FORESTS IN THE BIOSPHERE

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Contents

Summary

Given firstly in this contribution, is a brief presentation of life in the biosphere, then the role played by forests as a carbon reservoir is discussed. The author outlines the edapho-climatic and structural characteristics, along with the biodiversity of tropical, temperate and boreal forests.

Also outlined are the different major functions of forests in the biosphere, i.e., environmental influences, timber production, non-wood production, with special

emphasis on fodder, fuel and food production in developing countries where special cases are analyzed in depth.

Deforestation is described in all its aspects, giving global data, with special focus on the major agents of deforestation, and the indirect and direct causes of the process.

1. Introduction: Brief presentation of the Biosphere

The biosphere is the stratum of the Earth's surface which goes from a few kilometers into the atmosphere to the deepest openings of the ocean. This thin strip is a complex ecosystem known as "system of life", composed of living organisms, or biota, and the abiotic bodies from which they take energy and nutrients. In the biosphere there is a continuous cycling of matter, accompanied by a flow of solar energy, which is necessary for the reproduction of molecules and cells.
Between three and thirty million species of plants, animals, fungi, single-celled eukaryotes such as protozoans, and single-celled prokaryotes such as bacteria live in the biosphere. It is amazing to see that our inventory of the diversity on Earth is still so incomplete and so inaccurate. No more than 1.4 million species, i.e., 5 to 45% of the total species - of which about 50% are insects - have been identified, and less than 1% have been studied in their ecosystem.

2. Life in the Biosphere

Life in the biosphere is characterized by a tremendous diversity. It is organized into ecological groups and communities, or biomes, throughout the world. Forests are one of the largest and richest biomes of the biosphere. They encompass different sub-biomes such as the tropical rainforests, the boreal forests, and the temperate forests, which include the Mediterranean forests, etc.

Solar energy, through the process of photosynthesis, is the condition *sine qua non* of the existence of life in the biosphere. In the photosynthetic process, the plants transform solar energy into the chemical energy of living tissues, comprising herbivores, predators, parasites, decomposers, and all other forms of life. In this process, the chlorophyll molecules of the plants absorb the light energy to convert carbon dioxide and water into carbohydrates and oxygen gas. During this same process, fats, proteins, nucleic acids, and other compounds are also synthesized, in the presence of nitrogen, sulfur and phosphorus.

Plants capture only one to two percent of solar energy reaching the Earth surface, because the major part of solar energy occurs at wavelengths which are unsuitable for photosynthesis.

On the other hand, plants use the major part of the energy they assimilate, for their own respiration. The rest is stored in plant tissues for further use, called net primary productivity. Tropical forests, swamps and marshes constitute the biomes which have the highest net primary productivity; and deserts constitute the biome with the lowest net primary productivity.

3. Forests in the Biosphere

In its Forest Resources Assessment of 1990, FAO defines forests as "Land with tree crown cover (or equivalent stocking level) of more than 10 percent and area of more than 0.5 ha. The trees should be able to reach a minimum height of 5 m at maturity *in situ*. They may consist of either closed forest formations, where trees of various storeys and undergrowth cover a high portion of the ground; or of open forest formations with a continuous vegetation cover in which tree cover exceeds 10 percent. Young natural stands and all plantations established for forestry purposes, which have yet to reach a crown density of 10 percent or tree height of 5 m are included under forest, as are temporarily unstocked areas, as a result of human intervention or natural causes, but which are expected to revert to forest. These include: forest nurseries and seed orchards that constitute an integral part of the forest; forest roads, cleared tracts, firebreaks, and other small open areas within the forest; forest in national parks, nature reserves and other protected areas such as those of special environmental, scientific, historical, cultural, or spiritual interest; windbreaks and shelterbelts of trees with an area of more than 0.5 ha and a width of more than 20 m. Rubber wood plantations and cork oak stands are included. Excluded is land predominantly used for agricultural practices.

A forest ecosystem is a segment of landscape that comprises biotic and abiotic components; it is not only a sum of trees, but a complex of trees, shrubs, grasses, herbs, birds, mammals, reptiles, amphibians, insects, fungi, bacteria, viruses, water, soil, air, minerals, microclimates, mesoclimates, etc.

The biotic component encompasses three categories of organisms:
(1) the primary producers, mainly green plants,
(2) the consumers, which include all animals, and
(3) the decomposers, mainly microorganisms that break down the dead plants and animals into simpler elements, and recycle them into the biosphere.

The abiotic portion includes all non-living components, such as water, nutrients, gases, flow of energy, organic and inorganic substances, etc. Of all Earth’s habitats, forests are the most species-diverse. According to the Food and Agriculture Organization of the United Nations, the Earth's forest cover nowadays reaches some 3.86 billion hectares, an area as large as that of North and South America combined. This total represents around 27 percent of land use, and over 57 percent of it grows in developing countries, mostly in tropical and sub-tropical regions.

The world's original forest area was estimated to be 6 billion hectares. Over the last 8,000 years, 43 percent of this original area was lost, mainly as a direct consequence of anthropogenic disturbances. It is estimated that some 25 hectares of forests disappear every minute.

4. Forests, Carbon, Oxygen and Carbon Dioxide

Plants, in general, and forests in particular, convert atmospheric carbon dioxide to carbon-based compounds through the photosynthesis process. They cleave the carbon from the two oxygen molecules and release the oxygen back into their environment.

Forests are therefore the largest carbon reservoirs and are the primarily responsible for the presence of oxygen in the atmosphere. They contain up to 80 percent of the above-ground carbon in terrestrial communities and around 33 percent of the belowground carbon. It is estimated that about 50 percent of the carbon storage in forests occurs in high-latitude forests, with storage in above-ground vegetation and in peat deposits. The two largest forest reservoirs of carbon are the Russian expansion, with about 25 percent of the world's forest stored carbon, and the Amazon basin, with around 20 percent.

Until the beginning of the 19^{th} century(i.e., the Industrial era), there has always been a balance between the carbon in the forests of the world and in the atmosphere. But, since the 19th century, due to the overcutting of much of the world's forests, along with an increase in the consumption of the fossil fuel, the equilibrium was disrupted. The concentration of carbon dioxide in the atmosphere has been increasing steadily. Actually, the increase rate is estimated to be about 4 percent per decade. The deforestation in Brazil, Russia and other parts of the developing world are likely to be significantly correlated to this phenomenon of global carbon storage and cycling.

It should be pointed out that deforestation has also increased atmospheric levels of carbon dioxide, leading to global warming (called the greenhouse effect), the melting of the polar ice caps, which causes sea levels to rise, and a decrease in the global precipitation on Earth.

5. Types of Forests and Forest Biodiversity

Using seasonality as an essential characteristic, three major types of forest can be distinguished in the biosphere. These, classed according to latitude, are:

(1) Tropical forests,
(2) Temperate forests, including Mediterranean forests, and
(3) Boreal forests.

5.1. Tropical Forests

Tropical forests, both moist and dry, cover approximately 2 000 million hectares worldwide. They lie near the equator, which is a frost-free region, between the Tropic of Cancer and the Tropic of Capricorn, zone bounded by latitudes 23.5^{o} N and 23.5^{o} S. Their distinct seasonality constitutes one of their major characteristics: only two seasons are present: rainy season and dry season, with an absence of winter. Daylight lasts 12 hours, with a very little variation. The average annual rainfall exceeds 2 000 mm, and is evenly distributed throughout the year.

The average annual temperature lies between 20 and 25^{o}C. The average temperature of the three warmest, and that of the three coldest, months differs from the annual average by no more than 5 ^{o}C. The soil is acidic and poor in nutrients. It is subject to rapid decomposition and to heavy leaching. The vegetation canopy is continuous and multilayered, which allows little penetration of light. According to the seasonal distribution of rainfall, this group can be subdivided into four sub-groups: *Evergreen rainforest*, with no dry season; *Seasonal rainforest*, with some definite seasonal

changes, a short dry period and a very wet climate. The general character of the vegetation remains evergreen; *Semi-evergreen forest,* with a longer dry season. The upper tree storey consists of deciduous trees, while the lower storey remains evergreen; and, *Moist/Dry deciduous forest*, with a longer dry season, and a decrease in annual rainfall. In this sub-group, all tree storeys are deciduous.

The tropical forest biome has the highest abundance and diversity of species on Earth. It harbours around 70 percent of the Earth's plant and animal species, i.e., more than 13 million species. Approximately 90 percent of invertebrates, 70 percent of vascular plants, and 30 percent of all bird species are found in tropical forest ecosystems. In tropical rain forests, up to 200 or more distinct species are found per hectare , in tree species alone; while as few as one species per hectare are found in boreal forests.

Of the 18 terrestrial areas with high plant endemism, i.e., plants found nowhere else on Earth, fourteen lie within the moist tropical forests. These forests collectively harbour more than 37 000 endemic species, i.e., 15 percent of all plant species, in just 0.2 percent of the Earth's surface (less than 311 000 km^2).

In one square kilometer in Brazilian tropical forests, one could find 30 species of trees, 6 000 flowering plants, 50 species of mammals, 160 species of birds, 40 species of reptiles, and 25 species of amphibians.

In Amazonian forest, in Ecuador, 437 tree species have been recorded per hectare. In Panamanean tropical forest, up to 1 200 species of beetle have been recorded on a single tree species.

From the economic and scientific viewpoints, tropical forests are very important for plant improvement breeding. A significant example is that of a wild species of maize found in Mexican forests, that revealed itself resistant to five of the world's seven most destructive corn viruses. This species is actually a corner-stone genetic resource for corn improvement research programs.

Other examples could be reported, such as the bark of *Prunus africanum* which is used in the treatment of prostate disorder, and the periwinkle plant, i.e., *Vinca sp.* found in Madagascan tropical forests, which provides a drug successfully used in the treatment of lymphocitic leukemia.

In addition, in tropical forests are found, for example, the wild relatives of banana, grapefruit, lemon, avocado, cacao, coconut, oil palm, coffee, cinnamon, cashew, paprika, vanilla, and rubber. Also, red jungle fowl, the ancestors of the domestic chicken are found in the hot and humid tropical forests of Asia.

But, despite all of these impressive statistics, it is startling to realize that our knowledge of the tropical forests biodiversity is still so incomplete. Foresters, ecologists, botanists, systematists, geneticists, and other specialists have still to carry out decades of continuous research in order to better describe, study and understand this fascinating tropical biome.

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Biographical Sketch

Dr. Mohammed ELLATIFI, a Moroccan national, was born in November 1949, in Kalaat Sraghna, Morocco. He speaks and writes Arabic, English, Spanish, French, and German.
University Education:

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He joined the Forest Department in Morocco in September 1970 as Forest Officer and held various posts of responsibility at both regional and national level. From 1991 to 1996, he worked with the United Nations and for FAO as International Forest Expert in the Republic of Yemen and in Jordan.

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He has written two books on Statistics and Mathematics, two manuals on Applied Statistics and Operational Research, ten manuals on various aspects of Forestry (nurseries; forest seeds and seed collection, handling and storage; afforestation techniques; agroforestry; forest inventory), Statistics and Rural Development; and over a hundred scientific papers.

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