

Ecology and Environment

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This discussion note was written in 1988 to discuss the subtle differences between 'ecology', 'environment', and 'ecosystem', and to contribute to the ongoing debate about "conservation"

The cover illustration is by Uma Bordoloi.

1 DEFINITIONS

Ecology is the study of the interrelationships between different elements of nature, namely land, water, air, fauna, and flora.

Environment is the collection of factors that affect a particular thing. For example, factors that affect a human being can collectively be called the human environment.

Here we study aspects of the natural environment of human beings., that is, those factors in nature that affect human beings.

Ecosystem is the natural system where different elements of nature interact with each other.

2 HUMAN INTERACTION WITH NATURE

Apart from the aesthetic pleasure that nature provides, human beings "use" nature in two different ways. They consume various natural products like wood, fruits, leaves, grass, water, minerals etc. They also dump much of their waste into water or air.

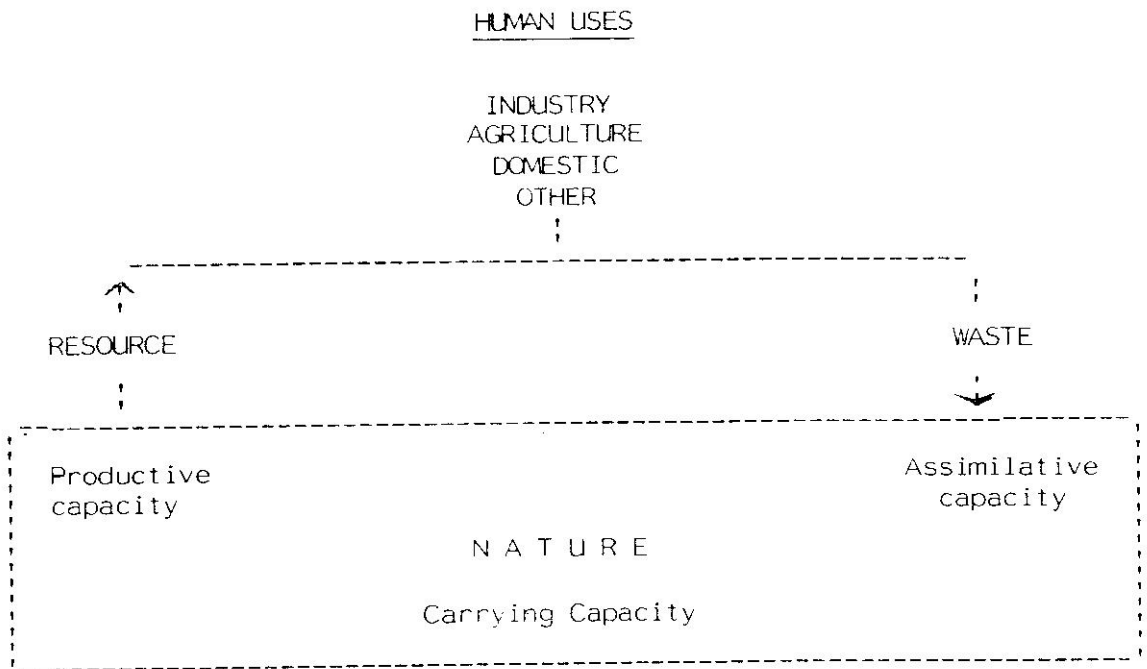
Human beings often manipulate natural systems for their own benefit. Clearing forests for agriculture or fruit plantations is one such manipulation. Daming rivers to produce electricity, or provide irrigation, is another such.

Undeniably human beings are as much a part of nature as any other animal, or plant. They have both a moral right and a biological necessity for sustenance through nature. Their demands on nature, then, should be considered as legitimate as those of any other living creature.

3 THE ECOSYSTEM

Carrying Capacity

The limits within which nature can respond to the demands of its various creatures is called its carrying capacity.



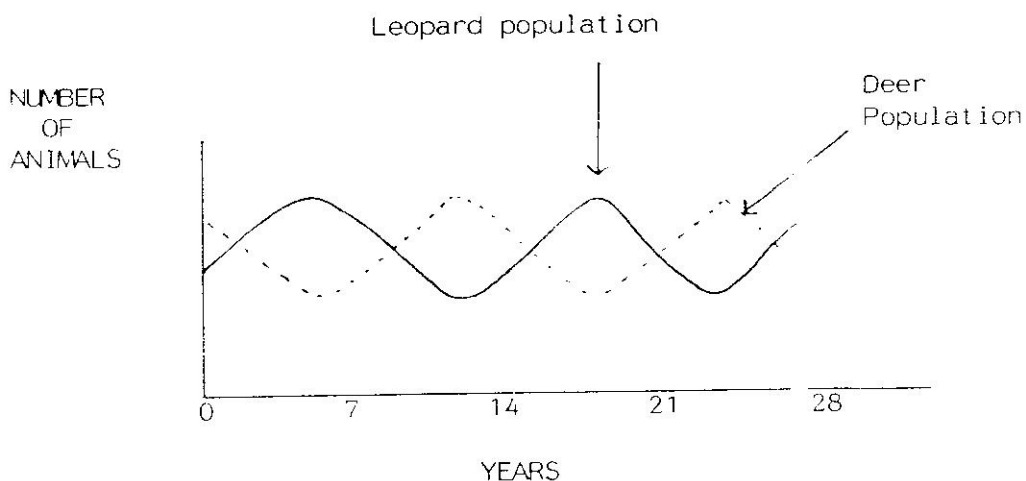
The Supply Demand Balance

It is not only humans who live off nature, all living creatures do so. Though nature has great abundance, it is not infinite. Therefore nature has to have some regulatory mechanism to ensure that it is not pushed beyond its carrying capacity. For, like human beings who die if their blood is drained or if poison is dumped into their bodies, so does nature die if it is drained or poisoned.

Fortunately all living creatures (except human beings) are frugal. They only consume as much as is minimally required, and they do not waste. Nature, therefore, to ensure that the carrying capacity is not exceeded, has only to control

the population of the various forms of life.

It does this by ensuring a balance between the predator and the prey, and between the food supply and the consumers. For example, in a forest where there are leopards (predator) and deer (prey), the population of leopards is dependent on the population of deer, and vice versa. When the population of leopards increases, the demand for the prey (deer) goes up, and consequently the population of deer falls. A point comes when there are too few deer to sustain the large population of leopards and, as such, the leopards start dying and their population drastically reduces. This reduced population of leopards takes the pressure off the deer, whose population then increases rapidly to a point where there is more than enough food for the leopards, and so the leopard population starts increasing, ad infinitum..... (See figure below).



Using devices such as these, nature ensures that carrying capacities are not transgressed, and that there is continuity.

Interdependence

All elements of an ecosystem are interdependent, forming a type of ecological chain where the breaking of any one link would destroy the chain. Each species is dependent

on others for its food, shelter and often for reproduction. The carcasses or wastes of one species becomes food for many others. Flowers and trees need birds and insects to help them reproduce. Many animals build homes and nests in trees, rocks, underground or in water.

" Sometimes plant and insect become total dependent one upon the other. The yucca grows in Central America. It has a rosette of huge leaves from the centre of which rises a tall stalk bearing cream-coloured flowers. These attract a small moth with specially curved mouth parts that enable it to gather pollen from the yucca stamens. It moulds the pollen into a ball and then carries it off to another yucca flower. First it goes to the bottom of the flower and lays its eggs inside the ovary. Then it climbs back up to the top of the stigma rising from the ovary and rams the pollen ball into the top. The plant has now been fertilised and, in due course, the ovary will swell into seeds. The moth's eggs will hatch into caterpillars which feed on some of the seeds. The rest will develop into new yucca plants. If the moth were to become extinct, the yuccas would not reproduce themselves. Each depends on the other. " (Attenborough, David, Discovering Life on Earth, p 58.)

Succession and Evolution

But ecosystems are mostly not static. They keep changing and evolving, responding to internal and external changes. Over the history of life we have seen that some species have appeared on earth at specific times, only to disappear again when the climate, or habitat, became unfavourable, or when competition from other species became too strong. Most of nature keeps changing at its own pace, and guided by its own logic. This process of natural change is called succession.

Genetic Diversity

The genes, containing the DNA molecule, determine the nature of all living things. The genetic code determines the form a plant or animal takes and its various characteristics.

An ability to identify and select genetic codes has led to major technological breakthroughs, most significantly perhaps the breakthrough in agricultural technology. By genetic engineering, the useful characteristics of various types of crop plants have been combined to create optimal strains : the "high yielding" varieties.

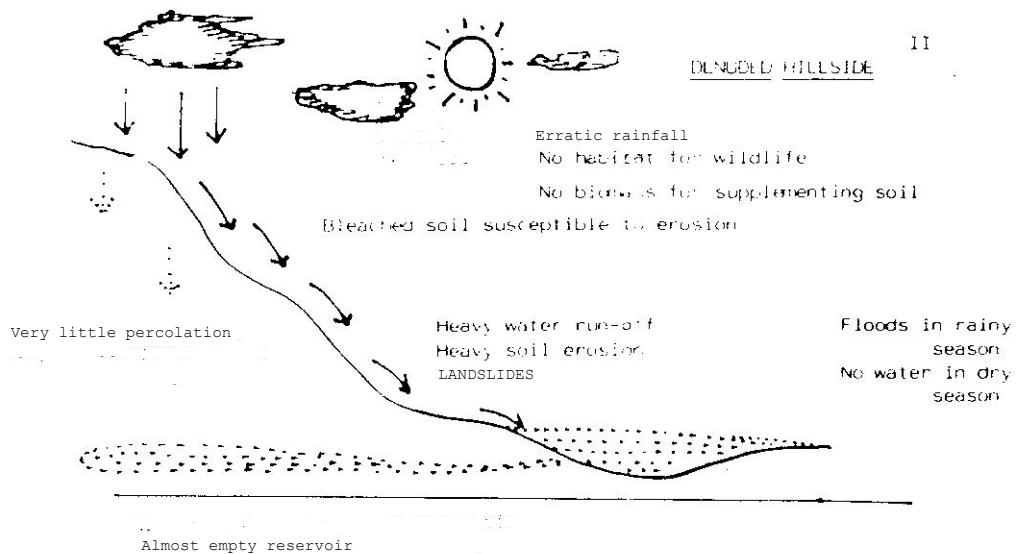
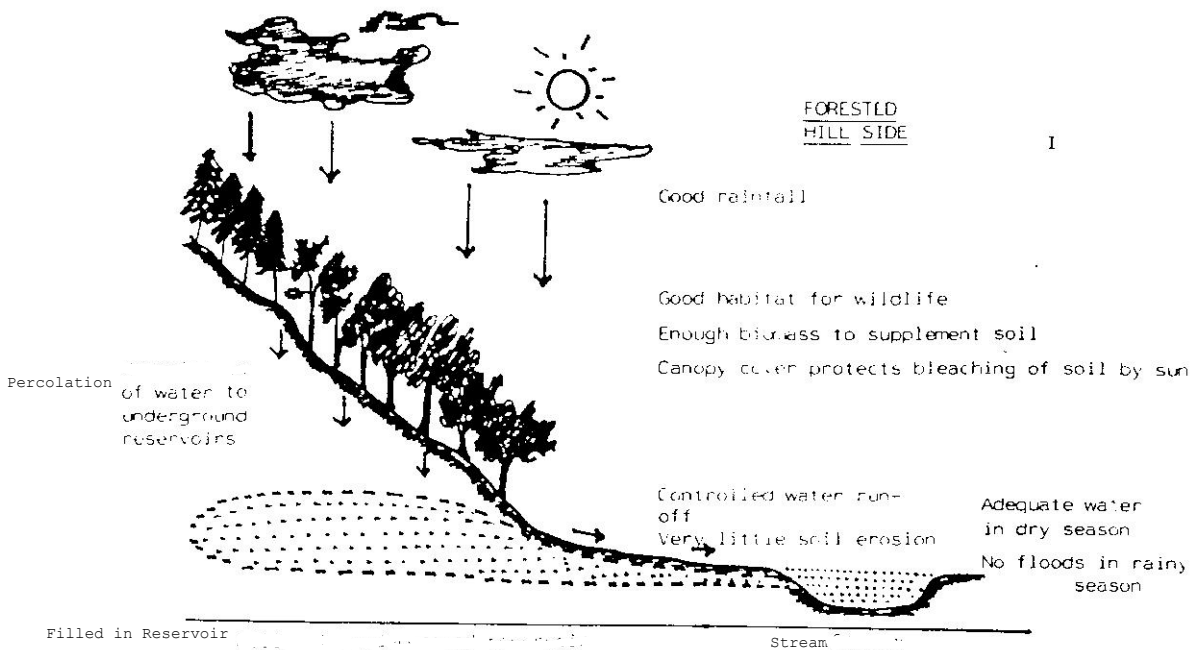
The richness of nature is symbolised by the diversity of species, each containing a unique genetic code. The accumulated knowledge of thousands of millions of years is stored in these codes. It is essential that these codes be preserved and not allowed to be destroyed, for we still have very little idea of which of them we, or nature, might require, and when.

4 THE FOREST-SOIL-WATER-AIR INTERCONNECTION

- Oxygen in the air is the basic precondition of all life, for all living things, plants or animals, need oxygen to survive.
- Trees and other vegetation help the air to maintain its levels of oxygen by cleaning the air of other substances.
- The forest binds the soil and prevents soil erosion.
- The forest also refurbishes the soil by providing biomass that is then biodegraded and decomposed.
- Naturally the forest, and all the plants therein, live off the soil, and many creatures live among the soil.

- Forests are essential for getting regulated rainfall.
- They also prevent excessive runoff of rain water and help to recharge the underground water reservoirs

(See the figures below)



Human beings, soon after their advent on Earth (35,000 years ago) worked single mindedly at disassociating themselves from the community of nature and from its customs and laws. These customs and laws evolved over three thousand six hundred and fifty million years, since the creation of earth.

Initially human populations were also controlled by the availability of food, and human beings were also frugal creatures consuming the bare minimum and wasting nothing. Evidence suggests that our ancestors were hunter-gatherers who roamed about looking for wild fruits and game.

But very soon human beings started cultivating plants and domesticating animals, thereby ensuring that their survival was not dependent on the availability of wild fruit and game. This was the first significant departure in nature from the traditional balance between consumer and food supply.

Growth of Human Population

As human populations grew, the land area under cultivation also grew, and so did the number of domesticated animals. More and more land was converted to farmland or pasture land, thereby denying access to a much larger number of creatures who lived off this land earlier.

However, despite their skills at cultivation and domestication, there were often miscalculations, and many human civilizations perished as a result of ecological collapses, their ruins forever preserved under the sands of deserts.

Though human beings had freed themselves from the necessity of gathering their food from the wild, they were still dependent on nature for rainfall and soil fertility,

and still vulnerable to crop pests, human and animal diseases, and to other natural "disasters".

Growth of Technology

But it was not only the growth of human population that threatened nature's carrying capacity, a much greater threat came from the new and often wasteful technologies that humans developed to exploit natural resources. In itself cultivation of crops and domestication of animals was also a new technology. Along with this humans started living in houses built of wood and stone and mortar, used wood as fuel, made implements and vessels, and even vehicles. Artisan skills developed, as did culinary skills and male and female fashions, and many plants, animals and minerals were used in growing quantities to satisfy newly acquired needs. (Many edible game birds became extinct because of over hunting, and the mink and egeret became threatened as the fur of the former and the feathers of the latter were much in demand for making coats and adorning hats.)

Humans learned how to make and use metals and chemicals, and perhaps for the first time began taxing the assimilative capacities of nature by dumping wastes into rivers and seas, and releasing toxic gases into the air.

The development of settled agriculture also meant that more things could be accumulated, as the earlier hunter gatherers were nomadic and had to carry all their belongings wherever they went. This was the beginnings of consumerism and the commodity race.

Today ecological disaster confronts humanity. It is said that for preventing a nuclear disaster we know which button must not be pressed, but for preventing ecological disaster there are no buttons to be safeguarded, for they have mostly been already pressed.

Ecological disaster is again not a reality of only the future, many countries and regions are already facing ecological disasters. Ethiopia and Somalia in Africa, Indonesia and Nepal in Asia, and even parts of Brazil in Latin America have faced the brunt of deforestation and land degradation. "Developed" countries like USA, France, Germany, and Canada are in addition facing problems caused by acid rains and by industrial pollution. In India, most of the very widespread illnesses are water borne and a result of contaminated sources of water.

Forests

The world is very rapidly losing its forest cover. Most of the tropical forests are under threat from growing populations without adequate means of sustenance and from spiralling industrial demand. In a country like India the forest cover has declined from about 28% of the land area of 328 million hectares to about 10% in the last 40 years. Even more alarming, according to satellite imagery, India is losing 1.3 million hectares of forests every year. At this rate in another 30 years at the most, India will have no forests left.

Almost all other "developing" countries are in similar straits, some even worse off. Bhutan is one of the only exceptions with an existing forest cover of over 60%. However

considering the hilly terrain and extreme climate, 60% is about the minimum required for Bhutan.

This loss of forest cover has had the following impacts.

1) It has adversely affected macro and micro climate, especially in the rain forest regions like Brazil and Indonesia, and made rainfall erratic.

2) It has directly resulted in the impoverishment of the soils by aggravated erosion and non-availability of biomass and nutrients.

3) It has caused grave hardship to the tribal and poor people dependent on these forests for their food, shelter and livelihood.

4) It has destroyed the culture and ethos of many civilisations by forcing the people to change their way of living, by impoverishing them, and by forcing them to migrate to urban centres in search of jobs.

5) It has led to the destruction, and sometimes extinction, of thousands of living creatures and valuable genetic stock.

6) It has seriously undermined the water regime in many countries, and has resulted in floods and droughts causing incalculable damage to life and property.

Pollution

Over the last hundred years or so, human beings have started taxing the assimilative capacity of nature like never before. Different types of waste products, each more toxic

than the other, is being increasingly dumped into our rivers and seas, on land and in the air. Millions of children die every year due to water borne ailments. The incidence of pollution related diseases, including cancer, is going up every day and especially affecting the poorer countries, and the poorest populations.

Dangerous chemicals like mercury and lead, and nuclear wastes, are not only killing the living but affecting the yet-to-be-born children by mutating genes and producing horribly disfigured babies.

Primarily there are three types of pollution:

- 1) Water Pollution
- 2) Air Pollution
- 3) Land Pollution

Water Pollution

In the less industrialised countries the major problem is that of water pollution. There are three main sources of water pollution:

- Domestic
- Agricultural
- Industrial

Domestic Pollution mainly consists of the wastes that we put out from our homes into water ways. This is one main source of disease. Such pollution contaminates sources of drinking water and can cause various diseases like gastroenteritis, cholera, dysentery and other stomach ailments. It also adversely affects the water ecosystem, killing fish and other riverine and marine life.

Agricultural pollution consists mainly of fertilizer and pesticide runoffs from agricultural fields into rivers and streams. These pesticides and fertilizers contain many chemicals which are not easily biodegradable and which enter the food chain. Most of these are very harmful to health.

Industrial pollution consists mainly of wastes and effluents from industries. These contain various substances including toxic chemicals which enter the water and are mostly not biodegradable.

The toxic pollutants from both agricultural and industrial activities get accumulated in the bodies of plants and animals and sometimes affect the health and life of the consumer many years later. This is because they mostly do not get flushed out of the system and their quantity keeps growing inside the body as more of the substance is imbibed.

Air Pollution

The burning of coal, and of petrochemicals are the two most significant sources of air pollution. Coal fired thermal power stations, and other coal fired furnaces and industries, emit large quantities of fly ash and sulphur dioxide. Fly ash is a major health hazard, as is sulphur dioxide, causing serious respiratory ailments. Sulphur dioxide also combines with water vapour in the air to form an acid which often comes down as acid rain.

Cars and other vehicles produce carbon monoxide and lead, both highly toxic and dangerous substances.

There are also other sources of air pollution, like wood fires, dust, and other gasses released by chemical industries.

Land Pollution

Various activities, especially open cast mining, can cause serious land pollution. Carelessly run mines scatter their overburden over vast areas, destroying the vegetation and soil of these areas. This overburden is carried to great distances by the wind and water, damaging widespread areas.

Sometimes industries also dump their wastes on land, especially if there is no water way nearby. This is another source of land pollution.

The practice of storing nuclear waste in underground chambers is among the most dangerous of activities and will have serious implications on the future and wellbeing of humanity.

7 THE CHOICES : PAST AND PRESENT

Today we live in a world of nuclear technology, of the internal combustion engine, of plastics and pesticides, and we have not only drained most of the earth, but also polluted it with the most deadly substances. But could we have done otherwise, or can we still do otherwise for what remains?

It seems certain that for a large part of human history there was genuine ignorance about the impact on nature of human activities. Till very recently droughts, crop failures, disease, as also natural disasters were considered solely the work of a displeased God. There was no understanding of the interrelationships in nature, or of its complexity, and if a stream or a well dried up no one ever connected it to deforestation in the catchment area, but were convinced that some one had cast an evil eye on them.

Slowly, however, this began to change and progress in science also encompassed the natural sciences. Unfortunately, this growth of scientific knowledge was not matched by a growth in rationality, or even sanity, among those who planned for and presided over human destiny.

Today it is clear that all economic development has to be done within the constraints of the natural environment. Whereas one can have short term economic development without considering the natural environment, no long term sustainable economic development is possible without respecting the carrying capacity of nature.

Science and technology can help both in determining what the carrying capacity of an ecosystem is, and how to enhance this carrying capacity. Therefore proper use of our scientific knowledge has to be made to ensure that development continues, but only at a pace where nature can support such development, for this is not just the best or rational way, it is the only way, a "no choice" situation.

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