Society-Engineer-Environment: Perspective of Practising Consultants

Société – ingénieur – environnement: point de vue de l'ingénieur-conseil

Gesellschaft, Ingenieur und Umwelt: aus der Sicht eines Beratungsbüros

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SUMMARY

In this article, an attempt has been made to draw up the present perspective of the interrelationship of society-engineer-environment from the point of view of practising consultancy agencies in the field of environmental management. The counteractive strategies, social role of engineers, environmental screening approaches for vulnerable projects, the concepts of sustainability and its quantifiable assessment possibilities, have been discussed.

RESUME

L'article exprime le point de vue d'un ingénieur-conseil spécialisé dans la gestion de l'environnement, sur l'évolution possible de la relation entre la société, l'ingénieur et l'environnement. Il traite de stratégies communes, du rôle social de l'ingénieur, des approches écologiques de projets sensibles, des concepts de développement continu et harmonieux, et de l'évaluation de diverses alternatives.

ZUSAMMENFASSUNG

Der Beitrag zeichnet die gegenwärtige Perspektive der Dreiecksbeziehung zwischen Gesellschaft, Ingenieur und Umwelt aus der Sicht eines Beratungsbüros mit Tätigkeit im Umweltmanagement. Er behandelt Eindämmungsstrategien, die soziale Rolle des Ingenieurs, Umweltveträglichkeitsprüfungen für sensible Projekte, die Konzepte dauerhaften Wachstums und Möglichkeiten seiner quantitativen Beurteilung.

INTRODUCTION

In today's world, the interrelationship of society, engineer and environment can be viewed from many angles. One such perspective is that of practising consultants engaged in project implementation. This perspective, perhaps, develops from the following definitions of these building blocks:

Society : A structured and collective system of human organisation for large scale community living that furnishes protection, continuity, security and an identity.

Engineer : A person versed in the art of science of making practical application of knowledge in the design and construction of bridges, buildings, mines, plants, machinery and the like.

Environment: The aggregate of surrounding things, conditions and influences.

The above characteristics of 'Society', 'engineer' or 'environment' introduce certain functional demands in them. An engineer turns out to be the initiator of industrialisation which in turn leads to urbanisation of the society with increased population. This in turn, puts pressure on the local environment and ecosystem of the planet earth.

The above interrelationship is best represented with a system that can be called as a "model of concentric subservience" (Fig.1), in which the engineer is at the core with concentric envelops of the society, environment and the planet Earth. The engineer's efforts of disturbing the nature lead to societal problems which in turn, result in the disturbance of ecosystems in the local environment. All these degradational effects are supposed to be solely contained by the planet Earth with its self-sustaining natural systems.

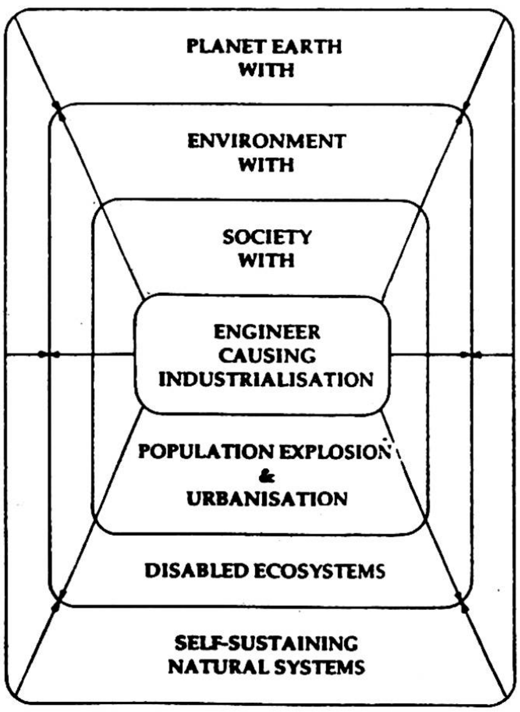

Fig 1. Model of concentric subservience

PRINCIPLES OF SELF SUSTAINENCE

Needless to mention that when there is no natural or man-made perturbation, the biosphere turns out to be an excellent autosustainable and self-generating system with only the solar energy as the external input (Fig.2) [1]. But the total elimination of natural or man-made perturbations is not possible in most circumstances. Even then, as long as the perturbations are within limits, the self-sustainance of cyclic phenomena can be restored as displayed in Fig.3.[2] which depicts man-made and

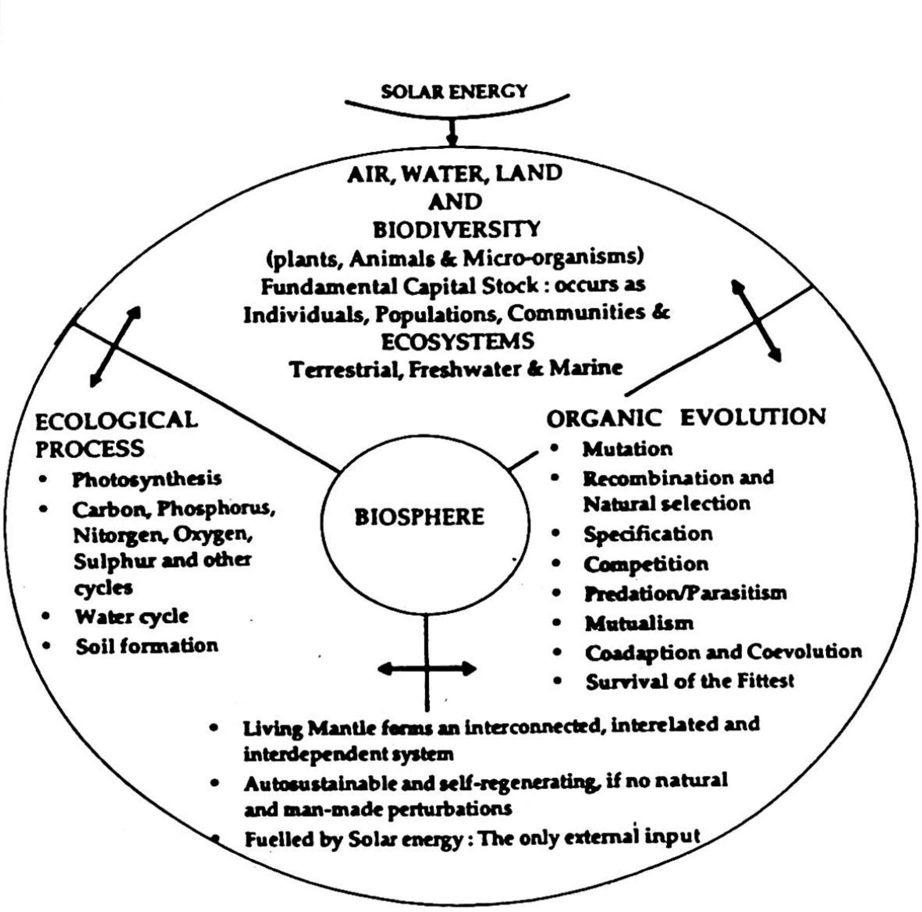

Fig. 2 Interactive components of Biosphere

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natural contributions to the natural carbon cycle through fossil-fuel burning and volcanic eruptions respectively.

If one attempts to critically study such phenomena in nature, one finds that the self-sustainance of natural systems is governed by the three basic principles of sustainability, which are as follows:

(i) Outputs: Waste emissions from a project should be within the assimilative capacity of a local environment to absorb without any unacceptable degradation.

(ii) Renewable inputs: These should be within the regenerative capacity of the natural system that generates them.

(iii) Non-renewable inputs: The depletion rates should be equal to the rate at which renewable substitutes are developed by human invention and investment.

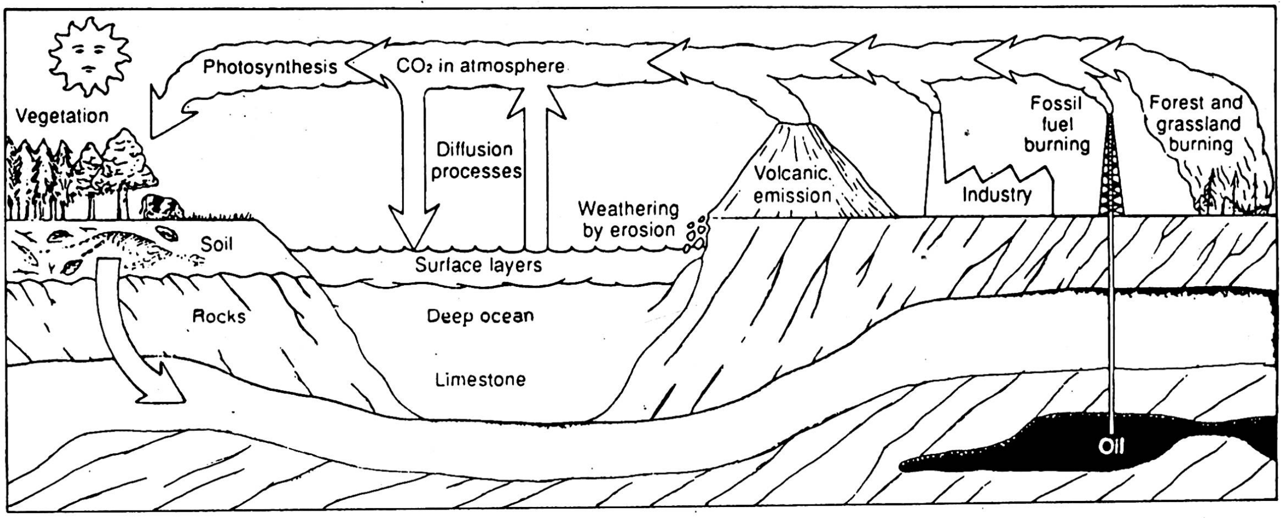

Fig.3 Carbon Cycle at global level

Unfortunately, the above principles of sustainability in real-life situations are difficult to be realised or implemented due to several constraints, two of which need special mention - fallibility of engineers and intrinsic conflicts in managing our environment. These aspects are expounded below:

CONSTRAINTS OF SUSTAINABILITY

Fallibility of Engineers

If one tries to track down the engineering catastrophies in historical times, one may find countless examples of failures, some of which are due to human frailties and some due to human faults. Let us consider the following examples:

* Failure of Tacoma Narrows Bridge in U.K. in 1836, in which case the disastrous effects of a natural phenomenon like wind excitation was, perhaps, beyond the comprehension of designers then.

* Collapse of Coledale Embankment in New South Wales in 1988, in which the proneness of the land to subsidence could not be gauged.

* Failure of challenger shuttle in 1986 which is ultimately traced to neglectof inspection of components.

All these examples reveal the concealed uncertainly in engineering profession which has been aptly defined in the context of structural engineering as follows [3]: "Structural engineering is the art of modelling materials we do not wholly understand into shapes, we cannot precisely analyse so as to withstand forces, we cannot properly assess in such a way that the public at large has no reason to suspect the extent of our ignorance".

Conflicts in Environmental Management

The above weakness of engineering profession gets aggravated manifolds with several conflicting issues that emerge in managing our environment. The more critical issues can be summarised as follows:

(a) While the growth of human population and human activity is explosive in nature, the counteractive approaches are adaptive and slow.

(b) While the environmental changes are science-induced, our understanding of such science is still incomplete.

(c) While in the management of environment there is a strong superimposed effect of economic and social processes, our understanding of such additional impact is grossly inadequate.

(d) While the economic development is a resource-use concept, the environmental protection is a resource conservation and management concept.

ENVIRONMENTAL IMPACTS OF HUMAN ACTIVITIES

In such conflicting situations aided and abetted by human frailties, the environmental impacts have been enoumous due to human activities. The decline of ancient civilisations in the plains of the Euphrates-Tigris, the Nile, the Indus, the Ganges, etc. was believed to be due to indiscriminate deforestation, decimation of animal life, etc.

With increasing tempo of industrialization in the 18th century the impacts of human activities on our environment have been significantly higher than what was, perhaps, experienced in the prehistoric times. An idea of the magnitude of such impacts can be had from Table 1 [4].

Table 1 - ENVIRONMENTAL IMPACTS OF HUMAN ACTIVITIES SINCE BEGINNING OF THE 18TH CENTURY

- POPULATION INCREASED BY A FACTOR OF EIGHT
- LIFE EXPECTANCY DOUBLED
- INTERNATIONAL TRADE OF MANUFACTURED GOODS INCREASED BY A FACTOR OF EIGHT HUNDRED
- LOSS OF SIX MILLION SQ.KM. OF FORESTS
- SEDIMENT LOADS IN RIVER SYSTEMS INCREASED THREEFOLD
- CARBON FLOW TO SEA ESTIMATED BETWEEN ONE TO TWO BILLION TONNES A YEAR
- WITHDRAWAL OF WATER FROM THE HYDROLOGICAL CYCLE INCREASED TO 3600 CUBIC KILOMETRES PER YEAR
- METHANE CONCENTRATION IN ATMOSPHERE DOUBLED
- CARBON DIOXIDE CONCENTRATION INCREASED BY 25%
- MORE THAN 70,000 CHEMICALS SYSTHESISED
- EMISSION OF IMPORTANT TOXIC ELEMENTS (TIMES MORE THAN THE NATURAL FLOWS)
  - — Pb (18), Cd (5), Zn (3)
  - — A, Hg, Ni & V (Each 2)
  - — S & N (≈)
- CFC & DDT ESTABLISHED AS MAJOR ENEMIES OF ENVIRONMENT

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The resultant environmental concerns are summarised in Table 2.

Table 2 - RESULTANT ENVIRONMENTAL CONCERNS

- *RURAL-URBAN DRIFT LEADING TO ENORMOUS PRESSURE ON WATER SUPPLIES AND WASTE DISPOSAL*
- *EROSION AND SEDIMENTATION CAUSING PERENNIAL AND RECURRING FLOODS*
- *POLLUTING EMISSIONS (PARTICULATE, LIQUID AND GASEOUS) LEADING TO CLIMATIC CHANGES/GREENHOUSE EFFECTS*
- *ACID RAINS AND PHOTOCHEMICAL SMOG*
- *DEPLETION OF OZONE LAYER AND THREAT OF UV RADIATION*
- *POLLUTION OF RIVERS AND INLAND WATERWAYS*
- *POLLUTION HAZARDS OF FOOD CHAIN*
- *DESTRUCTION OF BIODIVERSITY*
- *DESERTIFICATION*

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PRAGMATIC STRATEGIES FOR ENVIRONMENTAL MANAGEMENT

In the backdrop of what has been discussed above, it appears essential to adopt new and pragmatic strategies of environmental management which should consist of at least the following elements:

* Replace the "Pollute-First-and-Clean-later" approach by "Economic -cum-Environmental Planning".
* Environmental quality to match the needs and aspirations of the growing population.
* Minimise the deleterious effects of human and industrial activities through restorative and preventive measures.
* Balance the socio-economic development including the environmental preservation so as to spread the benefits as widely as possible.

Social Role of Engineers in New Strategy

With the adoption of such strategies it is possible to define the social role of engineers in environmental management as follows:

* To appreciate the new demands of the society and not to isolate from the social forces.
* To classify a project for environmental screening based on location (environmental fragility), scale (magnitude of environ-

mental effect) and sensitivity (sustainability or vulnerability of effects).

* To undertake Environmental Impact Assessment (EIA) studies for projects for which environmental screening is essential.
* To select Environmental Mitigation Plans (EMP).
* To fix up institutional arrangements for execution and monitoroing.
* To organise environmental management training.
* To adhere to the principles of sustainability within the limits of practicability and techno-economic feasibility.

The fulfilment of the above roles of an engineer becomes more pertinent in the context of projects already classified as of high priority for environmental screening, some illustrations of which as per the World Bank norms are given in Table 3 [5].

Table 3 - PROJECTS CLASSIFIED FOR RIGOROUS ENVIRONMENTAL SCREENING

- DAMS AND RESERVOIRS
- FORESTRY PRODUCTION PROJECTS
- LARGE SCALE INDUSTRIAL PLANTS AND ESTATES
- IRRIGATION, DRAINAGE, CHANNEL TRAINING AND FLOOD CONTROL
- LAND CLEARANCE AND LEVELLING
- MINERAL, OIL AND GAS DEVELOPMENT
- PORT AND HARBOUR DEVELOPMENT
- RECLAMATION OF NEW LAND
- RESETTLEMENT
- RIVER BASIN DEVELOPMENT
- THERMAL AND HYDROPOWER DEVELOPMENT
- MANUFACTURE, TRANSPORT AND USE OF PESTICIDES/TOXIC/HAZARDOUS MATERIALS

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The most critical role of engineers in handling these projects is to conduct EIA studies for which certain guidelines can be adopted as highlighted in Table 4.

Table 4 - CHECKLIST OF MORE IMPORTANT ISSUES FOR EIA STUDY

- USE OF AGROCHEMICALS IN A PROJECT
- PROTECTION AND MANAGEMENT OF BIOLOGICAL DIVERSITY
- COASTAL AND MARINE RESOURCE MANAGEMENT
- MANAGEMENT OF CULTURAL PROPERTY
- HAZARDOUS AND TOXIC MATERIALS HANDLING
- INDUCED DEVELOPMENT AND ASSOCIATE DSOCIO-ECONOMIC ASPECTS
- INVOLUNTARY RESETTLEMENT ISSUES
- LAND SETTLEMENT
- NATURAL HAZARDS
- OCCUPATIONAL HEALTH AND SAFETY
- INDIGENOUS PEOPLES
- TROPICAL FORESTS
- PROTECTION OF WATERSHEDS, DAMS, RESERVOIRS, IRRIGATION SYSTEMS, ETC.
- CONSERVATION OF WETLANDS
- CONSERVATION OF WILD LANDS
- PRESERVATION OF INTERNATIONAL AGREEMENTS ON RESOURCES

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Faculty Enrichment for Engineers

For more effective functioning in the realm of integrated E-C-E planning, certain preparation is necessary for engineers for enhancement of professional background. A few critical areas of faculty enrichment can be summarised as follows:

a) Innovative approaches for preserving biosphere, selecting cleaner technology and waste management.

b) Development of environmental information systems.

c) Adoption of systems analysis and modelling in environmental management, particularly in view of the multi-disciplinary nature and complexity of sub-system.

In this regard, mention may be made of the endeavour being made by ACC in rehabilitation of quarries, greening of land with appropriate plantations and waste management with new product technologies through in-house multi-disciplinary developmental efforts. In all such exercises, process engineers, agricultural scientists, organic chemists, material scientists, etc. work hand-in-hand.

ASSESSMENT OF SUSTAINABILITY

It need not, perhaps, be repeated that sustainability is the key word in the management of environment but it should certainly be considered that any quantitative assessment of environmental sustainability is always a complex issue. Often attempts are made to measure sustainability through such macroeconomic indicators as:

- Population stability
- Greenhouse gases
- Acidification
- Toxic substances
- Soil degradation
- Aquifers depletion
- Species extinction, etc.

For specific projects, other indicators like energy intensity,material intensity, renewable energy proportion, recycled proportion, etc. are also applied.

But none of these indicators or for that matter, even those developmental indicators like GNP, Price Indices, etc. do not reflect truly the development in a society. Hence, the environmental scientists and engineers, in association with the sociologists, are trying to look at the feasibility of adopting an all together new concept " QOL " - "Quality of Life" - as the proper indicator in economic cum environmental planning. Index QOL is conceived as a function of the objective conditions appropriate to a selected population and subjective attitude towards those conditions held by persons in that population. The mathematical representation of such a concept is obviously not easy, although numerous attempts are being made [6].

CONCLUSION

From the foregoing it is, therefore, obvious that the interrelationship of 'Engineer - Society - Environment' in our planet is an involved one in which there are opposing forces of degradation and restoration, demanding pragmatic management efforts. The practice of technology cannot be kept aside and at the same time, the degradation of environment cannot be permitted. This kind of dichotomous demands needs to be appreciated from what has been stated by Arnold Bacer: "If the practice of technology leads to frequent or dangerous dislocations in the natural environment or in the society, then it is perfectly right to suspect that there is something wrong with the technology itself". This concept is pervading fast enough through the entire society and the engineers are certainly re-orienting themselves to meet the social demands of industrial progress through cleaner technologies and effective waste management. In this approach, there is a strong role of specialised consulting agencies who are already geared up to manage the environment in association with their clients in a pragmatic manner.

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