

BRAIN STORMING SESSION
ON
HYDROLOGICAL PROBLEMS AND PERSPECTIVES
IN
WESTERN HIMALAYAN REGION

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*Environmental Degradation and Integrated
Watershed Development*

BY

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ENVIRONMENTAL DEGRADATION AND INTEGRATED WATERSHED DEVELOPMENT

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*As the Sun dries the morning dew,
So are the sins of man dissipated
At the sight of the Himalaya*

INTRODUCTION

The present-day condition of the world's greatest mountain range would give the scribe of this gem from the PURANS, cause to reflect and to cry out in sorrow and alarm. Perhaps the greatest sin of man is to contaminate that very source of inspiration designed for the dissipation of his sins.

*'And O, Ye Fountains, Meadows, Hills and Groves
Forebode not any severing of our loves!
Yet in my hearts of hearts I feel your might;
I only have relinquished one delight
To live beneath your more habitual sway*

-Wordsworth

And the curse of man ensured from the time he began seeking comforts beyond the sway of Nature. The calamity heightened as he ignored her simple 'communications' in pursuit of a 'civilization' that threatened the subtle web of her 'fair work'. Little did he think that a wide cleavage from Nature would be disastrous, beyond redemption. In his anthro-pocentric lust, he disturbed the harmony that prevailed between the biotic and abiotic realms, resulting from hundred of millions of years of evolution and adjustment of one organism to another to the habitat in which he lived. The primitive man occupied a niche and assumed a role comparable to other animals and the ecosystem maintained itself in a vigorously healthy condition. The 'paragon of animals' - the modern man, undid it altogether.

Assuming the role of a dominant organism, man has interfered with Nature's cybernetics and has, at places, replaced "biosphere" by "noosphere" introducing dramatic and unnatural changes which the eco-system finds hard to accommodate or absorb. The 'domino' factor is the crux of the whole problem of eco-disaster - an unresolved conflict between the demands of man for expanding population, productivity, power and pleasure, and the functioning of natural laws for maintenance and stability of eco-system. The resultant is deterioration of ecosphere, environmental harassment and pitiable decay in quality of life. Environmental decay varies inversely with economic and technological growth, which in turn varies directly with population growth.

Man, has of late, assaulted mountain environments ruthlessly, extending his 'anthrosphere' on the lofty summits. Mountains are no more sheer zones of innocuous primitive pursuits, they burgeon with myriad human activities recreative to extractive, demanding transfer of forests to agriculture, human settlement, resort housing, road building, construction of water reservoirs, timber extraction and the like, that create heavy strain on the ecosystem. Mountain malaise assumes dangerous proportions as man matches machine with them for massive development programmes. Development ecology forbids gigantism in mountain environments as they have limited carrying capacity. Sensitive in their make up; tectonically, meteorologically and biologically, they are most susceptible to slightest disturbance, and the consequences can be catastrophic. High altitude zones are highly sensitive, with still meager tolerance where steep slope, gravity, coupled with climatic stress make their recovery precarious. Empirical studies have proved that a single event, in high mountains can upset the vulnerable ecological balance of an entire mountain range. Yet, in face of such a grievous truth, dangerously unstable slopes are terraced, forests are felled and dams are constructed, with least concern for resource ecology. The worst sufferers are the sons of the soil, comprising over 400 million; of them about 40 million live in Hindukush Himalaya.

The sufferings and sorrows of the highlanders may vary in degree, the malaise remains almost the same ; rockfall, landslide, slope failure, avalanche attack, mudflow and the like. Diastrophic forces add up to man's misdeed that Nature resorts to NEMESIS. Man's contribution to erosion syndrome is more perceptible in developing countries where penury and poverty confound the dilemma of degradation. It has been graphically illustrated how man and nature wreck havoc upon mountain environment. Scenario is pitiable in some of the depressed economies where socio-economic constraints present a grim picture. It is, indeed, a sad spectacle to see young trees arriving on human back while standing Oak, Rhododendron or Betula are being set on fire for charcoal. Forests are their where-with-all : food, fodder, fuel, fibre and fertilizer, yet they have a few choices than to lop, cut or burn them for want of alternatives-ecological poverty trap. As the forest cover goes off, the mountains get poorer and man becomes all the more miserable. Mountain tragedy begins with vanishing tree cover, encompassing lowland areas and valley with siltation, floods and crop devastation. Drought and famine also do occur, tempting the highlander to outmigrate for want of alternative employment opportunity. Despite the impoverishment of men and mountains, forest depletion goes on, unabated. Some of the studies sound an alarming note.

A satellite based study (FAO, 1981) puts annual loss of all tropical forests - wet and dry - at 7.3 million hectares (18 million acres) - an area slightly larger than Sierra Leone. The US Global 2000 report estimated that one million tropical moist forest species could be extinct by the end of the century if present deforestation rate continues. In Sri Lanka forest may be gone in next 30 years if the present rate of cutting persists. Nepal is in danger of losing three-fourths of her forests by the end of this century. Ethiopia would be in a similar state within 20 years. Himalayas would not be saved

from disastrous collapse, if this state of affairs does not change. Already shrubs and cactii have replaced broadleaved trees and the process of desertification has set in many areas, as a consequence of retrogressive ecological change in water, vegetation and soil that have reduced biological productivity. More thoughtless development actions would confirm conservationist's fear that ecological balance of the Himalaya is about to be ruptured irreversibly. Certainly, Himalayas in distress and the people groan with ever-growing concern about calamities that overpower them day by day. More dampening reports have been received from the Himalayas, where massive deforestation, large scale use of dynamite, quarrying, road building and dam construction activities have weakened earth defence, causing floods and landslides that take a heavy toll of life and property. The Alaknanda and the Bhagirathi, the two boisterous streams of the Ganga, frown in fury and floods. In 1973 the dangerous deluge in the Alaknanda inundated an area of 1000 sq. Km and filled in a 75 years old high altitude Gohana lake with silt, sand and stones. Bhat (1980) reports that this flood washed away 10 km of roads, 6 motor bridges, 24 buses, and 366 houses collapsed and 500 acres of standing crop was destroyed. The devastating effect was felt downstream, 100 km from the flood source, in Srinagar (Garhwal) where a debris 6 feet high was seen inside the Industrial Training Institute. In lowland areas (300 km from the flood source), a 10 Km. long stretch of the Ganga canal from Haridwar to Pathani was choked and the canal filled in with 5 to 8 feet of debris. Due to its blockade, Kharif crops in 9.5 lakh acres in Western U.P. could not be irrigated. Thousands of tube wells remained without energy. Shorn off her primeval apparel, Hindu's holy Alaknanda repeats her wrath, year after year. Floods are not uncommon and land-slides are commonplace throughout the Himalayas from Western to Eastern areas. Children of high Himalaya breathe under the constant specter of death, with little hope. They witnessed the worst tragedy of their times in 1978, when the Bhagirathi unleashed a mammoth landslip (3.75 km long and 1 km wide) in Gairaidhar catchment of Kanoldiyagad creating two ephemeral lakes that eventually destroyed several villages. In 1979, Kuntha landslide, ravaged an area of 10 km, killing 39 persons, 100 cattle, and 129 houses and sheds were destroyed. 'Ill fares the land and to hastening ills a prey'. The situation in other parts of the Himalaya is none too-happy and sometimes the sordid events of landslides are narrated as though the Himalayas are made up of clay or that it may be some biocentric's concoction or an ecological cliché. Jack Ives (1982) provides an eye-witness account of his Darjeeling visit, in 1981, when it rained for three days (25"-50"). On the third day he found 2,000 landslides killing 3,000 people. Rivers debouching the mountain range had destroyed many rich farming and tea-growing areas by burying them under tons of sand and gravel. The 45 mile road to Darjeeling from the plains had 92 cuts at various places. Mountains are no more metaphor for resilience, strength and immutability : they are crumbling and fast eroding masses, instead.

Industrial societies of the West ignored this simple truth in the past, in their development craze; had to pay a very heavy price. Most of the Alpine countries blundered with Nature's scheme, more or less, by deforesting their mountain landscape and thereby subordinating ecology to economy.

Lichstenberger sums up how forests were extensively cleared up in Eastern Alps during the Middle Ages and how peasantry faced fuel famine. They, after all, had to recompense their eco-loss through indefatigable forestry programmes. It sounds a little incredible that the existing West German forest cover in man's most sanguine effort to restore Nature in to her pristine glory. Douguedroit reports that Southern French Alps have now a forest cover over 33 percent as compared to 19 percent in 1878 (Douguedroit 1981). All this has been achieved during the last hundred years by appropriate forestry practices, graduating landuse, reduction in population and decrease in cultivated area. According to recent FAO Forestry Report 1981), in Western last 14 years with seldom any major conflict with other potential users of the land.

Eco-consciousness of these nations must serve as an eye-opener to the developing societies who very often slavishly imitate their 'mores', ignoring the good side of it. Japan exemplifies an ideal blend of the old and the new. There are large number of preventive and restorative measures taken by the developed nations to achieve this. We today have large number of Govt. and non-Govt. organizations, Commissions, Authorities in the West which ensure the ecological balance and to stop pollution of their resources. The United States Environmental Protection Agency (EPA), Tennessee Valley Authority (TVA), UNESCO's Man & Biosphere Programme (MAB), World Meteorological Organization (WMO), United Nations Industrial Development Organization (UNIDO), Food and Agriculture Organization (FAO), Alps Authority, INTECOL and its various Commissions on Wet-lands, Forestry and others and many more on specific habitats like Great lakes Development Authority and many more throughout the World are striving hard to achieve the ecological balance and harmony between man and the Nature.

This year, northern India is enjoying a truly bountiful monsoon. But Punjab has been ravaged by flash floods; in Bihar the rivers are in spate, and in Uttar Pradesh they are edging up to the danger mark. Newspaper headlines tend, inevitably, to link the one with the other, but the floods are not being caused by the good monsoons. They are the product of human greed, ignorance and desperation, and are sounding the *tocsin* that the Himalayas are in danger. If something is not done very soon, the whole of northern India, Pakistan, Bhutan and Nepal may become a desert, and the 500 million people who now live there may well be reduced to a third of this number in as little as a century.

The reasons why life in the plains should depend so critically on the ecological health of the Himalayas are well know. Himalayas catch the rains that nourish the Indo-Gangetic plain. They feed the rivers that run through it and recharge the ground water that lies just a few feet below the surface. Both these crucial functions depend on a good forest and shrub cover. Without it the rainwater run off the top instead of sinking into the soil, the rivers flood, and the springs dry up. Valuable top soil is carried down from the hills-soil that has been built at the rate of an inch every 500 to 600 years - and the hillslopes soon become incapable of bearing any vegetation.

All these symptoms are plainly visible in the Himalayas and the Indo-Gangetic plain. The area of cropland being inundated and the damage done by floods has risen by four to six percent a year. The annual rate of siltation of the Himalayan hydel reservoirs is turning out to 1.5 to 8.5 times what the original dam builders had anticipated. And this is testify that rivers which were perennial thirty years ago in the Himalayas are now dry water courses in March, even before the summer has set in.

The speed at which forest cover is shrinking in the Himalayas is alarming. In the eight hill districts of Uttar Pradesh, while in theory 66.6 per cent of the land area is under good forests, satellite photography has shown that the actual area under good cover was just over 39 percent in 1973-79 and is doubtless smaller now. In Himachal Pradesh, the total area under forests has shrunk from 36 percent in 1960-61 to about 18 percent at the beginning of the eighties. At the current rate of decline according to one authoritative estimate, the Himalayas will be completely bare in less than sixty years.

In the last five years, not only the Center but the state governments too have becomes fully alive to the threat, and a number of important decisions have been taken to slow down the rate of felling of trees and to step up the rate of reforestation. The first and most important of these was the banning of contract felling by private contractors and the centralization of all commercial felling operations in the hands of the state forestry development corporations. The second, taken in Himachal Pradesh and J&K was to ban the sale of timber to anyone but the forestry corporation. This was designed to prevent the misuse of "timber distribution" rights- the villagers hereditary right to take a tree every few years for their personal use-to fell timber for the market.

These steps will no doubt reduce illicit felling for commercial purposes to a fraction of what it used to be. But commercial demand is only one of the causes of the destruction of the Himalayan forests over the last twenty years. The second is the demand for firewood from a rapidly growing population. Over the past two decades the population of the Himalayan districts has been rising by 2.3 percent a year, or somewhat faster than the national average.

The annual demand for firewood that is being met by the forests is thus around ten times as great as the commercial demand for timber. What is more, this is a demand that no one can either deny or even control so long as the population does not cease to grow. But this is not the only threat that the Himalayas are facing. An equally potent one emanates from the villagers' livestock. Cattle, sheep and goats do not only eat the grass and shrubs growing on the hillsides. They also eat the young saplings of oak or pine that are taking root. What is worse, careful studies of the effect of grazing on the soil, have shown that animal hooves compact the top soil and reduce its permeability by up to 90 percent. Thus even where grazing does not succeed in stripping the grass cover off the hillsides, it raises the run-off rate of water alarmingly.

Recent trends in animal husbandry are increasing the damage done by overgrazing to an alarming degree. As the better grazing has been exhausted, the only animals that can still thrive on what is left are the omnivorous goats. However goats do not only eat everything, they also pull out the grass and shrubs from the roots, and thus prevent its regeneration. It is worth remembering that the hills of Syria, Lebanon, Palestine, Greece and Italy were laid bare by goats. Tackling the threat from the demand for firewood and feed is far more difficult than tackling illicit felling. It has been summed up as the control of population growth, the reduction of live stock pressure, the planting of fuel wood species such as chir pine on the now degraded soils of the denuded forest areas, and a gradual replacement of subsistence agriculture with other forms of economic activity.

There is yet another danger looming large in Shivalik, known as a delicate ("Kuchcha") mountain range. The high mountain, faces collapse in a few years as a result of indiscriminate cutting.

A population explosion has forced the people from the foothills to seek living space on mountains harbouring natural forests. While authorities sit pretty, mass-scale felling continues. The tracks are covered by causing forest fires and blaming them on wood-picking villagers or cattle-grazing Gujjars. Only this summer 15 miles of Mohand Forest in Doon valley was destroyed in blaze which had raged for days, the cause for which was later reported to be "accidental".

Tree-felling and pharmacology, two diverse activities constitute a threat to these forests. The Ganga basin and the Himalayan range are widely popular for their medicinal plants, gum and resin trees. Many of these are now becoming extinct, including the Dashamul plant, Bel, Prishna-karni, Bidarikan Gokru (seeds used in preparation of courtesans), Bansa (for cough cure) etc.

It has been pointed out that at places where river waters had been rendered turbid or the flow was too fast causing tremendous soil erosion and silting, discriminate plantation could help. "This most effective and natural process would be to plant suitable species at suitable sites".

For instance, water turbidity can be reduced by planting certain water plants such as water hyacinth which has the capacity to absorb 25 to 30 types of minerals. Again, the flow of industrial effluent could be slowed down at strategic points by the water-hyacinth, which is a very fast growing and wide-spreading weed.

Imomea Carnea, a Mexican species (also known as Besharma, Sada Suhagan and Garib Nawaz) has sand-binding properties. Saccharum species can also grow in water as well as sand. Trees which comprise natural flora and can tolerate submergence should be preferred. These could be Kattha (Babul species), Shisham (Dalbergia species), Semul, Jamun etc.

In the Third World environmental pollution is mainly classified in the form of air, water, garbage and population pollutants. The air pollution is mainly due to the emergence of industrial pollutants and discharge of automobile vehicle smoke. As such, the air pollution consists of carbon dioxide, carbon monoxide and sulphur dioxide etc. This causes health hazard and the outcome of diseases are tuberculosis, lung cancer, asthma and bronchitis etc.

The industries located in the residential areas has become a serious health threats to the inhabitants particularly in the urban settlements of Third World. The industries which are discharging the obnoxious gases should be shifted away far from the inhabited settlement. The pesticides and insecticides though are crop protector, yet it is harmful to human beings. as such, restriction of pesticides and insecticides in terms of manufacturing plants should be envisaged with health considerations in the Third World.

The water pollution results due to the discharge of industrial waste into the river. Quit often the industrial poisonous waste like mercury is discharged into the river causes death to fishes and is harmful to the fly eater. The water-borne diseases are widespread in India. Stress should be given in our Five-Year Plans to supply clean drinking water particularly in the rural areas. The Ganga action plan is commendable, however it has to be enforced with a well-organized implementation machinery and strict control of legislation. The half burnt bodies should not be left in Ganga. The burning ghat should be away from Ganga.

The garbage pollution has raised a serious problem as a source of waste collection. The garbage is dumped in land-fills by the municipalities particularly in the metropolitan and large cities. In Calcutta, the garbage dumped on streets and disposed of after few days by the municipality has resulted into the emergence of many diseases. Even in small town settlements the discharge of garbage has become a serious health hazard. It is heartening to note that in Delhi, the landfill with garbage has been utilized for electricity generation. Thus garbage waste can be usefully utilized for becoming an environmental asset in the urban settlements. However in rural areas the biogas plant can be installed for generating cooking gas fuel.

The population pollution is mainly confined to the rising population in the developing countries. Due to the rising migration in the metropolitan and large cities, there has been the emergence of slum and squatter settlements. The lack of latrine facilities and its maintenance has resulted into a stinking environment indicating the unhygienic way of life. Thus in slum and squatter settlements there is a serious deterioration in the quality of life.

Furthermore, the density of residential areas in the congested cities has been rising and causes health hazards. A large number of people in the congested metropolitan and large cities are living in one

room tenement. However, this has created an over crowding situation in urban settlements with the denial of fresh air, light and privacy.

As such, the rising population has been responsible for greater waste products causing the alarming magnitude of environmental pollution. The health services have greatly deteriorated due to the population explosion, especially in the metropolitan and large cities. It is pointed out emphatically that family planning has lacked its impact in rural areas which are experiencing the population chaos of starvation, hunger, poverty and unemployment etc. In the Third World, the population pressure has a great constraint on land resources and causes traffic and transportation jams resulting emission of vehicle smoke. Due to the excessive urbanization there has arisen the large-scale industrial developments causing a serious deterioration in the quality of life.

Noise pollution has poised a threatening health hazard particularly in metropolitan cities like Ahmedabad, Bombay, Bangalore, Calcutta, Delhi, Madras, Kanpur etc. Due to noise threats and ill effects deafness particularly in the metropolitan has arisen. The vehicle noise pollution has reached its climax in metropolitan and large cities in the Third World. It is worth while to point out that the vehicle noise of horns, marriage band and industrial sound while discharging pressure of steam has seriously affected the health hazard. Even the religious all night loudspeaker has been responsible for health and noise hazard in the neighbourhood.

The frequent unnecessary horn blows causes ear irritation and mental tension in our urban settlements. Checks are required for the loud noise of vehicles which needs to be rectified. Even in the neighbourhood the functioning of factories causes noise nuisance and can result into madness, deafness and serious nervous break down. This has been on an rising trend in the Third World.

In America and UK particularly the horn blow of automobile vehicle, its noise occurrence has been minimized. However, in the Third World due to faulty regulation of traffic management, the noise pollution has not been controlled. Thus the noise nuisance is a serious challenging problem in the Third World particularly in the Asian countries.

The forestry resources are ruthlessly being destroyed. Surprisingly, the total percentage of the forestry areas has been disappearing throughout the world. However, in the Third World Particularly in India, there is a serious decay of forestry areas.

The monoculture cultivation of Eucalyptus is no solution of reafforestation planning. As such, eucalyptus has acidity soil characteristic, This has low water absorption capacity and has a commercial proposition for paper industry. However, the cultivation of Eucalyptus is not beneficial for checking floods and also is unable to promote the dense forestry composition to attract wildlife.

Presently in the Third World, the forestry areas are not well protected. Even for the local people wood is not easily available for cooking purpose. However, a long day search of women for cooking purpose in the forestry areas. The concerned forestry authority in Third World should innovate cooking technology substituting wood for the people of forestry area. The local people should benefit from the forestry resources. This is needed to evolve the local people to protect the forestry resources. In India, the chipko movement should be widespread through the perspective.

The wildlife has been destroyed in large number throughout the world. As such, the population of wild life has been reduced particularly in the Third World due to the illegal killing for purpose.

With the fast destruction of forestry areas and wildlife, there has been a serious deterioration in the quality of life and ecological imbalances. This situation has assumed a serious dimension throughout the world.

In the Third World with the gradual disappearance of forest, it is estimated that till 2001 AD a vast land would be converted into desert. Presently, the ruthless cutting of forest has been responsible for the annual occurrence of flood and also causes a drastic change in the climate. particularly in India, the flood menace has caused destruction of annual damage of property, men and crops amounting to a huge financial loss.

The environmental challenges need to be regulated through appropriate tools of legislation. Ineffective environmental legislation has aggravated the rising air and water pollutants. Strict penalties for industries emitting discharges without treatment is called for through legal action. In fact those industries polluting the source of water and air should be warned and continuance of untreated discharge before discharging in river should result into confiscation of industrial license.

The municipalities in urban settlements should strictly administer the industries which are health hazard. Legal prosecution is called to check the rising industrial in metropolitan and large cities.

The nuclear plants have emitted radio activity and are a serious environmental hazard throughout the world. This situation involves a challenging task if leakage occurs in the plant. The Third World should formulate legislation to ban the installation of nuclear plants. This would safeguard the environmental protection.

The environmental education has a specific impact on the people. During specific impact on the people. During the junior and senior classes, the environmental lessons would have to be given due importance concerning the sources of environmental pollution, preservation and conservation of forestry resources. For the rural and urban and urban settlements the hygienic way of living should

be emphasized. Beside the teaching lessons the environmental education should be streamlined through television, radio and seminar programmes. People's participation should have a meaningful orientation concerning environmental education.

The quality of environment is degrading rapidly due to various types of pollutants and contaminants released from different industrial units, urban settlements and agricultural lands. It may be difficult for mankind to get pure air and clean water in the times to come.

Various types of methods have been used to assess the status of the environment. One of the important methods that is finding greater acceptability by the scientists is the use of the living organisms for monitoring the quality of air, water, soil, etc. it is based on a simple principle that every living organism reacts to the changing environment. Some are very susceptible while others show varying degrees of resistance (i.e., pollution tolerant). Even human beings can function as bio-indicators.

If there is a sudden epidemic of water-borne diseases, man suffers from gastro-intestinal troubles and in this manner man serves as an indicator of poor quality of drinking water. It is essential that for bio-monitoring work such plant and animal species are selected which are very sensitive and show perceptible changes in their behaviour in a very short time.

Bio-monitoring is now regarded as a simple, workable, convenient and fairly reliable tool for feeling the pulse of the environment. An attempt is being made to build up a warning system with the help of living organisms so that adequate and advance precautions may be undertaken to prevent the deterioration of environmental quality.

The effect of toxic gases like oxides of nitrogen, sulphur dioxide and carbon monoxide can be easily determined by using certain lichens (Plants having both fungal and algal components) and mosses. Since some of these special groups of plants grow on the barks of the trees and are sensitive to poisonous elements they exhibit a sharp change in the pattern of their growth, reproduction and chlorophyll contents. The poisonous substances induce a variety of morphological and functional changes in the behaviour of the susceptible and non-tolerant species. Earth-worms and nematodes are good indicators of soil toxicity. The toxic level of pesticides accumulated in soil can be easily evaluated with the help of these organisms. The broad-leaved trees function as "pollution sinks" because they accumulate various types of dust surface. This, however, greatly disturbs the beneficial microbial population on leaf surfaces (phylloplane). The pattern of germination of the pollengrains of some plants also changes when toxic level in the atmosphere is high.

Very valuable information has been collected on monitoring of the aquatic ecosystem and water quality. Metal toxicity can be determined by analyzing the tissues of the fishes living in polluted habitats. By the large the benthic fauna (found on riverbeds) like the ciliates and micro invertebrates are good accumulators and indicators of toxic substances found in water. The effect of the toxicant may be at the level of community or individuals. Bio-indicators are of great help in quality management of the resources.

Another practice that is employed for bio-monitoring work is based on species diversity. In a healthy environment there is greater species diversity whereas in a polluted environment the species diversity is very low and there is predominance of the pollution to learnt species. Dominance of aquatic weeds like water-hyacinth reflects high level of toxic compounds in water. Water quality is also judged by the level of coliform bacteria (index of faecal matter) and other bacteria. In sewage water the population of faecal coliforms is invariably very high. heavy load of organic matter in the aquatic bodies is detrimental for the system.

A large number of algae like *Oscillatoria Sp.*, *Mirocystis aeruginosa*, *Euglena viridis*, etc and pollution-tolerant. Similarly some Zooplanktons like *Paramecium Sp.*, *Brachionus rubens* and *Rotatoria* show a great degree of tolerance to the toxic materials. *Daphnia magna* is being extensively used for testing the aquatic toxicity, because this organizer is very sensitive to toxic pollutants and is very widely distributed in the water bodies.

Daphnia is a preferred food of many fishes and constitutes an important link in the aquatic "food chain". The toxic level in the fishes rises by consuming toxic rich "link species". Biomonitoring seems to be a quick remedy for evaluation of the environmental quality provided selection of "indicator organisms" is made judiciously after proper observation experimentation.

The earth sustains all forms of life. Soil and water constitute the most important natural resources upon which the productivity of a nation depends. Nature takes centuries to form soil through Weathering and numerous soil forming agencies, but man destroy it is a few years by excessive exploitation and unintelligent use. History records how some well know civilizations like Mohanjodaro and Harrappa became extinct because of the people's neglect of their lands and their failure to conserve natural resources.

But since the dawn of civilization human endeavours to find a lasting adjustment to the natural resources area also visible on the land scape around the globe. Aqueducts, Urban drainage, diversion of water from rivers for irrigation and water mills have all been known from the earliest times. The ideal that deforestation in the upper reaches upsets the river regime and causes floods is at least as old as Pluto and Buddha.

Our policy on Science & Technology since independence, involving a vast sum of money, has largely failed to satisfy the needs of the rural poor and has mostly benefited the urban elites. Sustainable development (SD) means meeting the basic needs of present generation without interfering with the legitimate rights and impairing with the abilities of the future generation for which we are all morally oblige. The primary need of human beings for survival with dignity is Food and ENERGY, and in the process of obtaining and using them mankind produces exceptionally large amounts of WASTE, both solid, liquid and gaseous. Waste accumulates as pollutants and poison our biosphere, unless they are safely disposed. higher Technology, while solving a real problem have also created a number of other problems mostly environmental and ecological and the benefits in terms of economy have been outweighed by the losses in terms of ecology.

Sustainability and survival of mankind on earth would depend upon a technology which must ensure:

1. Sufficient production of food, fodder, fuel, energy and fertilizer without damaging and spoiling the environment;
2. Harnessing of the alternative, non-polluting and renewable sources of energy; conservation of the available resources; developing alternatives to the non-renewable ones; and renewing the renewable ones;
3. Reduction of all kinds of wastes; reutilization of the reusable ones and "recycling" of the others to take them back into human ecosystem through the production of "goods" and "means" for mass consumption and utilization;
4. Reclamation of the waste-lands; halting the process of soil erosion and desertification.

New technology approaches in Energy development, waste managements, land management, Industry and Agriculture which are small scale, efficient, non-polluting, less energy intensive, inexpensive and based on the Gandhian ideology are offering new hopes to the world particularly to the developing nations for development without destruction. As early as 1927 when Environment and Ecology was not even talked about Gandhijee had warned the world that the large scale industrialism would create problems of the type we are confronting today. he favoured "PRODUCTION BY THE MASSES" and not "MASS PRODUCTION" by individual. it is in this background, which has given rise to the concept of watershed Management, to seek solution to many of the problems which we face today, that I shall discuss with you.

WHAT IS A WATERSHED ?

Many definitions have been developed for the term watershed. While there definitions employ a wide variety of words and local terminology, they all practically mean the same thing. A very simple, definition that can be applied to watershed is that embraces all of the land and water areas which contribute/run off to a common point. The watershed above any point on a defined channel is therefore, all of the land and water areas which drain off through that point. The watershed may be

only a few acres or thousands of square miles, such as the watershed of the mouth of the Ganga river. The term watershed management implies the wise use of air, soil and water resources so as to provide a clean uniform water supply for beneficial use and to control damaging overflows. Water problems involve problems of soil, forests, power generation, irrigation and agriculture, flood control, navigation, industrial and municipal consumption of water and these require a coordinated approach.

THE AIMS AND OBJECTIVES OF WATERSHED DEVELOPMENT

The ultimate purpose of watershed development is socioeconomic and ecological upliftment of local population in particular and of the nation in general. By and large these programmes contemplate to:

1. Protect, conserve and improve land of the basin for more effective use by accelerating measures, to conserve soil and moisture on agriculture farms, grazing lands, wasteland and forests; the improvement and increase of timber yields and minor forest produces; wildlife; the enlargement of recreational facilities; the establishment of additional green shelter belts; extension of vegetative covers; rehabilitation of degraded forests and installation of other measures found necessary to contribute to productive and profitable land use.
2. Protect and enhance the water resources originating on the watershed of the basin thus contributing to irrigation navigation power; domestic and industrial use; to fish and wildlife; to recreation; to pollution abatement and other productive uses.
3. Establish watershed practices and measures to reduce floods and sediment damage; protect and effectuate large investment in water development, structures and safeguard farm land urban properties, railway lines, highways from flood and sediment damages.
4. Enlarge and improve agricultural production capacity of the basin by irrigation and drainage wherever this will improve and stabilize incomes not only for farmers but also for the community of which they are part.
5. Extend the use of electricity and alternative sources of energy to rural areas to reduce the heavy biotic pressure on forests.
6. Expand agricultural research, investigation and survey that are designed to give direction to resources development and use, solve problems arising from changes in land use, and discover effective production practices that will improve uses of soil and water resources.

ROLE OF FORESTS IN WATERSHED MANAGEMENT

Forests generally occupy a strategic position within a watershed. They are usually found at higher elevation, where slopes are steeper, soils are less stable and more easily eroded unless properly protected and precipitation occurs there in larger quantities. Such land constitute the zone of highest annual water field. Forest land are the major source of frequent devastating floods if not properly managed. Forest land offers the greatest opportunity for affecting changes in hydrobiological characteristics of watershed. Thus forest and vegetative cover undoubtedly and indisputably play very

important role in watershed management.

The National Forest Policy, 1952 has rightly laid down that in hills at least 2/3 rd land should be covered with forests whereas in the plain it would be enough if only 1/3 rd is reserved for it, provided the land so allocated are managed to produce the maximum products of utility and for all times. Such allocation and management is absolutely necessary for a dual purpose:

1. To preserve the physical features, prevent soil erosion and allow the rain water to seep through the soil to keep the soil moist in the field and later to allow the stream to flow all the year round. Indirectly this will automatically mitigate floods.
2. To meet the indispensable requirement of local population regarding fuel, fodder small timber and minor forest produces for sustaining their economy.

The floods and water cycle follow the regime of watershed which does not recognize man made boundaries. The watershed condition controls the infiltration, percolation of water and subsequent stream flow in the valley below. The quantity, quality and silt load in the stream indicate the hydrological condition, the conservation potential, state of erosion, soil conservation, effectiveness, and state of agriculture and forestry practices in the watershed.

STRATEGY FOR WATERSHED DEVELOPMENT

Since watershed may be of few acres to hundred thousand sq. km. its developmental efforts can be made at individual to national level. Soil erosion the biggest problem of air watershed is the result of wrong social habits, backward economy and improper land use practices. A permanent solution lies in correcting these basic causes. In addition, damage already done has to be repaired. This would need multi pronged strategies based on dynamic approaches to this complex socio-economic environmental problem. The remedial measures, necessary to meet this challenges problem. The remedial measures, necessary to meet the challenges will have to be carefully selected on the basis of their immediate and long range effects. They will have to be pushed through with most sympathy and understanding so as not to cause avoidable hardship to the people concerned. Bold decisions have to be taken at high level due to the political aspects of some measures necessary to achieve the end. Greater stress in the immediate future will necessarily have to be on the measures which would arrest erosion in the seriously affected areas. Steps calculated at removing the basic causes of the phenomenon will have to be taken simultaneously. The more important remedial measures to be adopted are only enumerated below.

1. Development and diversification of local economy in watersheds ;
2. Enforcement of proper land use policy;
 - a) Contour Farming; b) Terracing ; c) Strip cropping; d) Mulching; e) Crop rotation; f) Organic manuring; g) Shallow ploughing; h) Recycling of run-off collection, etc. i)

- Establishment of vegetative cover; j) Check dams; m) Gully plugging; n) Basin listing; o) Contour trenches; p) Pits; q) Interception ditches; r) Spurs etc.
3. Control over unproductive cattle population and grazing intensity;
 4. Revision of forest settlements for curtailing the heavy rights of users;
 5. Protection of agriculture land against soil erosion;
 - i) Diversion of unsuitable agricultural lands to farm forestry and other agro-silvicultural practices; ii) Compulsory terracing of the fields by individual or Govt. agencies; iii) Encouragement of horticulture; specialized cultivation of vegetables, medicinal plants etc; iv) Adoption of improved methods of cultivation.
 6. Improvements of forests and waste land by adopting soil conservation measures.
 7. Introduction of Social Forestry-cum-soil conservation extension services by N.G.O's;
 8. Short training courses and field visits for farmers/students, youth & other functionaries;
 9. Sustainable Technology for Food production;
 10. Recycling of waste;
 11. Technology for harnessing the Non-polluting and renewable sources of Energy;
 12. Reclamation of waste-land through Sanitary land-filling and composting.
 13. Optimal utilization of rain water by adopting the following methods;
 - a) Soil moisture conservation techniques; b) Water harvesting techniques; c) Minimisation of evaporation losses; d) Development of the ground water potential; and e) The transfer of surface water from surplus to deficient areas where feasible and appropriate.

ENVIRONMENTAL CONSIDERATIONS

If only the above strategy is followed in letter and spirit, we shall not have much problems of the deterioration of environment, rather it will definitely improve. There are certain issues which have to be properly managed, monitored and followed to save the environment from further deterioration.

Major destructive processes on soil often start with improper land clearing projects. The use of heavy machinery and deep soil-disturbing ploughs, such as the root sake and some plough, can leave behind a surface that is prone to erosion and structural collapse. Clearing lands which have uneven topography and are steeply sloped without incorporating appropriate terracing leads to excessive erosion. Soil erosion also reduces soil quality. Plant nutrients such as N,P,K are held within soils and are reduced with the loss of top soil and must be replaced by expensive fertilizers. Excessive soil compaction leads to plant root penetration, all of which reduce crop yield. Aside from the reduction by short or long-term productivity of soils, silting of reservoirs and increased turbidity, sediment deposition and related pollution in downstream rivers are a major consequence of excessive erosion. This can have detrimental effects on irrigation, electricity generation etc.

NEEDS

Most of the techniques for the control of erosion are known. In poorer countries, where cultivation of marginal and excessively sloped lands is increasing, pressure on farmers to feed their families leads to inappropriate cultivation techniques even against the Farmers' better judgement. The following steps need to be under taken :

1. Appropriate and cost-effective terracing techniques are urgently required;
2. Crop rotation should be encouraged or "Inter-cropping" should be introduced;
3. Fallowing should be followed with a minimum rest period of five years;
4. Minimum tillage techniques should be encouraged;

GUIDELINES

i) Minimize soil disturbance; ii) Preserve surface much layers iii) Maintain mulch cover throughout the season; iv) Avoid compaction by heavy machines; v) Establish early ground cover; vi) Plan & execute erosion control measures before & during clearing; vii) Avoid ploughing and harrowing in seed bed preparation; viii) Use "minimum tillage" or "no-till" methods where these are possible; ix) Control weeds using herbicides rather than by extra cultivation; x) Avoid excessive fertilizers use.

ENVIRONMENTAL IMPACTS OF IRRIGATION

The application of irrigation water, by aerial sprinkler systems or surface flow, can cause changes in the water-table level in the soil and in the ability of the soil to accommodate mineral salts. On all but the most impermeable of soils, source of the rainfall or irrigation water will percolate below the soil surface. Excessive amounts of irrigation raise this water table which causes the salts naturally present in the soil to rise to the surface forming a crust which is detrimental to crop production. Salinization of the soils often leads to significant economic costs. Farmers must switch or drainage systems. Indirect effects of irrigation include the reduction of groundwater supplies which are often, the main source of potable water. The concentration of water associated with irrigation has in many parts of the world led to an increase in the incidence of water-borne diseases such as schistosomiasis, liver fluke inflections, filariasis and malaria.

Finally, water that has been drained out of irrigated areas may lower the quality of water into which it flows. Inappropriate land levelling techniques could lead to soil erosion problems. The use of pesticides, herbicides or excessive use of fertilizers on irrigated land could damage the quality of water resources in the catchment area below to irrigation projects. Adverse effects upon fisheries other agricultural projects, human health, and any productive activity, including industrial may occur.

GUIDELINES

1. Appropriate drainage techniques be followed to minimize salinization.
2. Increased water requirements must be planned for in an integrated fashion, taking into account

other users of the aquifer;

3. Land levelling is very important to both the control of salt accumulation and of excess run-off into downstream areas.

ENVIRONMENTAL ASPECTS OF FERTILIZERS

Intensive use of fertilizers can have many undesirable side effects on environment. The most important is the eutrophication of streams, lakes and coastal waters. The quality of water deteriorates to such a degree that fish and other aquatic life are threatened and drinking water supplies reduced. Nitrates and phosphates are the main nutrients which either percolate through the soil and are dissolved in the ground water (leaching) or join surface water directly through run off. The degree of leaching depends on the quantity of fertilizer used, the soil type, the type of crop and time of year that the fertilizer is used. The estimates suggest that between 17 and 25% of the amount applied leaches into the groundwater. Similarly only about 50% of the fertilizer is actually used by the crop with the balance being lost through leaching, soil run off and volatilization. This is giving rise to concern for drinking water supplies. Health risks such as methane moglobineamia in infants and carcinogenic hazards occur from excessive intake of nitrates. Over time, accumulation of these and other substances can contractions in the crops cultivated.

GUIDELINES

1. Appropriate amounts of fertilizers and appropriate techniques for its application to minimize the run-off and teaching into ground water should be practiced;
2. Optimal levels of fertilizer use must be determined in each case;
3. Where applicable biological fixation of nitrogen in soil be exploited;

ENVIRONMENTAL IMPACTS OF PESTICIDES

The application of pesticides affects not only the quality of soils and water but may have undesirable effects on flora and fauna. It has caused a number of well documented environmental problems: Pollution of soil through pesticide residues, contamination of surface and ground water, extinction of many insect and bird species, contamination and build-up in human food chains, and the resurgence strains of mosquitoes.

GUIDELINES

1. The use of pesticides should be kept to a minimum;
2. The correct pesticide be used having minimum or short-lived side effects;
3. The users be educated in their correct use because most of the serious damage done to environment is through in appropriate dosages or inappropriate techniques of application;
4. Govt. should legislate against the use of particularly long testing and hence potentially harmful types of pesticides;

5. The capacity to monitor the use of pesticides should be strengthened;
6. Ideally, systems of integrated pest management should be encouraged.

The list of Environmental impacts of many of the activities, which are being followed in every sphere of life, is very long and one can write volume on it but because of constraint of time, I shall close here with the following statement.

The challenges of our watershed are a challenge to our fundamental problems of food, drink and safe environment; to the extent this challenge is understood & met effectively, better living is secured for men, women & children not only in the present generation but also in the future. The simple technologies based mostly on biological and ecological principles would restore for mankind a condition for comfortable living with dignity but perhaps not with luxury; would satisfy all their basic needs, but perhaps not their with luxury; would satisfy all their basic needs, but perhaps not their greed. It will ensure ECONOMIC PROSPERITY OF PEOPLE WITH ECOLOGICAL SECURITY OF THE EARTH. We have to choose between a "simple life style and Sustainability" or a "Luxurious extravagant life" and eventually mortality.
