GSV Technical Brief 003
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Ecosystem Functions, Services and Biodiversity-II (of III)

In Part I of this brief we have tried to explain what ecosystem means, and elaborated briefly on ecosystems services and functions. We also introduced biodiversity and the need for the conservation of diversity in the biological world. In Part II, we will try to describe the relationship between ecosystems functions and how these are related to biodiversity.

In Part III of this brief we will move on more on the components of biodiversity, the current thinking of GRSV as to why we should be concerned about biodiversity conservation and how conservation and use of biodiversity a different levels is essential and how such efforts can be balanced with developmental efforts. We will also try to link biodiversity conservation and utilization with sustainable development, especially in the context of climate change, with some examples.

Ecosystem Functions and Role of Biodiversity

'Does biodiversity matter for the functioning of ecosystems?' or 'Does it make any difference to the processes within an ecosystem if there are many or only a few species?' These are the central questions that arise when one is looking at the many ecosystems on earth. The functioning of ecosystems might be maintained by many or very few organisms, depending on the complexity of a particular ecosystem. Preserving stable ecosystem functions can be a very good reason to preserve biodiversity, because of their supportive interdependence, albeit a complex one. Some examples of impacts of biological diversity on various ecosystem functions related to mostly human needs, so as to understand our dependence on biodiversity.

<u>Regulating Functions</u>

- *Gas Regulation*: Living things on earth regulate biochemical and geochemical processes leading to changes in atmospheric gases [e.g. greenhouse gases, photo-chemical smog and volatile organic compo. Plants take-up carbon di-oxide and release oxygen, hence directly contribute to air quality.
- *Climate Regulation*: Plants and animals on earth, especially the plants, greatly influences of land cover and all biological mediated processes and thus regulate atmosphere and weather patterns, Including microclimates (for example provision of shade for shade-living beings) in which different plants and animals (including humans) live and function. For example, plants directly contribute to $C0_2$ sequestration and reduce global warming.
- *Disturbance Regulation*: The capacity (such as water and energy storage and surface resistance) of the soil, regolith (loose rocks/particles on the surface) and vegetation to resist/buffer the effects of wind, water and sea waves is

enormous. For example, mangrove and other vegetation along the coast help in mitigating impact of storms and tsunamis.

- *Water Regulation*: In any ecosystem, land cover (trees), land features, soils, rivers, lakes and wetlands over time and space greatly influence greatly the amount and quality of water. Although plants consume lot of water for their growth, large masses of them (e.g. forests) are essential in improving rainfall in any ecosystem. Although the composition of soils and rocks can be a source of impurities in fresh water but they also can help to filter out and decompose organic wastes introduced into inland waters and coastal and marine ecosystems.
- *Soil Retention*: Ecosystems minimize soil loss through having adequate vegetation cover, root biomass, retaining rocks and soil biota. Dense growth of plants helps greatly in the retention of soil and minimizes soil erosion due to wind and water.
- *Nutrient Regulation*: The role of ecosystems in the transport, storage and recycling of nutrients is important to agriculture. The plants and soil microbes assist greatly in the nutrient recycling, absorption and breakdown of organic matter to improve soil nutrition.
- *Waste Treatment and Assimilation*: Ecosystems are able to transport, store and recycle certain excesses of organic and inorganic wastes. It is estimated that about 40 billion tons of organic waste is naturally recycled by animals and plants, a service whose worth is estimated at $ 860 billion annually.
- *Pollination*: Both biotic vectors (e.g. insects, birds and mammals) and abiotic vectors (e.g. wind and water) assist in the movement of pollen that is essential to plant reproduction and food production. Pollination also has a major bearing on continued evolutionary potential of landraces cultivated by farmers. For example, pollinating insects increase fruit or seed quality or quantity of 39 of the 57 major crops worldwide.
- *Biological Control*: Control of pests by some living beings is called biological control. Such a system is important for traditional and organic agriculture and reduces the use of chemicals for controlling pests. Ecosystem changes affect the prevalence of crop and livestock pests and diseases. Changes in ecosystems can directly change the abundance of human pathogens, such as cholera, and can alter the abundance of disease vectors, such as mosquitoes.
- *Barrier Effect of Vegetation*: Vegetation impedes the movement of airborne substances such as dust and aerosols (including agricultural chemicals and industrial and transport emissions), enhances air mixing and mitigates noise. These effects also assist in mitigating increasing levels of atmospheric pollution. Examples include avenue trees along the streets and roads.
- *Pollution control*: Due to rapid advances in technology and industrialization over 100 000 different chemicals are produced and released into atmosphere and it is estimated that around 10% of these chemicals are carcinogenic. It has been estimated that there about 400,000-600,000 hazardous waste sites in USA alone. Biological methods more effective in removing toxins and benefits of bioremediation are countless.

Supporting Functions

- *Supporting Habitats*: Most natural and semi natural ecosystems provide suitable living space for many plant many animal species (i.e. biodiversity) facilitating breeding, reproduction, etc. For optimum human habitation, trees help in reducing landslides in sloping hilly areas, help in soil conservation and for proper land utilisation.
- *Soil Formation*: Soil formation processes include the chemical weathering of rocks and the -transportation and accumulation of inorganic and organic matter. About 99% food that we consume comes from land and to do so fertile soils are essential. This function of fertile soil formation is facilitated by diverse soil biota whose contribution is estimated to be around $ 4.5 billion worth of top soil annually. In addition, soil microbes fix atmospheric nitrogen worth over $ 90 billion.

Provisioning Functions

- *Food*: It refers to material that can be converted to provide energy and nutrition. Almost all the food is initially derived from photosynthesis. Historically there have been about 3000 plant species are known to be edible, all though the world's food supply depends on about 150 plant species and just 12 of these provide three-quarters of the world's food.
- *Raw Materials*: It refers to biomass that is used by humans for any purpose other than food. Most of our non-food requirements (e.g. gum and resins, fats, oils, starch, fibre, dyes) are derived from plants in forests or agricultural fields. Raw material for energy (fuel wood, fossil fuel, electricity) are also derived from plants. Meat, leather and skins are derived from animals.
- *Water Supply*: The role of ecosystems in providing pure water through sediment trapping, infiltration, dissolution, precipitation and diffusion is another miracle.
- *Genetic Resources*: Self-sustaining diversity of organisms that evolved over time (and capable of continuing to change) which can be measured at species, molecular and sub-molecular levels. For example, plant genetic resources are considered as building blocks of agricultural productivity improvement through crop improvement.
- *Ornamental resources*: Animal products, such as skins and shells, and flowers are used as ornaments, although the value of these resources is often culturally determined. This is an example of linkages between the categories of ecosystem services.
- *Provision of Shade and Shelter*: This relates to vegetation providing shade or shelter for other plants, animals and biota helping to ameliorate extremes in weather and climate at a local landscape scale.
- *Pharmacological Resources*: Many natural materials can be used by organisms to maintain, restore or improve health. Globally, around 60% of people continue to depend on traditional medicines which are basically drawn from the biological resources such as plants. In addition, many medicines, biocides, food additives and, and biological materials are derived from ecosystems (e.g. Recently vinblastin and vincristine, two anti-cancer drugs have been obtained from *Catharanthus* plant).

Cultural Functions

These are the nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences, including:

- *Cultural diversity*: The diversity of ecosystems is one factor influencing the diversity of cultures. Natural or semi natural features of the environment may be associated with the identity of an individual, a community, or a society, providing the particular individual or community experiences shared across generations. For example, in many parts of India sacred groves help in maintaining spots of high levels of plant diversity and the diversity of foods in different regions/cultures enhances the diversity of plants and animals.
- *Recreation and Tourism*: It is common that many people engage in some form of outdoor recreation. Thus, recreation and tourism represent an opportunity for promoting both biodiversity, landscape and tourism and to manage the interaction between ecosystems and people. Activities, such as walking, camping etc. offer an opportunity for many people to experience the benefits of ecosystem services directly.
- *Spiritual and religious values*: Many religions attach spiritual and religious values to ecosystems or their components. For example, in Bihar the pomelo is mainly grown for the use for offering during chhath puja.
- *Knowledge systems* (traditional and formal): Ecosystems influence the types of knowledge systems developed by different cultures. In the case of agricultural ecosystems the farmer's knowledge is an important source of agricultural practices, while the knowledge of traditional forest dwellers on plants and animals is an important source of information of the forest ecosystem.
- *Landscape Opportunity/Aesthetics*: This refers to the extent and variety of natural features and landscapes and appreciation of natural scenery. Ecosystems that have extraordinary geographic features and/or plant and animals. The examples include, the Gir forest, valley of flowers etc.

Concluding Remarks

We have shown here that the ecosystem, its functions and services are highly interrelated and impacts biodiversity that it contains and is in turn is influenced by biodiversity. Research to date shows that the ecosystems that are home to species-rich assemblages are generally more productive and efficient and healthier compared to those with fewer species. We know that the function, services and biodiversity are interrelated and one affects more of the other and many of one (e.g. function) can affect more of the other (e.g. services or biodiversity). There is, however, not complete information on how, for example, biodiversity affects the wide variety of ecological functions and how this leads to improved services. We believe this kind of understanding is essential for sustainable conservation and development with which GRSV is concerned.