Biomass

Edge of lowland tropical forest biomass at Nim li Punit, Belize. Source: C.Michael Hgoan

Biomass is a term in ecology for the mass of living organisms in a given ecosystem. Biomass can refer to the living stock of species in a given habitat, but can also refer to a harvested subset or to a decaying subset (especially in the case of forest floor detritus). Biomass may refer to the total mass of all species within the study area, and is thus sometimes called **community biomass**; but biomass may also refer to a taxonomic subset. Biomass can be expressed as the average mass per unit area or unit volume, or simply as the total mass in the community. Plants characteristically comprise the greatest part of the biomass of terrestrial system. In the animal kingdom, iIronically, the smallest creatures in an ecosystem typically represent the largest quantity of its biomass. It is important to note that the relative biomass species mix may change considerably from season to season and even from year to year[1] in a given location, due to climatic oscillations, predator-prey cycles and other temporal variables.

Biomass has been used as fuel since prehistoric times, and being advanced in current times increasingly with the growing thirst for energy by the expanding human population; however, deforestation with attendant biodiversity loss along with air pollution emissions and release of greenhouse gases are limiting factors on use of biomass for energy production.

Aquatic ecosystems

Aerial view of Okavango Delta wetland, Botswana. Source: C.Michael Hogan

Phytoplankton forms the obvious base of plant primary production in the food pyramid of aquatic ecosystems;[2] this component comprises a huge percentage of the biomass of such aquatic systems. Larger rooted plants such as the kelps also make up some of the plant biomass of aquatic systems. In the animal kingdom, copepods and other small aquatic fauna comprise a disproportionate amount of the animal biomass .It is worth noting that the plant species comprising freshwater and marine ecosystems are quite disjoint, with fewer than one percent of freshwater species being able to survive in saline media; in fact, specialization is so great that many genera have narrow salinity ranges of tolerance, such that they can only thrive in particular tidal reaches of an estuary.

Terrestrial ecosystems

Trees and shrubs may comprise a considerable amount of the terrestrial plant biomass where forests and woodland ecosystems are present. When decaying plant detritus is considered as a biomass component, then the leaf litter and decaying organic material on a forest floor can be a substantial component of the entire forest ecosystem. Faunal statistics generally follow the pattern of aquatic systems, such that arthropods comprise a very high percentage of animal biomass, with megafauna comprising a relatively small percentage. In the case of organisms other than animals and plants, there is a considerable fraction of organism biomass comprised by fungi[3] and bacteria.

Carbon sequestration

Biomass is an important storage system of carbon in the Earth's carbon cycle. In such analyses, researchers not only classify the carbon in biomass by kingdom, by terrestrial versus aquatic, but also by vertical zonation. For example in terrestrial vegetative systems, there is a typical zonation of aboveground biomass, root biomass, decaying surface detritus and soil organic matter; the latter materials are particularly important for peaty soils which can also be important carbon sinks for methane as well as carbon dioxide and more complex organics. In the case of terrestrial fauna, the distinction of above and below ground animals can be made, but in respect to microscopic fauna, measurements in soil are very difficult to discern the animal from plant component.

For aquatic systems, depth zonation is often used to classify biomass. A general pattern is the presence of greater amounts of biomass at shallower depths such as coastal shelves, since light availability is a limiting factor for biomass primary production at greater depths, with high autotrophic activity in the shallowest or epipelagic zone, moderate primary production at the next deeper mesopelagic zone and virtually no primary production in the bathypelagic zone or below.

Biomass as food

Biomass deriving from plants is by far the most energy efficient way of delivering food to humans (or any omnivorous species). The limiting factors of producing such vegetative biomass are the processes of carbonand nitrogen fixation.[4] Carbon fixation is chiefly conducted through photosynthesis, whereas nitrogen fixation in the natural environment is mainly conducted through symbiosis of certain host root systems with soil bacteria. Nitrogen fixation in vegetation normally produces ammonia, which in turn is used by plants to produce amino acids and proteins. Nitrogen fixation can also be accelerated by the very energy intensive industrial process of ammonia manufacture.

Photosynthetic biomass production is important in a large variety of basic foods including leafy vegetables, tubers and pulses. Nitrogen fixation is key in growth of legumes such as soybeans, lima beans, peanuts and kidney beans. Indirectly it is important for many other plants by producing nitrogen in the fallow cycle for such crops as alfalfa.

Cereals

Barley and other grains are grown on every arable hectare in Aberdeenshire, Scotland. These fields lie above Thornyhive Bay, illustrating the use of the most ragged edged grain fields in Scotland. Source: C. Michael Hogan

Cereal production is the mainstay of human foods with wheat, rice, maize (corn), barley, rye, sorghum and oats being the chief components. The worldwide 2007 production of cereals amounted to 2.3 billion metric tons, with notably high yields coming from Europe, North and Central America and notably low yield coming from Africa. This wide variations in yield per hectare arise due to the chemical intensive nature of farming in developed countries and also due to the low nutrient content of tropical soils. It is also worth noting that rice is essentially a wetland crop and efforts to expand rice production inevitably lead to very high water demands, exacerbating the world water crisis. It is surprising to observe that the world cereal production has only expanded about 27 percent in the last 23 years, notwithstanding the enormous increase in human population and the aggressive use of chemical fertilizers. This meager increase can best be explained in that the preponderance of productive agricultural lands have been placed into use decades ago, and that overdrafting of groundwater and steady decline in topsoil capability is working against increasing production. One should also note that the collective production of wheat, barley, rye and sorghum has been declining to level over recent years. It is also worth noting that a considerable portion of maize production goes to non-food uses such as ethanol fuel.

Tubers and root crops

These crops store the majority of their nutritive value in their root and tuber structures. Potatoes are stem tubers, which are the development of enlarged stolons thickened into a storage organ. A tuberous or storage root, is a modified lateral root, enlarged to function as a storage organ; important foods with such root tubers are cassavas, yams and sweet potatoes. World regions producing the greatest quantites of tubers and root crops are Asia, Europe and Africa.

Biomass as fuel

Fuel types


Wood fired lime kiln, Carpathian Mountains, Romania. Source: C. Michael Hogan

Biomass fuels include liquid, gas and solid fuel types. Liquid biofuels consist chiefly of ethanol, methanol and vegetable oils. Ethanol has achieved the greatest market penetration in motor vehicles a combined fuel with petroleum, commonly called gasahol. Methanol has certain technical issues of corrosivity and low fuel density, which impede its widespread use. Vegetable oils combined with gasoline have achieved a moderate reception in powering diesel motor vehicles.

Gaseous biomass fuels include (a) low energy molecular gases from gasification processes and (b) methane from anaerobic digestion or hydrogen gasification. Since these gas fuels have high storage costs, such fuels are likely to be consumed only immediately after production by direct combustion for electricity generation or local heating.

Pyrolysis of wood is the chief solid fuel mechanism, although the intermediate step of charcoal production is common in many developing countries. In addition to combustion of timber materials, a number of processes focus on the use of wood chips or other waste products from the timber industry. In certain northern latitudes, the cutting and burning of peat is a process that has been used for centuries; however, this process cannot be viewed as a sustainable practice.

Combustion and gasification technologies

Wood chip gasification plant, Gussing, Austria

There are two separate technologies available for utilizing biomass as fuels: combustion and gasification. In the case of combustion technologies, the biomass is simply burned at temperatures typically in excess of 550 degrees Celsius to produce heat that will be used in

direct form or that can produce electricity through a steam driven turbine technique. Gasification processes are generally more intricate, as liquid fuel is produced from biomass and then used as a portable fuel or in an integrated liquid burning fuel small scale power plant.[5]
Disadvantages of direct combustion technologies include abbreviated plant lifetimes (due to residue buildup) and high air pollution emissions (particularly oxides of nitrogen that can contribute to acid rain impacts). Disadvantages of the gasification technology include costly and complex systems, given the small scale of present facilities. Considerable research is being advanced for gasification, so that future breakthroughs may be forthcoming. In particular, considerable quantities of portable fuel have been produced from ethanol, whose use as a renewable energy source is reducing greenhouse gas emissions;[6] some unwarranted ciritcisms of ethanol have been focussed on energy budget analysis of this fuel. For example, some treatments of the energy used to create ethanol have included large amounts of pesticide, where, in fact, ethanol production does not use the same pest control chemicals as for food production.

Environmental consequences

Air pollution and carbon sequestration

Use of biomass for energy production suffers most of the air pollution and carbon dioxide impacts of fossil fuel combustion. Significant amounts of the pollutants carbon monoxide and particulate matter are produced from biomass fuels; some of these impacts can be mitigated by scrubbers or other emission control devices. In the case of carbon sequestration, there is a significant release of sequestered carbon for wood fuel use, since the regneration time of forests is quite long; conversely, in the case of crops used for fuel production (e.g. maize, switchgrass) the sequestration of carbon is renewable in the growing season; furthermore, there is evidence that deep rooted crops such as switchgrass may actually sequester carbon in a very efficient manner, from its deep root structures.[7]

biodiversity, erosion and water pollution

biodiversity loss of biofuels is a significant adverse impact, due to large areas of the natural environment that may be appropriated for fuel crops or for logging or slash and burn practices. The Central Highlands area of Madagascar, for example, represents a large scale eco-catastrophe, which was spawned by slash and burn practices, a chief aim of which was charcoal manufacture; in that region the large scale landscape is substantially denuded with permanent loss of both topsoil layers and future biological productivity. Furthermore, significant adverse water pollution impacts arise from such large scale slash and burn or clearcutting.
Even when the logging or cropping practices allow for erosion control and soil preservation practices, use of large scale monocultures poses a significant risk of regional biodiversity loss.

Measurement standards

Broadly, the subject of biomass measurement can be broken into several main segments. Firstly, a decision must be made as to the state of desiccation of the parameters to be measured. For example, the living organisms contain a substantial amount of water, which percentage varies due to the state of health as well as the recent meteorological history. The researcher must decide under what standard conditions that plant materials are to be dried, or whether they will be burned and reduced to ash. In the case of the latter, the measurement is usually called *residual dry matter* or RDM; the use of RDM is an important tool in studying the grazing efficiency and techniques for range management.
In the case of higher animals or for any endangered species, one often simply estimates the number of individuals present per hectare and estimates the number of individuals; such techniques are important to guard against animal cruelty and to minimize interference with the faunal component of sensitive ecosystems. For some systems that have commercial fisheries, the total catch mass can be used as a direct measurement of species biomass.

References

1. ^ Charles D.Bonham. 1989. *Measurements for terrestrial vegetation*. 338 pages
2. ^ David Newsome, Susan A. Moore and Ross Kingston Dowling. 2002. *Natural area tourism: ecology, impacts and management*. 340 pages
3. ^ George C. Carroll and Donald T. Wicklow. 1992. *The fungal community: its organization and role in the ecosystem*. Marcel Dekker. 976 pages
4. ^ Osamu Kitani and Carl W. Hall. 1989. *Biomass handbook*.Taylor and Francis. 963 pages<span class="ln2" />
5. ^ Peter Quaak, Harrie Knoef and Hubert E. Stassen. 1999. *Energy from biomass: a review of combustion and gasification technologies*. World Bank. 78 pages

6. ^ Organisation for Economic Co-operation and Development. 2004. *Biomass and agriculture: sustainability, markets and policies*. 565 pages
7. ^ USDA Agricultural Research Service. 2005. Soil Carbon under Switchgrass Stands and Cultivated Cropland (Interpretive Summary and Technical Abstract). April 1, 2005. U.S.Government Printing Office, Washington DC

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