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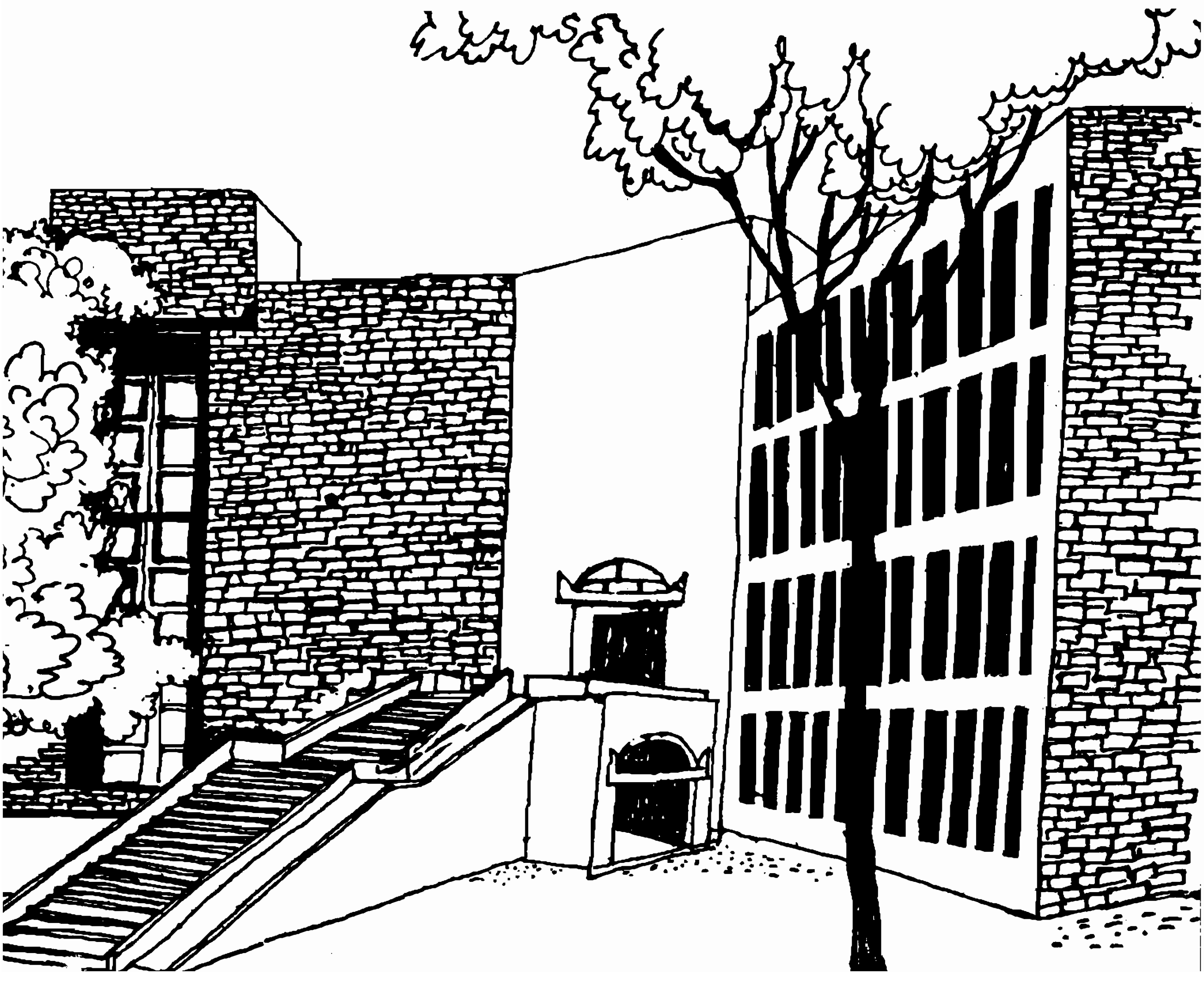

DATA SYSTEM FOR ENVIRONMENTAL IMPACT ASSESSMENT FOR HUMID-TROPICAL REGIONS: RELEVANT ISSUES

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W P No. 921
February 1991

The main objective of the working paper series of the IIMA is to help faculty members to test out their research findings at the pre-publication stage.

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INDIA

Data System for Environmental Impact Assessment for Humid-Tropical Regions: Some Relevant Issues[1]

Introduction

The food crisis and the poverty crisis affect the immediate present. The financial and environmental crisis portend an even gloomier future.[2] Environmental impact of human activities has both short and long-run consequences. However, it is the gradual long-run process through which the environmental impact becomes perceptibly and often irretrievably damaging or negative, that makes the subject even more dangerous and problematique. Since the 1960's, specially following Human Environment Conference held at Stockholm in 1972, there has been a worldwide increasing attention on the interaction between development actions and their environmental consequences. Under the politico-economic pressure of the national goals of rapid poverty removal and modernization-industrialization process, the environmental and ecological imperatives are often lost sight of. As a result, there is a world-wide growing recognition that environmental considerations should necessarily be incorporated in planning strategies, development programmes, legislative framework and in the whole decision-making process as an integral part. This is imperative in order to ensure environmentally sustainable development. However, because of the complexity of many environmental issues, inadequate data-base and scientific knowledge of various environmental parameters and the necessary multidisciplinary approach, sound environment management is difficult to realise both in industrialized and in developing countries. Environmental Impact Assessment (EIA)[32] has been identified as a major tool for the realization of environmentally sound development. Over the last decade in many developed as well as developing countries EIA systems have been or are being implemented. Although no two countries define EIA the same way and procedures and methods vary greatly, a comparative analysis of practical experiences with the application of different EIA-approaches in several countries can provide developing countries the critical insight about the problems of data requirement, analysis and application of the system. What follows in this paper is an attempt to synthesize these experiences in the application of EIA-system in order to outline the problem of data requirements and analysis for the developing countries in the humid-tropic region.

Humid-Tropics: The Characteristics

The world is divided into four Major Natural Regions based on broad uniformity of conditions of climate, soil, and natural vegetation. Tropical Region is one of the important Natural Regions covering a large area of the earth's surface. Within the Tropical Regions there are four types as shown in Table 1.The tropical humid and sub-humid areas have their own set of drawbacks being environmentally highly sensitive, as compared to say, temperate regions. Due to heavy convective rainfall, the nutrients are more rapidly leached out of the topsoil. The soil is often more acid, and insoluble compounds (aluminium and iron oxides) remain close to the surface. Frequently the oxides crystallize into a cement-like hardpan which roots cannot penetrate and therefore becomes impossible for cultivation. High temperatures break down organic matter rapidly and inhibit thé work of bacteria that fix nitrogen from the air. Almost the year-round high temperatures and high humidity provide ideal conditions for pests and diseases. On the other hand, the heavy rainfall causes erosion. The vulnerable soil of the tropic humid region is protected by its vegetation from her highly erosive rainfall. Thus, a healthy cover of vegetation is crucial for the stability and sustainability of this region. When the vegetation are removed, the soil is exposed to the power of wind and rain. Often, as a result, in the downstream the sediment clogs waterways, dams silt up permanently and the risk of flooding increased manifold. What is even more decisive as well as sad is the unpredictability of rainfall. There is almost a regular cyclical rhythm of drought spells without any predictable pattern or certainties.

Environmental Impact: Some Observations

In spite of a rather diverse and often an unsystematic approach to the EIA problem in various countries, there are wealth of existing information and knowledge about the likely environmental impact due to various human activities and resource management practices. While some of these information are scientifically and empirically tested over a period of time, some are at best "educated guesses" due to poor or absent scientific data-base for certain discrete and recurring issues and resources. In planning and implementing systems and procedures for EIA appropriate to the problems and circumstances in humid-tropical regions of developing countries, much can be learnt from the existing scientific data-base and experience in respect of environmental impact. In fact these data-base could be updated and improved considerably by better and appropriate use of existing tools and techniques. On the other hand, the areas of scientific data-gap and of ignorance could indicate the issues for intense and focussed research.

Table 1: Characteristics of Four Types of Tropical Regions

Types	Location	Major countries	Characteristics
1 Equatorial	0° to 10° North and South of Equator	Parts of South America (Amazon Low Lands) and Coast of Guinea, Parts of Africa (Congo Basin) and parts of Asia (Malaysia,Indonesia New Guinea, South Philippines).	Hot-wet climate. The sun's rays fall almost perpendicular. The average annual temperature is about 27°C with small daily variations. Rainfall is high, well distributed throughout the year averaging about 150 cm annually. Dense ever-green forests known as equatorial forests.
2 Savana Type	5° to 20° North and South of Equator	Parts of South America (Brazil, Argentina,Columbia Bolivia, Venezula) and large parts of Northern & Southern belt of Africa	It is generally hot and summers are exceptionally hot.The average monthly temperature during summer seasons ranges 32°C-38°C. Temperature is lowered in rainy season. Rainfall is seasonal, maximum in summer. The rainfall varies from place to place between 25 cum to 125 cum. Winters are dry because the area comes in the the belt of trade-wind. Wet summer, dry winter and greater evaporation due to heat are the factors which do not promote a perennial natural vegetation like forest. Vegetation is, therefore, grass land type known as Savana. The trees, if any, generally are broad-leafed deciduous variety.
3 Hot Desert	Between 20° and 30° North & South on the Western Margin of the continents.	Sahara and Kalahari of Africa, the Arabian and Thar desert of Asia, Atacama Desert of South America, and The Great Australian Desert	Very high temperature, with very scarce rainfall and high aridity. The scarce and unreliable rainfall is convectional type which comes in torrential form causing flood. Either no vegetation on their sandy expanses or some sparse xerophytic type vegetation.
4 Tropical Monsoon	---	Covering large parts of almost all the Asian countries.	Two clearly marked wet and dry seasons. It rains mostly in summer. Summers are hot and moist and winters are cold and dry.The annual average temperature is 26°C. Seasonal heavy rainfall and drought are common features. The climate promotes tropical evergreen forests, broad-leafed deciduous forests and scrubland vegetation.

What is ideally needed for EIA is a relatively accurate, quantifiable predictions of environmental impact encompassing both quantitative (biomass) and qualitative (diversity)aspects of the flora and fauna of the proposed area of impact. This means the determination of the cause-effect relationships between the impacting activity and the environment. Since EIA is essentially meant for helping decision-making process prior to implementation of the impacting activity, the data-gathering process could be accomplished either through well-planned scientific field work or literature searches or both. If it is possible to identify scientific documentation of actual environmental impact of a given activity under similar agro-climatic conditions, then these data could be suitably used for cause-effect predictions augmented by some baseline information collected from the impacting area of the proposed project. Following this rationale, an attempt is made here to document some scientifically observed environmental impact of certain activities relevant for humid-tropical region of the developing countries.

A *Impact of Deforestation-Devegetation*

"Water is the essence of earth, plants are the essence of waters" - a seminal environemntal wisdom expressed in the Upanishad thousands of years ago. The importance of vegetation cover, particularly, forests and grasses, in maintaining sustainable environment in humid-tropic regions hardly needs any further emphasis. Today, a tree or a grass cover is not only an economic commodity, but also a source of fuelwood, a form of protection for watersheds and soil erosion, a genetic resource, an aesthetic high-point and perhaps even a contributor to climatic stability.

Deforestation and devegetation are caused by a complex set of factors, such as, spread of agriculture, high population densities, timber for construction and industry and use as fuel sources. Each year 11 million hectares, out of a remaining total of 800 million hectares, of tropical forest are cleared, which account for 60% of the world's annual loss of forests. If this continues unabated, an estimated 10-20% of the earth's biota will be disappeared by the year 2000.

In the developing world woodfuel accounts for an extremely high proportion of the total energy used at a national level. In the Sahel countries, such as, Mali, Chad, Ethiopia, Somalia, woodfuel supplies over 90% of the total energy consumed for all purposes, while even in oil-rich Nigeria, it accounts for over 80% of the total national energy consumption. In the developing countries 48% of the total energy consumed is from biomass sources.[4]

In terms of percentages of total energy supplied by fuelwood are 76% in Africa, 42% in Asia and 30% in Latin America.[5]

It is significant to note that more than 80% of the wood harvested in developing countries is used as fuelwood. But domestic consumers are not the only users of woodfuel. A large number of industries and small business also rely on firewood and charcoal. While in India woodfuel provide only 6% of the total industrial fuel needs, in Sri Lanka firewood represents 57% of the industrial energy demand, in Mozambique it is 69%, in Tanzania 88% and even in Brazil it is as high as 21%. Baking, brewing, tea and coffee drying, tobacoo curing, fish smoking, sugar production, pottery, brick and lime making, are all industrial activities which depend heavily on woodfuel in most of the tropical countries of the developing world. In Kenya, for example, industries and small commercial enterprises account for 26% of total national firewood consumption, and 12% of charcoal use, while in Nicaragua they consume 19% of all woodfuels, in Chile 29% and India only 3%. A substantial part of the charcoal for Brazilian iron and steel industries come from eucalyptus wood grown in massive industrial-scale plantation, the area of which is planned to be increased to 700,000 hectares over the next few years. It is, however, interesting to observe that in the majority of woodfuel studies carried out so far, the demands of industry have almost been neglected. As a result, there are still major gaps in our knowledge of how industries obtain and use woodfuel and what impact they are having on local wood supply systems.

Soil Erosion and Desertification

How much of the water flows from the land to the streams immediately after rains, and how much sinks into the ground determine to a great extent both the incidence and intensity of floods and droughts. Forests and vegetation play a crucial role in controlling both floods and droughts, in the sense that they protect the soil from being washed away by the rain and also provides decaying organic matter in the form of leaf litter, which holds the rainwater and allows it to enter the groundwater. It has been observed in India that after the start of rainfall, water began to gush out of a deforested watershed within half an hour and in four hours entire water had drained away. On the contrary, no water came out of a forested watershed for two hours after the start of rain and even then maximum flow of water was only 40% of that from the deforested watershed.

It has been estimated that once forest lands are denuded, soil lose can increase by as much as 400 times. More than a billion tons of top soil wash down from Ethiopia's Central Highlands Plateau each year as a result of farming practices and deforestation.[6]

In Africa, losses of 20 to 50 tonnes of top soil per year are not uncommon in cultivated areas. According to UN Environment Programme estimates, a total of 742 million hectares - more than a quarter of the whole African content - is in the process of becoming useless for cultivation, undergoing various degrees of desertification. For, in arid and semi-arid regions, eroded land can quickly become desert.

By some estimates, one third of the total global arable land could be lost through desertification by the year 2000.[7] As drylands are stripped of woody vegetation through agricultural cleaning, overcutting of fuelwood, overgrazing and bush fires, spread of deserts accelerates as it is happening in the drylands in Africa, Asia and Latin America. According to the United Nations Environment Programme, some 1.3 billion hectares are at least moderately desertified in these three regions. Floods On upland watersheds, violent tropical rainstorms require close protection of the soil by vegetation not only to maintain the environmental stability of upland sources of streams but also to protect downstream hydropower reservoirs and irrigation systems for silt and debris. Despite their critical importance, an estimated 160 million hectares of upland watersheds in the tropical developing countries have been seriously degraded. The world's most severe upland watershed problem is the Himalayan range. In India, for example, the costs of the increasing flood damage and destruction of reservoirs and irrigation systems by sedimentation from misused slopes have averaged US$ 1 billion a year since 1978. Of the 5334 million tonnes of soil eroded every year, 20% goes to the sea, 10% gets deposited in dams reducing their storage capacity by 1-2% per year, and 61% gets transported from one place to another, much bit of it settling on river beds.[8] Rise in river beds is a major problem leading to floods in many Indian rivers.

Loss of Soil Productivity

Deforestation, overgrazing and the expansion of rainfed agriculture have severely degraded many watersheds and accelerated soil erosion. According to a study conducted by FAO, the maximum loss in soil productivity owing to land degradation is noticed in tropical humid regions of the developing countries. If soil erosion were to continue unchecked, the FAO estimated that rainfed crop productivity could decline by 38.6%. In Niger, for example, average grain yields fell from 500 kg per hectare in 1920 to 350 kg per hectare in 1978.[9] Research in the United States has shown declining yields in basic cereal cultivation of 25 per cent or more after soil erosion.[10]

Loss of Biota

As noted earlier, one of the serious environmental impact of deforestation, particularly of tropical rainforests is the loss of biota. Interestingly 60% of the world's annual loss of forests is due to destruction of tropical rainforests, which are estimated to contain almost half of all known animal and plant species, many of them are not yet catalogued by scientists. A single hectare of Amazon rainforests, for example, has been known to contain upto 230 tree species, as compared with the 10 to 15 species normally found in a hectare of temperate forest. The origin of many food and medicinal plants are in the tropics - a veritable genebank. The gene for semidwarfism that improved production in Asian rice came from a primitive Taiwanese cultivar. Resistance to virus came from a different wild donor species, one that probably evolved in the Silent Valley in the Kerala State of India.

Change In Climate

Still another serious long-run impact of deforestation could be a change in climate. Although not fully scientifically established yet, there is sufficient empirical basis to suggest that extensive deforestation can increase the regional albedo, reduce evapotranspiration, and diminish rainfall. It may also be related to the recent reduction in rainfall in Africa.[11] Also as vegetation cover thins, atmospheric carbon dioxide increases, adding to emissions from fossil fuel and contributing to concerns about global warming and radical climate change.[12]

B *Impact of Dams*

Pressed with the problems of food scarcity and the goals for rapid modern development, large-scale damming of rivers for irrigation and hydropower is promoted in most of the developing countries. The environmental impact of a dam has to be understood in relation to the following segments of basin: i) Catchment Area; ii) Dam, Reservoir and its Fringe Area; iii) Canal Conveyance Area; iv) Command Area; and v) Down Stream Area. All these segments are vulnerable to the environmental impact of dam, which could be both favourable and adverse, depending on the site characteristics and the scale of the project.

Apart from various advantages, some of the obvious and immediate negative impact of a dam are: (i) innundation of a large area in the catchment which may mean deforestation and displacement of the inhabiting population; (ii) problem of reservoir-induced seismicity (RIS); (iii) seepage losses, siltation-rise in beds, water-logging, rise in groundwater tables; and (iv) changes in the base level of the stream etc.

To illustrate, while about 5000 hectares of additional land are irrigated in the Sahel each year, about the same amount goes out of production due to poorly managed irrigation systems. The Metri project in Northern Kenya - a FAO sponsored project caused the river, naturally silty, eventually shift its channel and flowed on to the fields, leaving a layer of dry and racked mud in its wake. The negative impact of the Aswan Dam in Egypt is well-documented. Perhaps one of the biggest tragedies in USSR in recent years has been that of the Aral Sea in Uzbekistan. In a bid to bring more land under cultivation for cotton, all the waters of the legendary rivers, Syr Darya and Amu Darya have been used up. These rivers no longer fall into the Aral Sea which over the 10 to 15 years has shrunk to half its original size. A salt desert has surfaced in this area. Animals and plant life are perishing and people are falling sick.Experience in India shows that reservoirs formed by damming the snowfed rivers in the Himalayas are being filled with sediments at rates 3 to 5 times faster than estimated. The Ichhari Dam in river Tons which was impounded in 1975 silted upto the crest in February 1977. It is estimated that Kalagarh dam on river Ramganga will have an effective life of only 48 years as against 185 years as estimated by the designers of the dam. Siltrise in river bed can cause serious threat of flood. The devastating flood of July 1970 on river Alkananda, a major tributary of the Ganga, is still fresh in the memory of the hill people. During this flood 10 kms. stretch of upper Ganges got completely choked up by the sediment load carried by the flood waters. It has been estimated that the total sediment load carried during the course of the flood was 3.1 million cubic meter.

Located in an active seismic zone of Uttar Pradesh in India, the recently planned $ 1.5 billion Soviet-sponsored Tehri Dam project in the Himalayan Foothills is projected to displace 70,000 people. It is reported that the size of the dam and its location could trigger earthquake in seismically active area surrounded by two major thrusts on the north and the south. Also the most resistant rocks in the vicinity of the project area have been found to contain joints, fissures, shear zones, faults etc. Once the reservoir created by the dam is filled, there will be excessive water seepage which could lead to weakening of the structure. The dam could breach and collapse. In the event of a collapse, a population of about 170,000 in the towns of Hardwar and Rishikesh will be threatened.

Balbina Hydro-electric project, built with World Bank Loans, has become known internationally as one of the largest errors ever committed in the Amazon. Balbina's reservoir will innundate an immense, flat expanse of tropical reainforests, 2346 sq. km. to produce relatively small amount of electricity of 250 MW. The drowned area contains more than 150 timber species. The impact of flooding such large tracts of tropical forest, as experienced with the Brokonpondo Dam in Surinam and Gurna Una Dam in Brazil's Amazona's Statem have shown that the by-products from decomposing submerged forest can lead to massive fish kills, infestations of aquatic weeds, the production of hydrogen sulfide and other noxious substances, which not only threaten the dam's turbines and other machinery but pose serious public health risks.

C *Impact of Agricultural Practices*

We have earlier noted the impact of extension of agriculture into the forested land in terms of deforestation and devegetation. What is important to emphasize here is the impact of changing agricultural practices, especially, those of input-intensive, deep tillage intensive cultivation practices, commonly known as modern agriculture.

Shifting cultivation, for example, is still the dominant mode of farming in all but the most densely populated zones of Africa. It is essentially a no-input form of agriculture, relying on nature to restore the nutrients removed by the crops by allowing a sufficiently long rest or fallow period. With the active promotion of cash crops and 'modern' intensive agriculture, there has been a major change in agricultural practice in

Africa. The traditional fallow periods, once lasting upto seven years, are now being shortened by farmers determined to meet the increasing food demand. Governments are discouraging fallow periods too. The valuable practice of inter-cropping was discouraged in favour of sole cropping. Heavy machinery was used, destroying the fragile soil structure. Chemical fertilizers were used which acidified the soil in humid areas, and in dry areas often yielded less in extra production than they cost to buy. In overcrowded Rwanda and Barundi, fallowing had almost disappeared. Interestingly, under Senegalese law any land not cultivated for three years is confiscated. In three Nigerian villages, cassava yields fall from 10.8 tons to 2 tons per hectare as the fallow period shrank from 5.3 to 1.4 years.

The two major inputs in modern agriculture are chemical-fertilizers and irrigation. The continuous application of high doses of chemical fertilizers without appropriate corrective measures (i.e. equally high dose of organic manure application), not only destroys the soil structure but also causes acidity in the humid areas. Added to it is the badly managed high dose of irrigation inputs without adequate drainage causing salinity-alkalinity of the soil, along with the steep rise in water table. On the other hand, an indiscriminate and increased use of groundwater pushes down the water table further below. The net result of this process is rendering once-fertile land-resource into uncultivable waste. A similar phenomenon could be observed in a vast tract of Punjab in India.

The other important input into modern agricultural production system is the application of biologically active pesticides, which in most cases are toxic. Thus, they pose potential risks to human beings. Although, forty years of experience have provided little consistent data on how synthetic organic pesticide materials affect people, one unavoidable conclusion can be drawn that pesticide poisoning is a problem of serious proportions. UNESCO, for example, reports that during 1973-78, Sri Lanka alone had 14,396 cases of poisoning per year of which 988 were death cases.

With the increased use of synthetic organic chemicals for pest control, three problems have emerged:

1 Development of resistance to pesticides among anthropods threatening ability to continue growing, say, cabbage (in Malaysia) potatoes and cotton (in many parts of the world). Often it impedes the control of insect-borne diseases in the tropics, where some pest control programmes appear to be at the end of the line because the chemical industry can no longer come up with substitutes as quickly as the pest.[13]

2 Often pesticide applications disrupt the natural controls, so that once harmless species grow numerous enough to become pests. Loss of natural controls can enable pest population to rebound quickly after a pesticide application to even greater numbers because nothing keeps them in check.[14]

3 Together, resistance, secondary pest outbreaks and resurgence often leads to the "pesticide treadmill" - more and more chemical has to be applied to keep loosing everything.

The ways in which pests and crops interact with each other and rest of the environment are seemingly endless, given the local variation in weather, climate, soils and topography. Pesticide present a great dilemma:as their hazards become more apparent, so does the need to use them.

D *Impact of Air and Water Pollution*

The problem of pollution is not new. What is, however, new is its magnitude. Pollution has been defined in many different ways. In general, environmental pollution has been defined as the addition to the atmosphere of any material which will have a deleterious effect to life upon our planet. The material might be a toxic gaseous hydrocarbon with some longlasting effect on an organism ingesting it or perhaps a particulate irritant which could cause similar problems. A pollutant can thus be anything which when put into the atmosphere either purposely or through some act of nature reduces the oxygen content or significantly changes the composition of the air and water.

Air Pollution

The major sources of air pollution may be categorized as: (1) transportation, (2) domestic heating, (3) electric power generation, (4) refuse burning, (5) industrial fuel burning and process emissions. It is difficult to assign accurate percentage of contributions for each of the sources. But in one estimate it is suggested that transportation of all types, internal combustion engines and turbine engine-driven vehicles, contributes about 60% of the total annual emissions polluting the air; electric power generation contributes 10%-15%; domestic heating about 10%; industrial emission about 20%; and refuse burning about 5%.[15]

The individual air pollutants can be broadly categorized into five major areas: carbon monoxide, sulphur oxides, nitrogen oxides, hydrocarbons and particulates. The first three are essentially specific, while the last two could be made up of dozens of different compounds and elements.
In addition to the damage which air pollution causes in the human organism it causes similar and in some cases more severe damage to animals, to plant life, and even to our climate. Cubatao in Brazil, for example, may be the most polluted community on earth. Scores of plants including a petrochemical complex pump at least 75 pollutants into its frequently stagnant river, raising contamination levels in parts of town to twice those considered safe for humans. Similarly, deadly dioxius and other toxics, identified in some fish in the Great Lakes, are believed transported by air over great distance. Pesticides and herbicides found recently in alarmingly high concentrations in fog have been added to the list of potential culprits in forest dieback as in West Germany's Black Forest.

A filthy haze chokes Mexico city on winter morning. Vehicle exhaust, factory smoke, smoldering refuse heaps befoul the air inhaled by its 17 million people. Breathing this air has been compared to smoking two packs of cigarettes a day. In rural Nepal a cooking fire can fill a poorly ventilated house with heavier pollution than the worst urban smog, increasing risks of respiratory disease. Erasing the beauty of classical Greece, Sulfur dioxides in the smog over Athens chemically transform marble into gypsum, causing it to crack and flake off.

During the past two centuries carbon dioxide in the atmosphere has increased dramatically. The probable cause: the burning of fossil fuels and clearing and burning of forests by farmers. Scientists worry that the growing burden of CO_2 and other gases may change earth's climate. It is estimated that the earth's mean temperature could rise 1.5°C to 4.5°C by the middle of the next century if green house gases continue to increase at the current rate. Global rainfall patterns could shift, bringing heavy rains to previously arid regions such as the Sahel and droughts to productive farmlands. Smoke, made up of gases and particulate matter in large quantities are seen over many of our major cities in the last two decades, forms a blanket which shields some of the sun's radiation so necessary to life on earth.

Water Pollution

A major section of the population of the developing countries do not have the access to clean unpolluted potable water. The pollution of water is caused mainly by four ways: (1) industrial waste-water or affluents; (2) domestic waste-water or untreated sewage affluent; (3) inadequate disposal of solid wastes; and (4) cultural practices of using drinking water source for both livestock and cleaning clothes etc.

In India, for example, the total industrial waste-water generated in the country constitutes only 10 per cent by volume of the total waste-water generated by all urban settlements. All waste-waters, domestic or industrial, ultimately manage to get into the riverine systems of the country. The nature of impact of the waste-water on the river and its tributaries would depend on its characteristics and the pattern of travel the waste-water has undergone before reaching the river. The water quality status is measured by BOD (Biochemical Oxygen Demand) and DO (Dissolved Oxygen) profile. It is interesting to note that in India 6 out of a total 40 locations in inter-state major river-streams where monitoring was done, were found to need improvement of water quality by controlling discharge of pollution at source. The worse quality locations are downstream of Ahmedabad on the Sabarmati (average BOD 67 mg/1). The river water quality observation confirm the need for sewerage and sewage treatment.

Data Requirement for EIA

The foregoing discussion gives a broad outline of the nature, quantum and the coverage of data requirement for EIA. Easily it is an enormous task to collect and create the data-base of the magnitude as described above, depending of course on the existing level of information, expertise and data collection systems prevailing in a country. Perhaps, based on our earlier discussion it would be worthwhile to summarize in a tabular form the minimum quantum and nature of data to be required for scientific EIA for an impacting activity as shown in Table 2. However, before actually summarizing the data requirement, the following assumptions are considered: (1) that the data on environmental impact should be location or

Table 2: Data Requirement for EIA for Some Major Impacting Activity

Impacting Activity	Data on Existing Environmental Resources	Environmental Impacts Positive	Negative
1 Deforestation Devegetation	Types of forests and vegetation; Topography and soil structure; Population densities; Livestock Population; Area under forests and agriculture and grazing; Rainfall; Temperature; Slope; Patterns of Consumption and Exploitation of forests; Demographic and economic characteristics of people living in the area; Rate of deforestation and afforestation; Causes of deforestation and the rates according to causes; Existing rate of soil erosion and rate of rain water run off; Level of ground water; Organic matter content in the soil; Incidence of floods and droughts; Rate of siltation in river beds; Soil productivity; Existing flora and fauna or biota; Level of CO_2 in the atmosphere.	Employment and Income generation; Extent of meeting local needs;Infrastructure development; Socio-economic changes.	Extent of loss of organic matter to the soil; Extent of loss of ground water due to increased run-off of rainwater; Extent of increase in soil erosion; Extent of increased rate of river bed and reservoir bed siltation; Increased probability of floods and droughts; Extent of loss of soil productivity: Extent of loss of biota; Extent of increase in CO_2 in atmosphere Desettlement of human habitat.
2 Dams	Geomorphology; Topography; Hydrology; Slope; Forest cover; Rainfall intensity; Climate; Soil structure and characteristics; Wind velocity; River characteristics; Existing land use pattern; Ground water tables and quality; Stream load; Stream Confluence; Existing human settlements; Intensity of irrigation; Agricultural practices; Structure of the proposed dam, height, foundation; Seismic data; Canal size and design; Cross-drainage; Canal network; Alignment of the canal; Extent of command area; Length of the river after command area; Existing rate of siltation.	Increase in Water availability for irrigation;drinking and for livestock Irrigated agriculture and change in cropping pattern;Increased agricultural productivity; Flood and drought control Raising groundwater level; Employment and income generation; Added socio-economic infrastructure; Fisheries Development; Communication and transport linkage; Electricity generation; Attraction of migratory birds; Expansion of cultivated area; Agro-based and other service industries.	Extent of damage to forest resources and negative impact as described in item 1; Extent of exploitation of parent rocks and seismic threat Siltation rise in bed threatening life of reservoir and dam and threat of flood; Submergence of agriculture and forest land and human desettlement; Extent of adverse climatic impact; Spread of water-borne diseases and health problems; Rise in water table and increase in salinity-alkalinity; Loss of productive land; Water pollution due to industries; Adverse moisture balance; Reduction in stream flow; Change in resource benefits in the basin; Adverse impact on flora and fauna and change in micro-climate; Extent of seepage losses and water logging; Erosion of banks of the reservoir.

3 Change in Agricultural Practices to Modernisation	Area under agriculture and rate of expansion; Extent of deforestation; Existing cropping pattern and the extent of use of organic manure; Chemical fertilisers, Irrigation, fallowing use of heavy machineries; Levels of tillage; Intensity of cropping and use of pesticides; Soil quality; structure; Rainfall and wind velocity; Rate of soil erosion; Occurence of flood and drought; Temperature and humidity; Land use pattern; Livestock and population density; Level of ground water etc.	Increase in crop productivity and cropping intensity Increase in employment and income generation; Socio-economic infrastructure development; Development of trade and industries.	Negative impacts of deforestation and devegetation caused by extension of agriculture into the forest land as pointed out in item 1; Increase in rate of soil erosion due to repeated deep tillage and use of heavy machineries; Increase in rate of soil erosion due to repeated deep tillage and use of machineries; Increase in soil acidity due to use of chemical fertilisers without increasing organic manure input; Extent of damage to soil structure due to mono-cropping; shortening or disappearance of fallowing and its impact on productivity; Due to increased and ill-managed irrigation; increase in salinity; water-logging; Rise or steep fall of groundwater levels; poisoning due to pesticides; Increase in pesticide use and development of resistance to pesticide; Disruption of natural controls due to pesticides.
4 Industrial Projects	Demographic profile of the area; Physiography and nature of soil in the location; Township and Population; Elevation above mean sea level; Land details, topography, forest and vegetative cover and water sources in the area; Land use pattern; Extent and type of industrialization existing in the area within 50 km radius; Flora and fauna within 20 km radius from the site; Prominent endemic diseases and mortality rate in the area; Existence and distance from archaeological monuments, hills and mountains, rivers streams, ponds, dams, fisheries etc; Climatic features including rainfall, wind velocity, humidity etc; frequency of occurrence of inversion conditions; Existing sewage system of the town; Ground water quality within 15 kms. distance of down gradient; Details of water requirement and quality and	Increase in income and employment generation; Other infrastructural development including township and various service facilities etc.	Increase in the ambient air and water quality in relation to conventional pollutants e.g. SO_2, CO, HC, NO_2, Ozone, SPM within 10-20 kms. of the site in all seasons; Changes in the incidence of predominant diseases and human plants and animals; Extent of effect on forests and clients; Extent of effect on monuments; Increase in incidence of higher temperature; Changes in rainfall patterns, droughts.

quantity of discharge of solid waste and waste water and their disposal plan; Process details of the plant; Existing Concentration of SO_2, NO, HC, CO and other pollutants in the air and water and the rate of emission in the proposed plant within 10 kms. of the site for all seasons separately.

site-specific related to the proposed activity; (2) the environmental impact are usually multi-dimensional and inter-related in relation to physical, biological and other relevant socio-economic resources meaning multi-dimensional data requirement; and lastly (3) there are short-term and long-term aspects of environmental impact requiring often a continuous monitoring to generate time-series data.

Collection and Selection of Data

It is one thing to scientifically assess the data requirement for EIA, it is completely a different process to collect and analyse the data meaningfully. For,obviously the second part of the process is fraught with lack of data in the required scale and form, the strenuous time-consuming process of collecting data and the lack of available multidisciplinary expertise. The task of data collection becomes all the more difficult for those developing countries where EIA systems are newly being planned to be established or are established only recently. For, the data regarding environmental impact of a proposed activity is largely determined by the trends already set in due to past activities. This means existence of time-series data of the prevailing trends, which necessarily can only emerge through continuous process of monitoring of selected indicators, such as, extent of forest cover, extent of waste-land, rate of desertification, rate of change in population of endangered species, municipalities and industries adequately treating affluents, pesticide residues in water bodies, measure of air and water pollution including incidence of acid rain, incidence of floods and droughts etc.

It is also to be noted that EIA systems being site-specific, the coverage of the time-series trends data should necessarily represent characteristics of the impacting site. This means a network of monitoring covering various agro-climatic zones, rivers, cities etc. of a country and across sectors of development programmes. In India, for example, a network of about 12o monitoring stations to check water pollution has been created. Zoning and classification of all the 14 major inter-State rivers in India have been completed to provide a basis for water quality management. A river basin-wise inventory for Yamuna and Ganga - two major rivers in India - has been prepared to assess pollution load. 80 Stations are monitored on these two rivers flowing through Union Territories. Additionally, under Global Environmental Monitoring Systems (GEMS), 40 Stations are monitored including 10 groundwater stations in which water quality data get collected through international hook-up to Global Water Quality Network run by United Nations.

Similarly, an Ambient Air Quality Network is being established in India in a number of selected cities. For major industrial investment, particularly for major thermal power projects and dams a data collection process for EIA has been worked out in India (See Appendix 1). The kind of information required, the scale and complexity of it could easily be understood from the data-sheet presented as an example in the Appendix for an industrial project.

As mentioned earlier EIA essentially and ideally requires data which can establish cause-effect relationship. On the other hand, in spite of recent technological development, particularly, in relation to detecting mechanisms of the environment impact in many of these cases these scientific development can yet afford neither accurate quantitative measurements nor can they accurately discern between various types of pollution. It is, for example, often conspicuous to see the effects of air or water pollution on human or plant health, but even experts in the field cannot determine whether one or a combination of pollutants has caused the symptoms. A similar scientific uncertainty remains in relation to impact on climate. Added to it is the problem of lack of existing data-base and infrastructural facilities in many developing countries, which brings the question of proper selection of data.

While the scientific and reliable measurement, both qualitatively and quantitatively is necessary to the proper solution of the overall problem, there is no reason to await better detection devices before beginning the EIA system. Similarly, it can be argued that one need not await for establishing a [illegible] series data-base before operating EIA. For, the data-base could emerge while operating EIA system over a period of time. Since major sources of negative environmental impact are fairly well known and recognizable, the selection of data could be directed towards these efforts. This is not to suggest that there is no need for continuing R&D efforts in the field, which are extremely important both nationally and internationally. What, however, it means is directly greater efforts and time on preventing known environmental impacts of deforestation, air and water pollutants, which should have a much better pay-off for the future. The criteria for selection of data should be in this direction.

Conclusions; Towards An Action Agenda

There are historical reasons for inadequate development of data systems and information for EIA and environmental management.

- Firstly, suitable data in general are often not available in the developing countries for any kind of planning at the national level, much less at disaggregated regional or site-specific impacting area level. Further, since planning for development in the past has essentially been sectorwise (i.e. industry, agriculture, forestry etc.), there is notable lack of environmental data which inevitably cut across the sectors.

- Given the above mentioned global constraints in the field of environmental data, particularly, in the developing countries and the magnitude of environmental problems that is engulfing the earth, an urgent attention is called for successfully implementing EIA. This calls for the following important action agenda:

1. To create Technical Cells for Environmental Assessment in all the developmental departments or sectors, whose projects impinge on environmental quality. These cells would ensure that the project authorities carry out basic exercise of EIA for each project at the stage of preparing feasibility reports.

2. To create appropriate organisational infrastructure for continuous monitoring of selected environmental indicators and an umbrella organization where all these data are to be synthesized, stored and be disseminated under the computerised Environmental Information System.

3. To create within the existing (in case no such institution exists, a new one may be created) research and teaching institutions capacities to conduct both fundamental and applied R&D on various aspects of environmental management. Since environmental assessment is necessarily multidisciplinary activity, it is important to create an exclusive group identity within the existing institutions with multidisciplinary manpower.

4. In most of the developing countries, what would be lacking is the properly trained expertise and manpower. While a vigorous and purposeful training programme should be developed, it may be necessary to create a core group of expertise through training abroad. Similarly, appropriate expertise in the consulting agencies need to be developed over a period of time.

5. One of the important activities of the national environmental organisation as suggested above should be networking with various international environmental organisations for acquiring relevant data and information, participating in their workshop and training facilities and even availing of the required expertise and consultants for specific jobs.

Footnotes

(1) A different version of this paper was presented in the International Colloquim on Environmental Impact Assessement, held at Mexico on 29 Nov - 4 Dec 1987.

(2) Paul Harrison, *The Greening of Africa*, Paladin Grafton Books, London, 1987, p.23.

(3) EIA is used here as a generally recognized term to describe the process of examining activities to determine their environmental effects prior to making a decision on their implementation.

(4) Robert Williams, "Potential Roles for Bioenergy in an Energy Efficient World", *Ambio*, 1984, Vol.14, No.4-5: 201-209.

(5) J. Dunkerley and W. Ramsey, "Analysis of Energy Prospects and Problems of Developing Countries", Washington,D.C. Resources for the Future, 1983.

(6) Gerald Foby, "Wood-Fuel and Conventional Fuel Demands in the Developing Countries", Ambio, 1985, Nos.4-5, 253-58.

(7) *op. cit.* 5

(8) Centre for Science and Environment, *The Wrath of Nature: The Impact of Environmental Destruction on Floods and Droughts*, Delhi, April 1987.

(9) Alan Grainger, *Desertification*, London: IIED, 1982.

(10) D Pimentel *et al*, "Environmental and Social Costs of Biomass Energy", *Bio-Science*, February 1984, Vol. 34, 90.

(11) Brown and Wolf, *Reversing Africa's Decline*, 19-29

(12) M Woodwell *et al*, "Global Deforestation: Contribution to Atmospheric Carbon Dioxide, *Science*, 1983, Vol. 222, 1081-1086.

(13) Michael Dover and Brian Croft, *Getting Tough: Public Policy and the Management of Pesticide Resistance*, Washington DC, WRI, 1984.

(14) Mary Lon Flint and Robert van den Bosch, Introduction to Integrated Pest Management, New York: Plenum Press, 1981.

(15) R.D. Ross (ed.), *Air Pollution and Industry*, Van Nostrand Renihold Company, New York, 1972.