The Role of Plants in Man's environment

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> "Everywhere in nature, life is a collective enterprise. Man is dependent not only an other human beings and the physical world but also on all other creatures, — animals, plants and microbes, that have evolved together with him. Man will ultimately destroy himself if he thoughtlessly eliminates the organisms that constitute essential links in the complex and delicate web of life of which he is a part."
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> **Rene Dubos'.**

Plants form one of the commonest features in man's environment and they figure prominently in many of his activities. At times they have had a powerful, even dominating, influence over his mode of life, his philosophy and his cultural activities. This is not surprising when we consider how dependent he is on the plant world.

Plants are useful to man in many ways. They are, and always have been, directly or indirectly his only source of food. Much of his shelter and clothing comes

from plants. Wood still continues to be the cheapest and most readily available fuel. Vegetable fats, medicines, spices, perfumes, dyes, gums and resins, fibres and a host of other products needed by man come from plants. Technological advances have not reduced this dependence. On the countrary, industry itself now draws much of its raw material and its energy requirements from the products of the plant world. With the rising populations and the resulting increasing demands for food, shelter, clothing and other basic amenities all national development plans call for greater production and this, too, will have to come mainly from plant sources and the world's vegetation.

Less obvious and much less known is our dependence on plants for their role in the development and the maintenance of man's environment. The primeval earth was no home for man. It was rough and desolate and marked by turbulence and disorder. Life first arose in the oceans and later, some 400 million years ago, spread over to the land. Green plants then enriched the air with oxygen, regulated the flow of water, and stabilized the earth's surface, thus providing a life supporting atmosphere as-well as a fertile soil. It was in this environment that man arose about a million years ago.

Organisms and their physical environments, or habitats, are interrelated and interdependent and they function together as integrated units or ecosystems. In each ecosystem, the habitat provides the living space, radiant energy, air, water and minerals. The organisms, between themselves, fix solar energy, produce organic compounds, organise them into living matter, and decompose all wastes and dead matter into simple minerals which could be used over again. Predators and parasites regulate populations at levels which the systems can support. The end products of one set of organisms serve as the raw materials for the activities of another. The "building-up" and the "breaking-down" processes are complementary and balance one another. Continuity of life is made possible by the parallel continuity of death. The closed cycling of matter and its continuous use and reuse make possible the perpetuation of life in a system with finite resources.

The Role of Plants

Plants play the principal productive and protective role in ecosystems. In general, plant reactions modify local environmental conditions and improve them bringing them up to the most favourable levels possible under their respective climates. Once these levels are reached they counteract the basic tendency in all systems to "run down", and they help to maintain the system in a state of dynamic equilibrium or a steady state.

Organic matter production

Plants are the only organisms that can harness the sun's energy and combine it with elements from air, water and minerals to form organic matter and living tissues. They thus provide the sustenance to all other forms of life. In the process of doing this they also purify the air by removing the carbondioxide and enriching it with oxygen.

Soil

Soil is not a simple function of bedrock and climate. To these have to be added the protection by a plant cover. Higher plants, however, cannot grow on bare rocks. Even under our humid climates a sloping surface of a bare rock becomes totally dry almost within minutes after a rain ceases. Crustose lichens which form the familiar orange or grey patches on old rocks, are about the only plants which can successfully grow on them. They initiate the formation of soil by etching into the rocks they cover and by binding the resulting particles with their organic wastes and exudates. Mosses then enter and spread out to form compact cushions which have high water-holding powers. This makes the habitat less susceptible to drought and it enables hardy herbs and wiry grasses, and in due course, shrubs and trees, to colonise the area. These successive waves of plant groups progressively build up the soils, step by step, until a soil and a vegetation that is in equilibrium with the physical environment ultimately develops. The whole sequence from the bare rock to the development of the balanced condition or *climax* may take several decades to several thousands of years depending on the climate, the nature of the bedrock, and the topography of the land.

Even after the stable condition or climax has developed, the soil and the vegetation remain interdependent. Neither can exist alone by itself. In a forest, the soil supports the trees and the trees in turn maintain the soils. The tree cover shields the soil from sun and rain, and any adverse effects of wind action. Leaf litter forms a protective covering on the forest floor, and on their decay adds humus and minerals to the soil. This humus and channels created by decaying roots make the soil loose, porous and permeable; and the network of roots assisted by the dead organic matter bind the soil particles together and check erosion.

Climate

Vegetation generally has a moderating influence on local climates. This effect is especially great at or near the soil surface, the region most important for soil micro-organisms and for the early stages of development of the higher plants.

A plant cover, by shielding the soil from intense solar radiation during the daytime and by reducing the outward radiation of heat during the night, lowers both the maximum and the minimum temperatures. In tropical lowlands, the daily range of temperature of fully exposed soil may often exceed 30°C on a bright sunny day, but the same type of soil with a good plant cover may have a range of only 2°C to 5°C.

Forest trees reduce wind velocities within the forests as well as on their leeward sides. In Sri Lanka, in the Uva basin planted tree belts have converted barren grasslands into prosperous areas of vegetable cultivation almost within a decade or two.

Relative humidities are generally higher under vegetation than in the open. In rain forests, at or near ground level, the air remains nearly saturated with water vapour almost right through the year.

Foresters have claimed that "forests increase both the abundance and the frequency of local precipitation over the areas they occupy," but most meteorologists consider that the forests have little or no effect on rainfall. Evidence on this is inconclusive.

In mountains and mountain valleys with frequent fogs or fine misty rains, however, a forest cover is said to increase the precipitation reaching the ground by amounts 2 to 3 times that in the open. Even in lowlands, where the daily temperature range is wide enough, much dew may be intercepted by the trees on cool nights. Koelmayer (1961) says that occult precipitation of this type is "quite prominent in our dry zone forests where a steady drip of water is experienced in the early hours of the morning during the drought."

Water balance

Even though forests may not increase the total rainfall they certainly increase the usefulness to organisms of whatever rain that does come down. The global water cycle may roughly be divided into four processes:- (i) evaporation from the sea and the land, (ii) transport of vapour in the atmosphere, (iii) precipitation on the land as rain, mist or dew, and (iv) the flow back over and areas to the sea. It is chiefly during the last stage that water is available for use of life on land. Bare rocks hold little or no water. Water falling on them runs off and flows back rapidly to the seas but vegetation delays this flow and enables terrestrial life to use it for longer periods.

In a forest little or no rain comes down directly to the soil. It is almost completely intercepted by the canopy of the tree leaves and branches. A part of the rain goes back to the atmosphere as transpired water. A part is absorbed by the vegetation. The balance flows down tree trunks or drips from the leaves to the forest floor and filters down through the litter and the network of roots into the porous soil below. Underground seepage then carries it gradually into the springs or to rivulets and streams from where it finally flows back to the sea.

The almost complete absence of surface runoff delays the return flow, and water is stored for some time by the vegetation and the soil as by a massive sponge or reservoir which fills up with excess water during heavy rains. This reduces peak flows after storms and the water held back is gradually released to the waterways for several days or even weeks after the rains cease. Forests thus regulate waterflow. They reduce the intensity of floods and may at times prevent them altogether and they increase the dry weather flows.

Evapotranspiration from forests is generally greater than evaporation from comparable areas of denuded soils. This loss is more than offset by the much larger amounts held back by forests and forest soils. In general, taller, fast-growing trees lose more water than shorter, slow growing ones and the species combinations present in natural forest ecosystems maintain the most favourable moisture conditions in their particular ecosystems.

Stability of ecosystems

Plants form the base of all food chains. The diversity of plant species sustains a corresponding diversity of animal species. By the checks and balances they collectively exert, population levels of all organisms are kept within the limits of the carrying capacities of the various habitats. In the tropical rain forest, for example, the multitude of species present maintains a stable equilibrium and pest outbreaks or population explosions are practically unknown.

Effects of the removal of vegetation

Removal of the plant cover without providing for an adequate artificial equivalent brings about a complete change in the soil microclimate and this leads to a very rapid deterioration of the soils. Exposure to the direct sun and to air movements make the soils heat up and dry. An upward movement of water and the resulting physico-chemical changes make the soils hard and impervious. The nutrient cycle breaks down with the loss of the products of leaf falls, and humus and minerals are no longer added to the soils. Any residual organic matter that may still be left in the soil rapidly disappears due to photochemical decomposition. The bare and hardened soil becomes subject to the full force of falling raindrops. The water does not infiltrate into the soils but drains off and causes severe erosion. The soil removed in this manner from cleared hill slopes may be as much as 25 to 30 times that from similar but forested soils. The soil brought down from the highlands may then cause silting of rivers and streams and may even cover lowland vegetation or cultivated fields bringing about their destruction as well.

With the removal of the plant cover and the erosion of soils the highlands cease to serve as natural reservoirs. The regulated flow of water is replaced by destructive floods and even a few days of drought may cause all natural waterways to run dry. The impoverishment and the erosion of soils make the habitats more susceptible to extremes of climate, and in regions with a marginal or low rainfall, may even cause a progressive desiccation of the land.

Land Use and Conservation

Our value systems have often been almost totally blind to the realities of the biophysical world. What nature has provided free has been ignored and taken for granted. The protective and ameliorative values of forests have been considered as irrelevant or unimportant as these cannot be readily quantified in economic terms. Misuse of land and overexploitation of forests for private gain have damaged or destroyed much of our land and this now constitutes our biggest environmental problem.

Sri Lanka has a total land area of about 16 million acres. The Report of the Land Utilization Committee (1968) gives the forest area in the Island as 44 per cent or nearly 7 million acres. These figures look very impressive but in fact only about a tenth of this is actual productive forest. The balance nine-tenths constitute waste lands with secondary jungle or low scrub. This area is so degraded that its average yield of usable timber is as low as 0.3 cu.ft. per acre per year. (Koelmeyer 1961). In addition to this several hundred thousand acres are covered by the weedy grasses *mana* and *illuk*. Climatic factors do not preclude the presence of forest in these grassland areas. Historical and experimental evidence seem to indicate that much of this, too, is man made and created by deforestation and subsequent soil impoverishment. Frequent firing is now causing further degradation of soils, and on steep slopes heavy erosion is even causing the exposure of underlying rocks in some areas.

Ours is primarily an agricultural country and all agriculture depends on soil and water. The minimum extent of land that should be under forest for efficient soil and water conservation is, according to foresters, at least 25 per cent. In the wet zone of Sri Lanka, where with heavy rains protective forest is most needed, we now have only about 9 per cent, and in the montane catchment of the Mahaveli Ganga it is as low as 8.5 per cent. Well managed tea does conserve the soil very effectively but appears to be less efficient than forests for regulating water flows. To ensure a regular dry weather flow from the rivers and to minimize flood damage total protection of the few existing forests and more reforestation are very essential.

Land use and conservation need not be antagonistic. They both now claim to have the same objective, namely "the rational use of the earth's resources to achieve the highest quality of living for mankind". Land can be used without destroying it. Biological resources under proper management are renewable and some can even be made more productive with use. In Sri Lanka the lands still available and suitable for development are in the dry zone plains. Nearly all this area was once cultivated and is now under secondary jungle or unproductive scrub. Nothing would be gained by retaining them as they are. Opening up of such lands would provide new opportunities for both agriculture and reforestation, and for rational land management where none existed earlier.

Rational land management, however, requires the preservation of natural landscapes as well. Natural areas relatively undisturbed by man are becoming more and more scarce, and every effort should be made to preserve what is still left. At most we now have only about 50,000 acres and this is less than 0.3 per cent of the Island's total areas. They can provide us with much valuable information as to how we can manage our cultivated areas best and they are the only standards or baselines by which we can judge our man-made ecosystems. They can also serve as refuges for endangered species and provide necessary material for future genetic improvements and biological controls.

Natural landscapes have important aesthetic and recreational values as well. They provide man an escape from the pressures and cares of crowded cities. Psychologists attribute anxiety and despair and the breakdown in human relationships to a breakdown in relationships between man and his environment. Today, urban man spends much of his time in environments created by technology where his contacts with nature are almost distorted. Even in the midst of peace and plenty, man is anxious, because the world around him separates him from the world he evolved in and fails to satisfy his basic psychological requirements. "Modern man", says Dubos, "is like a wild animal in a zoo fed abundantly, protected from inclemencies, but deprived of the natural stimuli essential for the many functions of his body and mind."[2]

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