanding. This can be called as bivariate or multivariate analysis. But biological systems or an ecosystem is extremely complex. Its functions, due to any practice by man, as for example construction of a dam, afforestation, consequences of applying fertilizers and irrigation to a crop-field or adoption of newer technologies, can not be forecasted in time-scale by bi-or multivariable analysis, System analysis is concerned with the explicit recognition, and handling of *complexity* in the development of abstract models.

Models may be constructed for a variety of reasons. By providing an abstract and simplified *description* of some system, they may be used simply to guide research efforts or the problem for more detailed study. More often, as stated earlier, Mathematical models are developed for prediction of dynamic changes over time. The failure of a model to predict change, is in itself useful because it may point out floaws in the

conceptual framework from which the model was developed. Models can be evaluated in terms of 3 basic properties or goal : *realism, precision* and *generality*. *Realism* refers to the degree to which the mathematical statements, when translated into words, correspond to the biological concept that they are intended to represent. *precision* is the ability of the model to predict numerical change and to mimic the data on which it is based. *Generality* refers to the breadth of applicability of the model (the number of different situations in which it can be applied. Two concepts related to realism and generality are *resolution* and *wholeness*.

It is convenient to think of mathematical model as having 4 basic elements. *System variables* are sets of numbers which are used to represent the state or condition of the system, at any time. Ecological systems are usually thought of, as consisting at any time, of a series of components, compartments; in models, one or more system variables are used to characterize the state of each component. Flows or interactions between components are represented by equations on *transfer functions* or functional relationships. Input to the system, or factors affecting but not affected by the components of the system, are represented by equations called *forcing functions*. Finally, constants of the mathematical equations are called *parameters*.

Models may be either *Stochastic* or *Deterministic*. Stochastic models attempt to include the effects of random variability in forcing functions and parameters. Deterministic models ignore these changes in variations.

The flows and transfers can be represented by all purpose differential equation.

$$\frac{V}{t} = MRF.f(\text{input variables}) - g\ (\text{output variables})$$

Where,

MRF is the Maximum Relative Function

f and g — stand for the function of

V — is the parmeter in question say Net Assimilation Rate (NAR), and

t — is the unit time period

Thus, consequences of any perspective planning and managerial practice can be predicted along timescales. This is the key tool towards environmental management.

Some examples of the paradox

(1) Air pollution and Taj Mahal at Agra

concern regarding threat to Taj Mahal from air pollution has been raised eversince Government of India decided to set up Oil Refinery at Mathura in the year 1973.

Several Expert Committees/ Agencies, starting with Varadarajan Committee in 1974, who gave green signal to the Mathura Refinery, have given conflicting and controversial reports over a period of last 20 years. The matter took a serious turn when "in public interest" a Writ Petition was filed in the year 1984 by Mr. M. C. Mehta, Advocate (recently he got a 'Foreign Award' for this right concern for Taj Mahal) in the Supreme Court against Government of India and Mathura Refinery with the prayer that Taj Mahal be saved from the effects of air pollution which is being caused by the Refinery and directives be given to GOI for taking suitable steps including shifting of Mathura Refinery. The petition came for hearing in 1993 and the Hon'ble Supreme Court asked U.P. Pollution Control Board to file status of pollution in Taj Trapezium Zone (TTZ). Eventually 212 industries were ordered to be closed at Agra as they did not reply to the notice from UPPCB. Later some were allowed to resume work after installation of Air Pollution Control Systems. Some 150 factories were likewise closed at Ferozabad. Several industries still remain closed for want of finance and fear that cost of their commodities might rise and may not be able to compete in the market. Then defaulting industries and others were proposed to be shifted out of Agra TTZ. On April 29, 1994, the Honourable Supreme Court, after taking notice of the newspaper reports to the effect that industrialists/workers in and around Agra are agitating against the proposal regarding shifting of polluting industries from within TTZ - which is being considered by the Supreme Court, asked GOI, DOEn to set up another investigation from a reputed Technical/Engineering authority. To that date the Supreme Court was depending upon *4 months* report and recommendations of National Environmental Engineering Research Institute (NEERI) of April, 1993. The NEERI Recommendation is inhuman on two counts: firstly, this will amount to dislodging some 3 lakhs workers in Agra Industries and putting them on streets bringing about economic deterioration of Agra. Secondly, NEERI recommendations mean that Agra atmo-

sphere, if getting poisonous due to industries, the poison shall be shifted elsewhere. Supreme Court is processing this, dated April 11, 1994.

The Holistic Approach : In holistic approach following components of TTZ have to be considered at ONE integrated system:

- Macroclimate - Meteorological conditions
- Geomorphology, grond and surface water including river Yamuna system
- Man, his cultural heritage, industries, institutes, export and import of commodities, Archeological buildings including Taj Mahal and tourism

Amputation or separation of any of the components can not be done since otherwise entire TTZ will collapse. Agra as a whole will suffer in all and every function then. Towards a functional working solution for sustainable development of TTZ following issues need people's involvement :

(i) Protection of Taj Mahal itself both from physical and biological weathering

(ii) Regular monitoring of Air Pollution at Taj and 4 other locations in different wind directions understanding monthly contributions of SO_2, N_2 X and SPM from industries, transport, diesal generators and the other major source, the Mathura Refinery, and suggesting suitable abatement measures to minimize air and water pollution and towards sustainable development of TTZ. Understanding dynamics of physico-chemical and biological weathering and effect of air pollution is necessary. THIS TRUTH IS NOT YET KNOWN

(iii) To restore regular electric supply at Agra as one of the top priority steps in environmental management

(iv) Effect of air pollution and water pollution including disposal of liquid and solid waste on human and animal health, agriculture and gardens has also to be taken care of with the same attention. These constituents are affected much earlier than Monuments

(v) Economic status of the people, their future outlook and growth : *Taj can not be preserved like pickle in the oil of human suffering.* Hence, the Agra Industries and those of Ferozabad should neither be shut down nor shifted elsewhere

(vi) Covering entire TTZ with green mantle and necessarily filling river Yamuna with water by putting low dam-like construction (weir) down Taj Mahal. This will minimise emission of SPM, SO_2 and N_2X from otherwise barren river bed.

People must be made aware of these environmental facts

(2) Tehri Dam and likewise Narmada Dam

Tehri Dam and Narmada Dam have been attracting nation-wide attention. Some NGOs have been making lot of effort to stop construction of Dams in the garb of issue of people's land inundation and rehabilitation problems. Some activist members of these NGOs have received "foreign awards", obviously for trying to stop India's progress.

In Holistic Approach to Environment, Development has to be made, electricity has to be produced and water has to be given for irrigation. People must be made aware of these facts and should agree to the alternate facilities. What is more important is conservation of the catchment area to minimise siltation. Displaced people must be rehabilitated and entire economy of the region boosted.

Environmental Scientist has to always prescribe methods to minimis environment cost of development and not oppose development.

(3) Ganga Action Plan

It is just futile to install few charners at some locations along river Ganga in order to clean it. It will never be cleaned, since : 90% of Ganga water is held in fish-ladder dams at Hardwar and channelised in the two main canals entering Uttar Pradesh. Remaining 10% of water passess through industrial cities of U.P. in the river. This 10% water in Ganga is bound to be 100% polluted. In U.P. Plain in absence of recharge of wells along Ganga, farmers deepen their wells and are obliged to give 4-5 irrigations (as the water table has gone down) to *Rabi* crops, instead of 1-2, they used to give. The Result: deepening of wells has struck brine water since the wells have gone below sea level in the old sea bed.

Added to the problem, is open canal evaporating 36% of its water and infiltration from ill paved canals leading to increase in water table along the canals. This increase in water table causes floods every year in those regions. All these facts are to be made known to the people so that they are involved in getting the canals run through big cement pipes. 36% of water so saved be put in river Ganga at Hardwar and there will not be any

problem in the river due to flushing away of the pollutants.

(4) Wasteland development and afforestation

Afforestation in general and afforesting wastelands have not been successful so far. The reason: we have not cared for the people's fuel and fodder demands. We have to seriously look into this matter by making people involved in all types of afforestations, including combating desertification. *They have to be made Partner to it.*

It comes to that for recovery and rehabilitation of the degraded lands we need knowledge and consideration of several factors like:

(i) Full knowledge of the structure and functions of the native biome that was initially present on that degraded land by making inventory and monitoring of the adjoining ecosystems. This will give information about potentiality of the land in terms of organic matter production

(ii) The knowledge also yields a list of indigenous species that could be used in afforestation, if it is so desired

(iii) This inventory will also include the Driving Variables and the Abiotic State Variables, both, of the site and of the adjoining less degraded ecosystem

(iv) But prior to making any recommendation for the development of the degraded lands it is essential to know the forces responsible for the degradation, i.e., we have to ensure that the people having the access to this land is continuously provided with fuelwood and fodder for their livestock. Otherwise, whatever development is made will go in vain. If you fence the land for afforestation without the consideration of the man's needs, the fencing will be cut off and no amount of force will be able to keep it intact. I am pleading for understanding and involvement of the man himself in the development fo the degraded lands. It should not be a tussle between the government and the people, but it has to be partnership of the people with the land forgetting the government machinary and feeling that they themselves are part of the degraded land and they have to develop it along with fulfilling their own needs. There is no alternative, in my opinion, to the hypothesis I have just offered.

The Proposal

Every villager, who wishes to take, irrespecive of his family alliances and numbr of individuals present in it, be allotted suitable area of land which is in degraded stage today. It comes about 5 ha per man. This area be given to every person who demands it so as to cover the entire village system. He be allowed to develop this area as his own with the following basic conditions :

(1) The land shall be allotted for a period of 5 years, extendable in periods of 5 years each depending upon the work done in it

(2) He has to show at least 1,000 woody tree species standing per ha area, after the completion of 5 years

(3) He be allowed to cut away the herbage from his area for consumption by his livestock or he may sell it and draw profits

(4) Whatever extra number of trees he is able to grow in the land allotted, be allowed to be harvested by him. He may use it as fuel wood or even sell it if he likes and keep profit

(5) The most important condition will be that the law may be suitably modified, so that the land area allotted to him is only for the purpose of development of land and no ownership right be conferred on him. In case of his death, the so developed area will not automatically belong to his son, who can only be one of the applicants for allotment.
On the part of the Government, the Forest Department has to create enough nursery beds for supplying seedlings to the people at nominal cost or no cost. Those farmers who wish to raise nursery be supplied with seeds, polythene bags, etc., and they may also sell the seedlings at nominal cost

(6) Invitation to multinationals for establishing 100% export oriented industries in India will cause further degradation of land and water and add to energy crises

(i) On September 21, 1994, 35 foreign proposals have been cleared by the Empowered Committee of Government of India. The projected export earning of over Rs. 1,100 crore over a period of 5 years has been set. Seven projects are for setting 100% export-oriented units in food processing, horticulture and textiles. One project approved is of Japanese Co., for granite stone product, one of S. Korea for brass and stainless steel thin walled capillary tubes with export earning of Rs. 20 crore, one Indonesian on manufacture of resin/turpentine derivatives used in making pulp paint ink, etc.

On 22 September 1994, Government of West Bengal opened its doors to foreign investment and technology in its new industrial policy. The policy is prefaced with reminders about the basic principle of State Policy, that is self reliance and employment generation. the deal is with Singapore with attention on petrochemicals, electronics and software, iron and steel metallurgical and engineering industries, textile, leather and leather products, food and vegetable processing, edible oil, aquaculture, medicinal plants, rubber, palm oil and tea, chemicals, pharmaceuticals, etc.

(ii) Just 3 days prior to the above two announcements, on Sunday Septemeber 18, 1994, the President Hon'ble Dr. Sharma called for judicious application of technology for the country's development keeping in mind that it has the capacity to undermine the environment, irreversibly, unless we take appropriate preventive measures. Economic development and environmental protection are intrinsic to each other. He added that the present generation is only a "temporary guardian" of planet earth." Our actions, if judicious, can preserve and even magnify this inheritance. If injudicious, we can become a destructive force.

Thus, we are in a grip of paradoxical situation. Conceptual fig 4 depicts that along time scale, environment evolves to reach a maximum potential point depending upon magnitude of physical subenvironment, especially the Driving Variables. Upto that point in an ecosystem P/R Ratio is more than 1. Then, it attains dynamic equlibrium along with oscillation and somewhat progression with P/R = 1. Raw material can be used only upto that region (Region of optimised sustainable development under planned economy). If the environment is over-used, the environment degrades, bringing about resource depletion and pollution. Free economy shatters then.

We have to be cautious for this environmental *boomerang*. Foreign investors will not only take away hard currency but will over-use the natural resources much beyond the homeostatic platform degrading the environment to the point of almost no return or return with very heavy energy input; even then from where this extra energy will come. With country's geographical area being 328 mill ha and human population around 1,000 mill, it comes to 0.328 m^2 area for each and every activity per person. The area can not meet the requirement, hence the over-use. Aalready Indian environment is in a state of degradation.

We must understand the concept of optimised sustainable development and follow it ardently to save our environment. Indeed, *Economy and Environment are two sides of the same coin*. Ladies and Gentlemen, I have tried to cover the holistic approach to environment and concepts and principles in Environmental Management. Of course, I could not cover all the environmental problems of the country.

Thank you very much.

REFERENCES

Kirwin Joe 1994-The Population-Environment Link, *Our Planet*, **6(3)** p 4.

McCarthy M M, R C Durfee M L Newman S L Yafee R Betson C W Craven Jr T L Cox J Holbrook D D Huff R Strand 1974 Regional Environmental System Analysis : An Approach for Management. *Proc First Intern Cong of Ecology : Structure, Functioning and Management of Ecosystems, The Hague, The Netherlands* p 130-139.

Odum E P 1971 *Fundamentals of Ecology*. W B Saunders Co, Philadelphia London Toronto.

UNESCO 1972 *Programme on Man and the Biosphere (MAB), Expert Panel on Project* 3 : Impact of human activities and land use practices on grazing lands ; *savanna, grassland (from temperate to arid areas), tundra*. Final Report, Montpellier.