Sabu Abdulhameed · N.S. Pradeep
Shiburaj Sugathan *Editors*

Bioresources and Bioprocess in Biotechnology

Volume 1: Status and Strategies for Exploration

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Dedicated to Prof. M. S. Swaminathan for his pioneering scientific innovations to fill granaries and hunger-struck stomachs

Prof. M. S. Swaminathan

Foreword

It is a legal obligation for the parties to the Convention on Biological Diversity to evolve effective strategies and action plan for the conservation, enhancement and sustainable utilization of biodiversity, especially taking into consideration of benefitting such efforts to the livelihood means and services to local communities. Conservation and documentation of "high-value" wild plant diversity, particularly rare, endemic and threatened (RET) plant species, medicinal plants of ethnobotanical applications and agrobiodiversity and multiplicity of habitats and landscapes which provide are the significant areas of biodiversity action.

In addition to the CBD obligations, the national and state governments also have to work towards achieving the commitments under six other biodiversity-related conventions such as (i) CITES, (ii) CMS, (iii) the Treaty, (iv) the Ramsar Convention, (v) the Convention on World Cultural and Natural Heritage and (vi) the International Plant Protection Convention. In order to address the complete spectrum of biodiversity management, effective coordination and cooperation from all the concerned institutions and policy makers is required. Besides these conventions, the 2030 Sustainable Development Goals and the Paris Climate Action also have implications on the biodiversity management of any state.

So, it is important for any democratically elected government to formulate appropriate policies and practices that help the utilization of biodiversity and ecosystem services for developing in a sustainable and inclusive manner. The first and foremost action in this regard is to work towards achieving the Aichi Biodiversity Target Number 1, which aims to achieve the goal that "all people become aware of the values of biodiversity". Awareness level of the importance and implications of

biodiversity and ecosystem services among the public as well as policy makers and the practitioners is very important for safeguarding and protecting in optimum and in a balanced way. The power of knowledge will help these actors to go for effective lobbying, advocacy and actions in biodiversity management.

The book entitled "Bioresources and Bioprocess in Biotechnology (Volume I: Status and Strategies for Exploration)" edited by Dr. Sabu A., Dr. N.S. Pradeep and Dr. Shiburaj S. is aimed towards this direction. The book chapters are contributed by eminent researchers in the broader area of sustainable biodiversity management. The volume comprises literature on the current status of biodiversity; biodiversity education; documentation, conservation and preservation; biodiversity law; and many other important topics related to biodiversity and its sustainable utilization.

Because of the importance of the topics covered, I think this volume will have wider acceptance and open up avenues for scientists to engage in consistent dialogue with the policy makers at different levels – state, local, national and global. It can also lead to a new alliance between scientific, governmental and commercial forces and find effective ways for lobbying, advocacy and innovative actions in sustainable biodiversity management.

In my opinion, the primary audience who will benefit from this book would be the research and teaching professionals, practitioners, policy makers, farmers/fishers and farmer/fisher representatives like NGO professionals, who work in the area of sustainable agricultural and rural development. This kind of a publication will be highly useful for those planners and practitioners in the area of biodiversity for climate adaptation.

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September 29, 2016

Preface

The evolution in diversity of life on earth is capable of transforming the world. Biodiversity and biological data thereof is increasingly being analyzed and integrated to enhance and revolutionize the researches and expand the knowledge of biodiversity. Biological diversity is the variety of the world's organisms, including their genetic diversity. All life on earth is part of one great, interdependent system. It interacts with and depends on the nonliving components of the planet such as atmosphere, oceans, freshwaters, rocks, and soils. Humanity depends totally on this community of life, the biosphere of which human populations are an integral part.

Bioresources are important components for progress and economic activities of any nation. But bioresources management and utilization for human welfare are very important for the optimum utilization of the bioresources. It includes genetic resources, organisms or parts thereof, populations, or any other biotic component of ecosystems with actual or potential use or value for humanity. Application of the knowledge of biodiversity and bioresources in an economic and sustainable manner will add value to human lives. Biotechnology is a technique that can be applied to study genetic diversity in crop plants, domesticated animals, industrially important microbes, bio-waste recycling, propagation and mass multiplication of threatened genetic resources, large-scale production of therapeutically important substances, genetic transformation, cryopreservation, DNA banking, etc. It involves manipulation of genetic information of a particular bioresource and the application, production, maintenance, conservation, security, and various other aspects of components of biodiversity.

Despite some conservation success especially at local scales, and increasing public and government interest, biodiversity continues to decline and is being lost as on today more rapidly than at any time in the past several million years. The current losses to biodiversity can be attributed to direct causes including habitat loss and fragmentation, invasion of introduced species, overexploitation of living resources, and modern agriculture and forestry practices.

Sustainable management of the ecosystems and the rich life within them remains one of the key natural resource management challenges. The conservation and sustainable use of biological diversity are of critical importance for meeting the need of

food, fodder, fiber, health, water, and other needs of the growing world population for which purpose of, access to, and sharing of both genetic resources and technologies are essential. Here we are trying to document together the various aspects of biodiversity with a view to make it available for the judicious utilization by mankind.

Kerala, India

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Part I

Bioresources

Bioresources: Current Status

1

N.S. Pradeep, Shiburaj Sugathan, and Sabu Abdulhameed

Abstract

The continued existence of mankind relies upon the accessibility of bioresources and their proper management. Overexploitation of bioresources leads to many environmental problems that the humanity is facing today. Destruction of vegetation has resulted in land degradation, denudation, soil erosion, landslides, floods, drought, and distorted ecosystem processes. Conventional resource management systems are considered as balanced system and often guaranteed reasonable sharing of benefits from natural resources. But people in most parts of the world have already forgotten the real values of bioresources and its conservation. It should be determined to conserve and sustainably utilize biological diversity for the benefit of present and future generations. This chapter briefly explains the knowledge of current status of bioresources associated with its management and utilization.

Keywords

Biodiversity • Ecosystem • Sustainable life • Bioprospecting

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1.1 Introduction

Bioresources or biological resources are biodiversity goods and include all products and services originating from natural environment that fulfill the requirements of humans, occurring at a frightening state due to the consequence of increasing population pressure, agricultural land degradation, and urbanization. According to the Biological Diversity Act 2002, "bioresources means plants, animals and microorganisms or parts thereof, their genetic material and by-products (excluding value added products) with actual or potential use or value, but does not include human genetic material." The availability of bioresources and their proper management are directly depended on the continued existence of mankind. Human race has been experimented with various sources of energy ranging from wood, coal, oil, and petroleum along with nuclear power through the different stages of development. Today humanity is facing various environmental problems due to the overexploitation of bioresources by the exploding population (Tynsong et al. 2012).

Energy considered as a fundamental part of a society plays a crucial role in the development of socioeconomic status by nurturing the quality and standard of living of life. Consumption pattern of energy is directly related with economic development of a particular region. As the economy grows, the energy demands also increase, creating a change in the consumption pattern and causing conversion loss and end-use efficiency. The countless energy sources like wood, coal, oil, petroleum, and nuclear power have trailed with the different developmental stages of mankind. However, unintentional developmental activities and promiscuous exploitation of resources cause serious environmental and ecological problems and create devastating changes in bioresources also (Ramachandra et al. 2004).

Drivers that cause to create changes in bioresources are *direct drivers* (local land use; species introduction or removal; technology adaptation and use; external inputs such as fertilizer use, pest control, and irrigation; harvest and resource consumption; climate change evolution; and volcanoes) and *indirect drivers* (demographic, economic, sociopolitical, cultural and religious, science and technology). Changes in indirect drivers such as population, technology, and lifestyle directly lead to changes in direct drivers. For example, the hunting of animals or the application of fertilizers for increasing food production causes changes in biodiversity and ecosystem services that in turn affect human well-being. In the past 50 years, changes in bioresources due to human activities were more fast, and the drivers of change that thrash biodiversity and ecosystem services are still steady, showing no data of declining over time.

1.2 Biodiversity and Its Link to Bioresources

Biodiversity takes part an important role in supporting and regulating bioresources. The Millennium Ecosystem Assessment of UNEP recognizes that biodiversity and bioresources, otherwise known as ecosystem services, provide a key active and constitutive part determining human well-being. These are essential for human

well-being because biodiversity loss and deteriorating bioresources directly or indirectly cause worsening health, higher food insecurity, lower material wealth, increasing vulnerability, worsening social relations, and less liberty for choice and action. However, presently there are few studies that demonstrate the links between biodiversity and bioresources. Studies indicate that biodiversity that affects bioresources in turn changes human well-being. Advanced work that reveals the links between biodiversity and bioresources and also human well-being is vital but often difficult in illustrating the value of biodiversity.

Bioresources, at a given time, are strongly controlled by the ecological characteristics of the most abundant species, not by the number of species. The traits and its relative abundance of species determine its relative significance to ecosystem functioning. For example, the individuality of most abundant plant species such as their life, size, rate of assimilation of carbon and nutrients, mechanism of leaf decomposition, wood thickness, etc., usually drives ecosystem's processing of matter and energy. Accordingly protecting or renovating the composition of biological communities, rather than maximizing species numbers, is important to maintain bioresources. Loss of ecosystem functioning due to local extinctions by direct or indirect biodiversity alterations (species loss from a local area) can have remarkable impact on bioresources. However, local extinctions have received little attention compared with global extinctions.

Changes in biotic interactions, both direct (predation, parasitism, or facilitation) and indirect (predator preying on a dominant competitor such that the dominant is suppressed, which permits subordinate species to coexist), cause important consequences in bioresources. Exclusion or introduction of organisms in ecosystems that disrupt biotic interactions or ecosystem processes also leads to changes in bioresources. The impacts of either the removal of existing species or the inclusion of new species are difficult to anticipate because the network of interactions among species and the network of connections among bioresources are complex. Loss of individual species implicated in key interactions can also influence ecosystem processes and bioresources. For example, coral reefs, one of the most species-rich communities on earth, are directly dependent on a single key biotic interaction: symbiosis with algae. Coral reefs provided ecosystem services such as habitat construction, spawning places, and nurseries for fish, carbon and nitrogen fixing in nutrient-poor environments and nutrient cycling, and wave buffering and sediment stabilization. The disruptions of the symbiotic relation dramatically affect the climate change and variability on coral reefs.

Many rural communities used biological resources directly as an insurance and surviving mechanism. This is a biological "safety net" that has increased the security and flexibility of some local communities. The economic rights of poor are becoming dangerously threatened due to fluctuating product prices in the world. This can be overcome by the availability of an ecosystem-based food security, which provides an important insurance program. Survival of indigenous plants is most important for vulnerable people, who have little access to land, employment, or market opportunity. Maintaining agricultural biodiversity is an option for improving food security. Practices with wild relatives of domestic crops give genetic

variability that is crucial for overcoming occurrences of pests and pathogens and also the environmental stresses. Increasing local diversity is a critical factor for the long-term productivity and viability of agricultural systems. Natural disasters increase human suffering, and economic losses can be prevented by the proper management of biodiversity. Rich sources of biodiversity like mangrove forests and coral reefs are excellent natural barriers against natural disasters like floods and storms. Their loss or reduction has increased the intensity of flooding on coastal communities.

Various sub-global assessments indicated that lots of people living in rural areas showed their interest in surviving ecosystem variability and bioresources as a part of risk management strategy. They maintain a diversity of bioresources as a solution to reduce their alternatives. According to these assessments, the diversity of species, food, and landscapes serves as "savings bank" for rural communities to survive with alteration and guarantee sustainable livelihoods.

Wild sources of food that provide a somewhat balanced diet are important for the poor and landless people. About 7000 species of plants and several hundred species of animals have been used for human food consumption. Some native and traditional communities currently consume 200 or more species. Worldwide overexploitation of marine fisheries has led to a decrease in the availability of wild fish protein, causing serious human health issues in many countries. Risk of exposure to many infectious diseases may depend on the preservation of biodiversity in natural ecosystems. So many evidences are accumulating to support that greater wildlife diversity may decrease the spread of many wildlife pathogens to humans.

In developing countries wood fuel provides more than half the energy used. In rural areas 95 % of energy is consumed in the form of firewood, while in urban areas 85 % is used in the form of charcoal. Areas with high population density may suffer with shortage of wood fuel without any access to alternative and inexpensive energy sources. People in that area are exposed to illness and malnutrition due to the lack of resources to warm homes, cook food, and boil water. The continued destruction of forests and watersheds diminishes the quality and availability of water delivered for agriculture and household use. For the clean drinking water to be available, it is necessary to protect the ecosystem than construct expensive buildings and operating water filtration plant. Also the loss or damage of ecosystem components may harm social relations because spiritual and religious values of many cultures are attached with ecosystems or their components like tree, hill, river, or groves.

Biodiversity loss in turn leads to the loss of bioresources and also means a loss of choices. For example, fishermen in local areas rely on mangroves as breeding grounds for local fish populations. So the destruction of mangroves causes loss of local fish stock and it affects their income for many generations. In some occasions the loss of biodiversity is irreversible, and the value placed on biodiversity for future generations can be significant. However, placing an economic figure on future values is very much difficult.

1.3 Bioresources for Sustainable Living

Biodiversity directly offers bioresources such as plants, animals, bacteria, and fungi that are needed by individuals in order to earn income and protect sustainable livelihoods. It also supplies a source of revenue through supporting the ecosystem services. For example, apple cultivation in the Himalayan region in India provided around 60–80 % of total household income. Honeybee diversity is also rich in this region and has an important role in pollinating crops and plants, and in turn this leads to the high productivity and ecosystem sustainability. In the early 1980s, market demand for particular types of apples led farmers to uproot pollinated varieties and plant new, sterile cultivars. These steps negatively affected pollinator populations by extreme use of pesticides. The consequence was a reduction in apple productivity and also the extinction of a lot of natural pollinator species.

Biodiversity also donates to a sort of other industries, including pharmaceuticals, cosmetics, and horticulture. Market movements widely fluctuate according to the industry and the country involved, but several bioprospecting activities and subsequent generation of revenue are expected to enhance over the next decades. The present economic trends suggest that pharmaceutical bioprospecting will increase, especially as new methods use evolutionary and ecological knowledge. Biodiversity loss can impose extensive costs at local and national scales. Current indications recommend that the preservation of the uprightness of local biological communities, both in expressions of the identity and the number of species, is vital for the protection of plant and animal productivity, soil fertility, and their steadiness in facing the altering environment.

The marine microbial community offers critical detoxification services. But very little information is available on how many species are participating in detoxification services; however, these services may significantly depend on one or a few species. Ecosystem services such as water filtration, reduction of eutrophication effects, etc., are provided by some marine organisms. For example, American oysters are used in Chesapeake Bay for filtering water as part of ecosystem services and proved that Chesapeake has much clearer water. A number of marine microbes can degrade toxic hydrocarbons into carbon and water due to oil spill, but this process requires oxygen. Consequently it is threatened by nutrient pollution, which produces oxygen scarcity.

Conservation of biodiversity is important as a supply of meticulous bioresources, for maintaining diverse ecosystem services, for sustaining the flexibility of ecosystems, and also for providing alternatives for next generations. The benefits that are provided by biodiversity to mankind have not been a sign of resource management; hence, the current rate of loss of biodiversity is higher.

The connection between biodiversity and bioresources depends on composition, comparative abundance, functional diversity, and taxonomic diversity. If various dimensions of biodiversity are driven to very low levels, particularly trophic or functional diversity within an ecosystem, both the level and stability of supportive services may decrease.

1.4 Value of Bioresources

Bioresources are represented as "natural capital assets" of a country. But the benefits that are attained from bioresources through better management are poorly discovered. Bioresources have great economic importance; habitually most of their values are not captured by the market. Therefore, the potential of bioresources are never estimated properly. Actually this misjudging is considered as an important factor because of rapid exhaustion of biodiversity and loss of territories and species. Reduction of these "natural capital assets" significantly declines the national wealth of countries with economies that are especially dependent on natural resources. The richness resulting from these ecosystem "surprises" can be extremely high. The majority of our biodiversity is on common land so its property rights are not obviously defined. Consequently, at the collection point, the bioresources derived from biodiversity do not expose its real "value."

Bioresources guarantee provision of energy to the poor and weaker groups. Bioresource utilization is still growing because in many areas, there is no practical alternative to biomass fuels for the poorest regions of the population. Dependence on biomass for energy is responsible for the unending deforestation and loss of vegetation. The production of biomass in all its forms for fuel, food, and fodder demands cautious planning of bioresources for ensuring environmentally sustainable land use (Ramachandran 2007). The costs and risks associated with biodiversity loss are expected to increase and it strangely affected the poor. The marginal value of biodiversity increases as the biodiversity and bioresources decrease. In rural areas, dependence on bioresource to meet the daily requirement is more than 85 %, due to the prevailing use of fuel wood for cooking, while about 35 % demand is in urban areas. The urban populations basically depend on commercial energy sources than the rural; they are primarily dependent on noncommercial energy sources such as fuel wood, cow dung, etc. High persisting use of biomass in rural areas also increases the dependence on fuel wood. The use of fuel wood in cooking has been indicated in rural systems increasing from 56 % in 1989/1990 to around 62 % in 1994/1995 (TERI 2001–2002). Different phases of bioresource reduction have an uneven impact on poor people. For example, the decline in fish populations mainly affects the communities that depend on fish as an important food. Likewise, the poor and vulnerable population suffers utmost due to the spoiling of dry land resources.

Now so many tools exist for computing the values of bioresources, despite only stipulating ones are regularly valued. Some are very hard to value, due to the lack of knowledge regarding the full costs, risks, and benefits. In general economists are looking forward to recognize the various explanations why bioresources are valuable to people. It supports the fact that bioresources directly or indirectly support people's own consumption. Various valuation methods are now available to estimate these different sources.

Many bioresources do not have markets or readily noticeable prices though lack of a price does not mean lack of value. A substantial body of research on nonmarket valuation is now available for some ecosystem services like clean drinking water,

recreation, or commercially harvested species. The existence value of species and other "nonuse" values cause a greater challenge for measuring the complete value of conserving biodiversity and natural processes because ecosystems are dynamic and complex and also during the course of time the human preference may change which creates difficulties for trying to value the natural systems. It is clear in theory that getting realistic estimates of alternative value is difficult in practice. Better quantification of the benefits derived from ecosystems would provide greater movement for biodiversity protection and create a clearer picture of the equitability of the distribution of benefits.

The value related with private use of bioresource by individuals will typically ignore the "external" payback of conservation. For example, a farmer may benefit from rigorous use of the land but usually does not bear all the consequences caused by leaching of excess nutrients and pesticides into ground or surface water or the consequences of loss of habitat for native species.

The indirect value of bioresource conservation can be highly significant in contrast with the direct economic values derived from a particular area. The economic studies of changes to bioresources in specific locations such as mangrove forests, coral reefs, etc., and the costs of bioresource conversion are often found to be significant and sometimes exceed the benefits of the habitat conversion. The exhaustion and degradation of many bioresources represent the loss of a capital asset that is defectively reflected in conventional indicators of economic growth as well as growth in human well-being. These natural capital assets significantly change the balance sheet for economically developed countries which largely dependent on natural resources. Factors like edaphic, meteorological, geographic, agro-climatic conditions, socioeconomic status of the people, etc., are highly influencing the availability and accessibility of diversified bioresources.

1.5 Current Status of Bioresources

Freshwater Global freshwater utilization was estimated to expand 10% from 2000 to 2010; these rates reveal population growth, economic development, and changes in water use efficiency. Global water withdrawal is about 3600 cubic kilometers per year or 25% of the continental overflow to which the majority of the population has access during the year. If uses for navigation, waste processing, and habitat management are considered, humans use and regulate over 40% of renewable available supplies. Differential development pressures due to regional variations and efficiency changes during 1960–2000 increased water use of 15–32 % per decade. Areas for the largest amounts of renewable freshwater supply are forest and mountain ecosystems, having 57% and 28% of total runoff, respectively. These ecosystems offer renewable water supplies to two thirds of the global population. Sixteen percent and 0.2% of global runoff water is generated by cultivated and urban ecosystems, respectively, but it is associated with nutrient and industrial water pollutants because of its closeness to human settlements. From 5% to possibly 25% of global freshwater use exceeds long-term reachable supply. Much of this water is

used for irrigation with severe losses in water-scarce regions. The water requirements for aquatic ecosystems and crop protection result in competition for the water resources. A number of the key consequences of this competition include transport of sediments, modification of habitat, chemical pollutants, and disruption of migration routes of aquatic biota. The struggle for freshwater in some areas in the world to completely expand the coastal zone results in oxygen depletion, coastal erosion, and harmful algal blooms.

The supply of freshwater can reduce severe pollutions due to anthropogenic activities in many parts of the world. More than the past half century, there has been a faster discharge of artificial chemicals into the environment. Inorganic nitrogen pollution of inland waterways, for example, has increased substantially. It is twofold in the preindustrial state and increases of more than tenfold occur in industrialized regions of the world. Most anthropogenic chemical substances are long-lived and changed into by-products whose characteristics are yet unknown. As a result of pollution, the capacity of the ecosystem to provide clean and consistent sources of freshwater is spoiled. Large numbers of dam building have created both positive and negative effects. Positive effects include stream stabilization for irrigation, control of flood, drinking water, and hydroelectricity. Negative effects include fragmentation and destruction of habitat, loss of species, stagnant water-related health issues, and loss of sediments and nutrients that support coastal ecosystems and fisheries.

Water shortage is a globally significant condition for 1–2 billion people worldwide, primarily causing problems in food production, human health, and economic development. The global increase in water insufficiency from 1960 to present measures to nearly 20 % per decade, with individual continents having values of 15 % to more than 30 % per decade. Unequal level of economic growth, education, and governance results in differences in managing the capacity for water scarcity. Diseases from inadequate water, sanitation, and hygiene cause a total of 1.7 million deaths and the loss of 50 million healthy lives annually. At present 1.1 billion people suffer from lack of safe drinking water and 2.6 billion lack basic sanitation. Human health and economic productivity can be improved by making some investments in drinking water supply and sanitation. Every day each person needs 20 to 50 liters of pure water for drinking and personal hygiene to survive. But the present state of freshwater resources is insufficiently monitored. New techniques are available for evaluation of impurities, but its universal application is lacking, and there are no regular epidemiological studies to recognize their impact on human well-being. The Convention on Biological Diversity has established ecosystem-based approaches; the Convention on Wetlands, the Food and Agriculture Organization, and others could significantly develop future condition of water-provisioning services for balancing economic development.

Food Over the past 42 years, global food production has increased by 168. The cereal production has increased by about 130%, but now it is growing more slowly. However, an estimated 852 million people were undernourished in 2000–2002; it was 37 million from the period 1997–1999, and of this around 96% live in developing countries. In most areas of the world, rising incomes, urbanization, and changing

utilization patterns have increased per capita food consumption. Important drivers of food provision are food preferences which arise from cultural differences. As incomes increase, demands for high-value products such as livestock and fish also increased, but cereals remain as the major single component of global diets and to occupy the most areas of cultivated land. A diet with sufficient protein, fats, micronutrients, and other dietary factors is very important for well-being. Normal daily calorie intake has declined recently in the poorest countries. The world's poorest depend on starchy foods for energy, which leads to considerable protein, vitamin, and mineral deficiencies. Another health problem is overconsumption. Consumption of fruits and vegetables improves nutritional status and children's growth rates.

At present many countries face epidemic of diet-related obesity and noncommunicable disease, mainly among urbanized people where they have adopted diets with higher energy than traditional diets with diverse fruits and vegetables. Some other people suffer from diseases due to contaminated food. The risk of foodborne illnesses is increasing when the people eat more perishable foods such as meat, milk, fish, and eggs. Health threats from food differ by climate, income, diet, and public infrastructure. Improperly prepared or inadequately refrigerated animal foods cause health hazards. Microbial contamination is of particular concern in developing countries. Other health concerns related with food production are diseases transmitted from animals to humans, animal wastes with toxins, overuse of antibiotics in livestock production, etc. Poor people have less capacity to purchase food by spending money, so they completely depend on local food production for eliminating hunger and also promoting rural development. Food-insecure people in developing regions are increasing due to underdeveloped market infrastructures. In these areas, local food production has the main advantage for eradicating hunger and providing insurance against increasing food prices.

Maintaining a focus on increasing food production systems will be a main concern for both global food security and environmental sustainability. Government policies are also significant drivers of food production and consumption models. Many investments in rural roads, irrigation, and agricultural research serve to encourage food production. The increasing demand for livestock products is increasingly being met by industrial production systems, especially for chicken and swine mainly in Asia. This has contributed large increases in production. However, it creates serious waste problems and also high pressure on cultivated systems which provide feed inputs, which in turn cause demand for water and nitrogen fertilizer. Annual fish consumption is increasing, but total fish production has declined to some extent in industrial countries. Global fishing has been decreased since the late 1980s due to overexploitation. In 2002 the volume of fish consumption was 27 % of all fish harvested and 40 % of the total amount of fish products consumed as food.

Along with fish, wild plants and animals are also chief sources of nutrition in some diets, and some wild foods also have significant economic value. However, the importance of wild food is improperly understood and is excluded from economic analysis of natural resource systems as well as official statistics. Plants and animals are under pressure on unsustainable levels of harvesting, and there is a need for

conservation of wild food resources to satisfy the nutritional needs of people who do not have access to agricultural land or resources.

Timber, Fiber, and Fuel Last four decades, global timber harvest has increased by 60%. The growth rate has slowed in recent years and is expected to grow more slowly in the near future. The term "timber" is used for denoting trees and their direct products. Pulp production from harvested wood was increased threefold since 1961. Timber provides common industrial wood products, but there will be scarcities of high-value species and best quality woods due to past overharvesting. In the future timber production from forest and agricultural areas will increase. Top quality woods from large and old trees of extremely valuable species are limited in most regions. They can be renovated through protection and sustainable forest management. In 2000, 5% of the global forest was covered by plantations, but they provided 35% of harvested round wood. It is predictable to increase 44% by 2020. Major changes in timber production resulted from a combination of economic stress, globalization, and changing national policies. The main issues associated with forest goods are the thinning and mining of plantations (Karnataka Forest Department Report 2001). International business in forest goods has increased much faster than the increase in production. Between 1961 and 2000, global exports of timbers were increased approximately 25-fold. International moves toward forest certification and sustainable forest management have prolonged rapidly in recent years. To date they have been used in industrially developed countries and developing countries. The global forestry sector annually offers survival and employment of 60 million people with 80 % residing in the developing world. Forest land in the industrial world is owned and managed privately or publicly. Most of the forest in the developing world is a public resource. These ownership factors create very different and diverse opportunities for people to interact with and benefit from forest products and services. Labor necessities per unit of production will continue to shrink in all regions due to technological change. Up to 15 % of global timber trade involves illegal activities, and this problem will require a major effort by both government and private industries. Fifty-five percent of global wood utilization is for fuel wood, and it is the primary source of energy for heating and cooking to 2.6 billion people. Global utilization of fuel wood emerged to have peaked in the 1990s and it is now supposed to be slowly declining. More precise data on fuel wood manufacture and utilization are hard to collect. The burning of fuel wood without suitable smoke venting generates significant health risks, and due to the shortage of woods, poor families may use dung or agricultural residues for heating and cooking. The consumption of cooked food may decline when adequate fuel is not available leading to unfavorable effects on nutrition and health. Through application of a variety of modern industrial processes, wood and forest biomass, manure, agricultural crops and residues, municipal and industrial wastes, and various other nonfossil organic resources can generate renewable energy and fuel. These technologies are being rapidly developed throughout the world. Biomass-based energy production, expected to expand slowly in the future, begins to affect energy economics because of shortages and supply disruptions.

Since 1961, global cotton production has doubled and silk production has tripled, and production of other agricultural fibers such as wool, flax, hemp, jute, and sisal has declined. Many species of wild mammals, reptiles, birds, and fishes are becoming endangered because they are frequently poached for their skins, furs, wools, and hairs that are traded in the international market to make products ranging from clothing and accessories such as footwear, shawls, and wallets to ornaments and furnishings.

Bioprospecting

Bioprospecting is the term used for the exploration of biodiversity for new biological resources of social and economic value, mainly carried out by industries that comprise pharmaceuticals, crop protection, botanical medicines, cosmetics, agricultural seeds, horticulture, environmental monitoring, and construction. Earth covers around 5 million to 30 million species, containing thousands of genes. But only less than 2 million species have been illustrated and the knowledge on the global distribution of species is limited. Less than 1% of species have provided the fundamental resources for the improvement of all civilizations. It is expected that the application of advanced technologies to the exploration of the unidentified species will yield more benefits for humanity. The fundamental resource for bioprospecting is biodiversity. A wide variety of microbial, plant, and animal species and their genes are sources of industrial products. Species-rich environments may be anticipated to supply many valuable products for long term. In order to provide more opportunities for bioprospecting in the future, conservation of biodiversity is necessary.

Well-planned bioprospecting contributes to ecosystem conservation and socioeconomic development. Bioprospecting can achieve various goals like building technological and scientific capacity to manage and study biodiversity; producing revenues for protected areas, conservation projects, and local communities; increasing knowledge of the commercial and noncommercial significance of biodiversity; enhancing biodiversity science; and creating business-dependent sustainable management of resources and profit generation for corporations and shareholders. New industries like bioremediation and biomimetics are well established and increase, while others have a less assured future. The current economic environment proposes that pharmaceutical bioprospecting is about to increase. By carefully implementing bioprospecting, biodiversity can be utilized properly for the sustainable management of natural resources, economic development, and poverty alleviation. Established biodiversity-based industries like farming, forestry, grazing, and fisheries, with its use such as food, medicines, and fiber production, can generate biodiversity knowledge.

Opportunities for bioprospecting industries in a country will depend on many aspects such as conservation status of its biodiversity and the trends in a diversity of markets. Threats like species losses can affect the improvement of new valuable products for humanity, such as medicines, new crop varieties, and industrial processes. Depletion of global biodiversity may change bioprospecting in many ways. Other threats include loss of traditional knowledge, the impact of modern

agricultural technologies, and depletion of natural resources. Several international and national laws and regulation measures like ethics, high-quality contracts, and institutional policies have supported bioprospecting partnerships. The Convention on Biological Diversity (1992) and International Treaty on Plant Genetic Resources for Food and Agriculture (2001) are the two recent international agreements. Around 100 countries have introduced laws and policies for regulating biological resources and benefit-sharing. Further, some indigenous communities, researchers, and bioprospecting companies have developed documents containing ethical and legal framework for easy operation of bioprospecting.

Marine Fisheries All oceans are affected by humans with overfishing having direct impact on food provisioning services, which will affect future generations. Beyond the 50 meters of ocean depths are affected by fishing and pollution. Recent studies indicated that global fish catching peaked in the late 1980s and is now decreasing in spite of increasing fishing effort. Industrial fishing vessels are with greater efficiency in offshore and also in deeper waters to meet up the global demand for fish. Deep ocean fauna is also affected by fishing. Recent huge investments in fishing and advanced navigation aids cover almost whole regions of ocean, including polar, deep, and low-productivity areas. These catches easily deplete populations of long-lived species.

Overfishing causes negative impacts on marine biodiversity. Local extinctions of large, long-lived, slow-growing species resulted from the fragmented habitats and lowered biomasses due to unrestricted fishing. In addition, harsh fishing practices have long-term impacts on marine habitats. Trawling, dynamiting, and dredging are some of the destructive fishing practices that can change the structure of marine ecosystems with significant changes in their ability to provide services, such as food and income generation. Continuing losses in species and habitats due to destructive fishing eventually reduce the biodiversity of marine habitats. But in this case, some systems may recover the availability of some services and products somewhat quickly; more vulnerable structures, like cold-water corals and seamounts, may take hundreds of years to recover. The implementation of no-take marine assets combined with other intrusions, such as controls on fishing, would be more practical to fisheries management. Marine reserves can supply better fisheries management by rebuilding stocks through maintaining biodiversity, enhancing recruitment and spillover effects, buffering marine systems due to human disturbances, and maintaining the ecosystems.

Aquaculture is not a key to the crisis of dilapidated wild-capture fisheries. More successful approaches are good control and efficient management of wild fish capturing. One of the major problems related with aquaculture industry is the use of fishmeal and oil derived from wild-caught small pelagic fishes such as salmon and tuna. In countries like Chile, people are now largely using small pelagic fishes as a source of cheap protein for fishmeal. So the contribution of wild marine fish as an inexpensive source of protein for several countries is declining. In developing countries like China, per capita fish consumption has decreased from 9.4 kilograms per person in 1985 to 9.2 kilograms in 1997, and the current trend is also not at all

hopeful. But in some areas, fish consumer prices have increased faster than the cost of living. All fish products are highly commercial and approximately 50% of fish exports are from developing countries.

Predictable uses of marine systems are farming of marine organisms, bioprospecting, oceanic mining, and carbon sequestration. However, the probable impacts of these activities are not well understood. In some cases, to test the theoretical basis for the activity, only restricted field studies have been accomplished. Policies will need to contract with the insecurity of probable impacts and the limited understanding of marine biodiversity. National and regional ocean policies having an integrated ecosystem management structure are likely to be implemented. Restoration of marine species and habitats might include such policies and thus form part of a preventive strategy for protecting against management errors.

Coastal Systems Coastal ecosystems or coastal lands are near-shore marine areas where freshwater and saltwater mix together. These are the most productive but highly threatened ecosystems. These ecosystems produce more bioresources than most other systems. On the other hand, these undergo some rapid environmental change. Globally there was loss or conversion of approximately 35% of mangrove area, and in the last few decades, approximately 20% of coral reefs have been destroyed and an annual loss of 20% coastal wetland also has been reported. Nearly 40% of the human populations in the world live within the 100 kilometers of the coast. Demographic trends imply that coastal populations are increasing rapidly through increased fertility, migration, and tourist visitation to these areas. Coastal population densities are nearly three times more than that of inland areas. Coastal communities and industries increasingly utilize fisheries, timber, fuel wood, construction materials, oil, natural gas, sand and strategic minerals, and genetic resources. Most of the ecosystem services are provided by coastal communities aggregating near the coastal systems. Around 71% of coastal population, living within 50 kilometers of estuaries, provides protein to a large percentage of the human coastal populations. However, many of these habitats are unprotected or slightly protected; as a result, bioresources in these areas are at high risk.

In all regions coastal fisheries have limited stocks of finfish, crustaceans, and mollusks. Illegal and destructive fisheries result in overexploitation and habitat damage. In response to declining capture of fisheries, demands for coastal aquaculture have been high. But in the last 10 years, the increase in aquaculture production has also caused habitat loss, pollution, and overexploitation of fisheries for fishmeal and fish oil. Overexploitation of other resources like mangroves for fuel wood, seaweeds for consumption, sand for construction material, etc., also destabilizes the ecological functioning of coastal systems. Development-related loss of habitats and services are the greatest threat to coastal systems. Humans are facing increasing coastal erosion and flooding, declining water quality, and increasing health risks as a result of coastal degradation and alteration. Urbanization, port development, aquaculture, resort development, and industrialization are regularly involved in the destruction of coastal forests, coral reefs, wetlands, etc. Worldwide sediment flows in rivers increased by about 20% as a result of enhanced human activities, but