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FORESTRY FOR SUSTAINABLE MANAGEMENT

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Abstract: Sustainable management of natural resources has become a key issue for survival of life. The most appropriate method to do that would be to assess the ecological sustainability by way of understanding the ecosystems/ landscape complexities and their uniqueness. Traditionally monitoring of populations or habitats involved field based observations, an approach that is time consuming and also requires specialist's involvement. Remote sensing and GIS technology can be used as an effective tool in resource assessment.

Keywords: Biodiversity Monitoring, Ecosystem Evaluation, Forest Governance, Habitat Management, Remote Sensing and GIS Technology, Sustainable Forest Management.

1. Introduction

Forests in India has categorized into three major groups as: (1) Reserved Forests (an area notified under the provisions of Indian Forest Act or State Forest Acts having full degree of protection). In reserved forests all activities are prohibited unless permitted. (2) Protected Forests (an area notified under the provisions of

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Indian Forest Act or State Forest Acts having limited degree of protection). In protected forests all activities are prohibited unless permitted. (3) Unclassified Forests (an area recorded as forest but not included in reserved or protected forests category). Ownership status of such forests varies from state to state. The National Forest Policy, 1988 lays out clear directions and guidelines for forest conservation and afforestation. The pressure on India's forests continues to be very high with more than 200 million people being dependent on forests for livelihood. The rapid growth of the Indian economy puts additional demand on forests for infrastructure and industrial development. In this context, scientific monitoring of the country's forest and tree cover is an important national priority.

Sustainable management of natural resources has become a key issue for survival of life on planet Earth. In this effort, conservation of biodiversity has been put to the highest priority through Global Biodiversity Conservation (GBC). It is realized that the threats to the species/ecosystems are the greatest in recent times mainly due to unsustainable exploitation of biological resources. However, natural hazards also contribute to the loss of biodiversity and there is an urgent need to conserve gene pool *in situ* before it is lost forever. The most appropriate method to do that would be to assess the ecological sustainability by way of understanding the ecosystems/ landscape complexities and their uniqueness. There could be several factors either acting singly or in combination, for the extinction of a species. For generating baseline data on plant species, habitats, ecosystems, and for subsequent monitoring, reliable and well-documented information is a prerequisite. This would help in identification of 'hot spots'. It is interesting to note that majority of 'hot spots' are confined to most species rich tropical habitats.

India with a geographical area of 2.4% of the world has about 8% of the world's total biodiversity with an estimated 50,000 plant species, of which about 15,000 are flowering plants. Of these, approximately 5000 species are endemic to India and distributed over 141 genera under more than 47 families. The

endemism of Indian flora is very high, about 31.5% of which, nearly one third of the flowering plants, are represented as endemic species. In the light of the current problem of loss of biodiversity, it is necessary to identify priority areas for conservation of genetic resources. Successful action to conserve biodiversity must address full range of causes, of its current loss and focus its attention to embrace gene, species and ecosystem through integrated approach. The basic approach in the biodiversity evaluation is the conventional biodiversity evaluation procedure from species level to the biome level. Accordingly, a group of subject experts, like taxonomists, are essential for the studies. Again, the time, money and efforts of these groups of experts, for the identification and evaluation of the species status, are enormous. This approach of biodiversity characterization is now changing, by the advancement of scientific and technical development, like Geographic Information System (GIS) and Remote Sensing (RS).

Tropical rainforests are unique in the high levels of biodiversity they exhibit. Around 40% to 75% of all biotic species are indigenous to the rainforests. Rainforests are home to half of all the living animal and plant species on the planet. Two-thirds of all flowering plants can be found in rainforests. A single hectare of rainforest may contain 42,000 different species of insects, up to 807 trees of 313 species and 1,500 species of higher plants. Tropical rainforests have been called the 'jewels of the Earth' and the 'world's largest pharmacy,' because over one quarter of natural medicines have been discovered within them. The natural terrestrial ecosystems like forests, grasslands, scrub lands, fresh water and ocean systems, microbial ecosystems, managed vegetation systems – agriculture and plantations provide immense potential in terms of bio-resources. India has a forest cover of 67.8 million ha, covering 20.64% of the total geographic area. Forests are widely distributed across the country, across different bioclimatic and topographic zones. Indian forests offer valuable ecosystem services as carbon sinks, soil erosion control, mitigation and various goods. Its rich floral diversity is represented by 47000 plant species.

The negative impact of biodiversity due to land cover change is a major concern of conservationist. The land cover change is often accelerated by anthropogenic influence. The demographic explosion and the ever changing needs of inhabitants, leads to the land cover change. There is a clear need to monitor these bio-resource and land-form changes, since such information could be a major contribution in biodiversity monitoring. Monitoring biodiversity is an essential component of conservation because it allows problems to be identified, priorities to be set, solutions to be developed and resources to be targeted. Traditionally monitoring of populations or habitats involved field based observations, an approach that is time consuming and also requires specialist's involvement. It is a fact that the overwhelming majority of species and ecosystem receive no systematic monitoring. The need to improve vegetation monitoring is widely recognized.[1] Targeting species and sites of highest conservation value or priority would result in the highest biodiversity conservation priorities being monitored, whereas wider countryside monitoring would monitor potential habitat for threatened assemblages.[2] The forest management strategies are to be revised on conservation point of view and a holistic approach is essential for sustainable forest management. For creating better management options we should consider a number of ecological and environmental aspects as follows.

[1]B. Husch, T. W. Beers, and J. A. Kershaw, *Forest Mensuration*, New Jersey: John Wiley, 2003; P. S. Ashton, T. J. Givnish, and S. Appanah, "Staggered Flowering in the Dipterocarpaceae: New Insights into Floral Induction and the Evolution of Mass," *American Naturalist*, 132 (1), 1988.

[2]J. K. Sharma, K. K. N. Nair, G. Mathew, K. K. Ramachandran, E. A. Jayson, K. Mohandas, U. N. Nandakumar and P. V. Nair, 2002. "Studies on the Biodiversity of New Amarambalam Reserved Forests of Nilgiri Biosphere Reserve," *Research Report No. 247*, Peechi: Kerala Forest Research Institute, 2001, 233.

2. Tropical Deforestation and Its Impact on Biodiversity

Tropical rainforests are among the most threatened ecosystems globally due to large-scale fragmentation by human activity. Habitat fragmentations caused by geological processes such as volcanism and climate change occurred in the past have been identified as important drivers of speciation. However, fast human driven habitat destruction is suspected to be one of the major causes of species extinction. Tropical rain forests have been subjected to heavy logging and agricultural clearance throughout the 20th century, and the area covered by rainforests around the world is rapidly shrinking. Forest cover protects and stabilizes soil and local climates as well as soil hydrology and efficiency of nutrient cycle between soil and vegetation. Virgin forests, especially those in the tropics are an irreplaceable repository of the genetic heritage of the world's flora and fauna. World-wide about 2.8 million ha (69% of the forest areas) area is covered with closed forest, and 1.3 billion ha area with less dense wooded forests. Natural shrub lands and degraded forests in developing countries cover 675 million hectares. On a global basis, the world's forests are disappearing at a rate of 15 million hectares each year, with most of the losses occurring in the humid parts of Asia, Africa and Latin America. African countries accounts for 62% of the deforestation of the world's open tropical forests and woodlands. The over exploitation and mismanagement of forest resources have resulted in the decline of wilderness areas and biodiversity. Interspersions of human habitation have resulted in shrinkage and depletion of habitats, leaving many species on the way of extinction.[3] According to estimates,[4] 5-10% of the tropical forest species would face

[3]P. S. Roy and Shirish A. Ravan, "Habitat Management for Biodiversity Maintenance Using Aerospace Remote Sensing," *Tropical Ecosystems: A Synthesis of Tropical Ecology and Conservation*, eds. M. Balakrishnan, R. Borgstrom and S. W. Bie, New Delhi: Oxford & IBH Publishing, 1994, 309-346.

[4]"Forest Resources in the Tropical Areas," Rome: Food and Agriculture Organization of the United Nations, 1992. The document, "Forest Resources Assessment 1990: Tropical Countries" (FRA90), has

extinction in the next 30 years. Tropical rainforests are very wet places, receiving heavy rainfall either seasonally or throughout the year. They are close to the equator and get lots of sunlight and warmth. Temperatures are uniformly high, between 20 and 35°C. They usually receive more than 200 cm rainfall per year.

3. Measuring Biodiversity

An objective measure of biodiversity is a difficult preposition. However, relative measure is possible with respect to some particular purpose. For conservationists, the measure of biodiversity should quantify a 'value' shared broadly among the people for whom they are acting. One such value is to ensure continued possibility for adaptation and use by people of changing world. Arguments for measuring biodiversity value as character 'richness' do at least provide a reasonable starting point. The habitat surrogates including classification of vegetation, details of physical environment, factors determining the biodiversity loss in a spatial context may be of practical information value and could reduce sampling intensity. This information base could also guide detailed sampling on the ground. These large-scale habitat surrogates include entire functions' system and are more likely to promote population viability in the ecosystem.

4. The Ecosystem Approach

The Ecosystem Approach has been prominent on the agenda of the Convention on Biological Diversity (CBD) since 1995. The

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recently been finalized and published as FAO Forestry Paper No. 112 (FAO 1993). The document will be complemented by a study on Forest Resources of Temperate Zone Developing Countries, and by a Global Synthesis covering the forest resources of the world, which both will be published by FAO in 1994. The latter document will incorporate also data from the two-volume report on the state and trends in temperate zone developed countries, "The Forest Resources of the Temperate Zones," recently published by the Joint Division of the Economic Commission for Europe and FAO (ECE/FAO 1992), and will thus aim at producing a truly global picture of forests and forestry in the world at the end of 1990.

CBD definition of the Ecosystem Approach and a set of principles for its application were developed at an expert meeting in Malawi in 1995, known as the Malawi Principles. The definition, 12 principles and 5 points of 'operational guidance' were adopted by the fifth Conference of Parties (COP5) in 2000. The CBD definition is as follows:

> The ecosystem approach is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. Application of the ecosystem approach will help to reach a balance of the three objectives of the Convention. An ecosystem approach is based on the application of appropriate scientific methodologies focused on levels of biological organization, which encompasses the essential structures, processes, functions and interactions among organisms and their environment. It recognizes that humans, with their cultural diversity, are an integral component of many ecosystems.[5]

The ecosystem approach is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. Application of the ecosystem approach will help to reach a balance of the three objectives of the Convention. It is based on the application of appropriate scientific methodologies focused on levels of biological organization which encompass the essential processes, functions and interactions among organisms and their environment. It recognizes that humans, with their cultural diversity, are an integral component of ecosystems. According to the ecosystem approach, forest ecosystems should be managed for their intrinsic values and for the tangible benefits they provide to human beings, in a fair and equitable way. Forest ecosystem managers should consider the effects, actual or potential, of their activities on forest ecosystems, to avoid unknown or unpredictable effects on their functioning

[5]"Ecosystem Approach" <www.cbd.int/ecosystem> (3 September, 2014).

and, therefore, on their values. Forest ecosystems should also be understood and managed in an economic context. In addition, market distortions that adversely affect forest biological diversity should be reduced and incentives that promote forest biodiversity and sustainable should be aligned.

Finally, the ecosystem approach stresses that forest ecosystems should be managed within the limits of their functioning. Therefore, the conservation of their structure and functioning should be a priority target. This is a prerequisite for keeping their full values, including the goods and services that forests deliver to human beings.

5. Independent Certification

With third-party forest certification, an independent organization develops standards of good forest management and independent auditors issue certificates to forest operations that comply with those standards. Forest certification verifies that forests are well-managed – as defined by a particular standard – and chain-of-custody certification tracks wood and paper products from the certified forest through processing to the point of sale. There are many potential users of certification, including: forest managers, scientists, policy makers, investors, environmental advocates, business consumers of wood and paper, and individuals. Third-party forest certification is an important tool for those seeking to ensure that the paper and wood products they purchase and use come from forests that are well-managed and legally harvested. Incorporating third-party certification into forest product procurement practices can be a centrepiece for comprehensive wood and paper policies that include factors such as the protection of sensitive forest values, thoughtful material selection and efficient use of products. This rise of certification, however, led to the emergence of several different systems throughout the world. As a result, there is no single accepted forest management standard worldwide, and each system takes a somewhat different approach in defining standards for sustainable forest governance.

6. Forest Governance

Although a majority of forests continue to be owned formally by government, the effectiveness of forest governance is increasingly independent of formal ownership. In the developing countries, the role of the state has diminished and the market forces have increasingly taken over the dominant socio-economic role. The market forces are not only inappropriate for sustaining the environment, but are in fact a major cause of environmental destruction. The people cannot be left to do as they wish with land or environmental resources. Thus, decentralization of management offers an alternative solution to forest governance. The shifting of natural resource management responsibilities from central to state and local governments, where this is occurring, is usually a part of broader decentralization process. There are four distinct decentralization options: these are: (i) Privatization – the transfer of authority from the central government to non-governmental sectors otherwise known as market-based service provision, (ii) Delegation – centrally nominated local authority, (iii) Devolution – transfer of power to locally acceptable authority and (iv) Deconcentration – the redistribution of authority from the central government to field delegations of the central government. The major key to effective decentralization is increased broad-based participation in local-public decision making. In 2000, the World Bank report reveals that local government knows the needs and desires of their constituents better than the national government, and it is easier to hold local leaders accountable. Many reasons point to the advocacy of decentralization of forest. (i) Integrated rural development projects often fail because they are top-down project that did not take local people's needs and desire into account. (ii) National government sometimes has legal authority over vast forest area that they cannot control; thus, many protected areas result in increased biodiversity loss and greater social conflict. Within the sphere of forest management, as state earlier, the most effective option of decentralization is 'devolution' – the transfer of power to locally accountable authority.

It is necessary to recognize and advocate for better forest governance more strongly, given the importance of forest in meeting basic human needs in the future and maintaining ecosystem and biodiversity as well as addressing climate change mitigation and adaptation goal. To manage forest ecosystems in a sustainable way implies knowledge of their main functions, and the effects of human practices. In recent years, scientific literature has shown an increasing attempt to understand integrated and long-term effects of current practices of forest management on sustainable development. But often, environmental or socio-economic effects are considered in isolation, or there is no sufficient understanding of the potential long-term impacts of current practices on sustainable development.

7. Payment for Environmental Services

Payment for Environmental Services (PES) schemes for forest services (recognizing carbon value) may be foreseen as part of forest management implementation, providing new incentives for changing into more sustainable decision patterns. Experience, however, is still fairly limited and is concentrated in a few countries, notably in Latin America, and has had mixed results to date. Important environmental, social, and economic ancillary benefits can be gained by considering forestry mitigation options as an element of the broad land management plans, pursuing sustainable development paths, involving local people and stakeholders and developing adequate policy frameworks.

8. Habitat Management in Tropics: Challenges

Most tropical ecosystems are rich in species, though most species occur only at a very low density, and hence the area needed to conserve viable population is large. The tropical habitat experience more severe climatic variations. Rainfall in the tropics is much heavier while the tropical sun makes conditions hotter and drier. These factors make tropical soils highly prone to erosion and vegetation susceptible to the wildfire. Ecosystems are often very susceptible to degradation due to fire, overgrazing

and cultivation. The ecological amplitude of the tropical species to withstand adverse conditions is always low; hence, even the minor perturbations in the habitat factors are highly lethal to the species. This makes it difficult for original vegetation to return. The tropical forest lands are experiencing direct and indirect pressure due to accelerated growth of human population coupled with increasing per capita demand for goods and services from these lands and resources. There far less understanding of tropical ecosystems as compared to temperate ones as we do not even have the basic resource inventory for most of the region.

9. Habitat Analysis

The characteristic of habitat is of prime importance in biodiversity management. The quality of habitat is generally reflected in the status of vegetation cover. The vegetation cover is governed by the complex phenomenon of interaction of physical environment. The vegetation community formation is mainly governed by factors like i) Flora, ii) Accessibility factor, iii) Ecological efficiency of species, iv) Habitat and v) Time. Of these habitat plays a key role in biodiversity. From biodiversity point of view, the site characteristics are largely controlled by presence of life forms, physical and climatological factors; they also affect the species (floral and faunal) diversity and their abundance.

10. Remote Sensing Technology for Habitat Management

Remote sensing technology has become indispensable for natural resource management. To have a good knowledge of habitats and ecosystem implies information about their potential extension, composition and evolution, including notably their rate of transformations. The terrestrial vegetation systems like forests, grasslands, scrubs and agriculture provide unique reflectance properties of electromagnetic radiation received. In view of the very large extent of heterogeneity of the country, the satellite remote sensing technology can help in deriving synoptic and periodic information on Bio-resources from forests. Remote sensing and Geographic Information System (GIS) can also help

in establishing a monitoring system to update the data required for biodiversity conservation on continuous basis. In remote sensing, maps are created from numerical data collected by satellite that measure the amount of reflected energy from different land features. These data are translated into information based on ground data and theme. The data then can be analyzed in GIS domain in combination with other data acquired physical parameters and other related inputs for creating information base for land use and habitat modifications. Aerial remote sensing data can also be integrated suitably with satellite techniques to obtain more detailed information of the identified 'hot spots'. Thus remote sensing gives a horizontal view and helps in delineating different landscape elements and their spatial characteristics.

11. Measuring of Landscape Composition for Forest Management

Landscape composition can be measured in ways analogous to measurements of species composition.[6] The landscape richness measurement approach (the number of different patch types in a landscape) is the widely used method. Yet another approach includes the relative abundance or dominance of different patch types along with richness. Measurements of landscape diversity are analogous to common measurement of species diversity.[7] Different patch types provide different habitats and species composition. The total member of species in a landscape would increase as landscape richness increases.

A patch is a relatively homogenous, non-linear area that differs from its surroundings. The definition and identification of individual patches and their boundaries are important steps in

[6]W. H. Romme, "Fire and Landscape Diversity in Subalpine Forests of Yellowstone National Park," *Ecological Monograph*, 52 (2), 1992, 199- 221.

[7]R. H. Whittaker, *Communities and Ecosyst*ems, New York: Macmillan Co., 1975, 385; "Consideration of Climax Theory: The Climax as a Population and Pattern," *Ecological Monograph*, 23, 1978, 41-78.

characterizing the structure of a landscape. Since vegetation commonly does not exist as discrete entities, boundary delimitation of patches may have some problem. In many cases, the boundary is not so clear, and patches are more difficult to delineate. Most method of patch identification combines qualitative and quantitative approaches. A subjective determination of how different two areas must be for considering them as different patches is often needed. Once the patches in a landscape have been identified, there are many ways to describe and quantify these.[8] The patch size and shape are the most understood characteristics with species diversity. The relationship between patch size and species richness goes well beyond the familiar species area curve.[9]

12. Forest Fragmentation

Forest fragmentation is another feature to be considered in sustainable forest management. Fragmentation of landscapes results in geographical isolation and the probability of decolonization depends on the distance of fragments from the main core and on the quality of surrounding habitat. Similarly fragmentation study takes into account of connectivity (corridors), ecotones, population structure, etc. The magnitude of fragmentation increases the vulnerability with a threat on biodiversity of patches. The reduction of size and quality of mega patches due to fragmentation and subsequent loss of corridors in wildlife habitats is yet another important aspect to be considered.[10] The probability of biodiversity loss, due to

[8]K. H. Ritters, R. V. O'Neill, C. T. Hunsaker, J. D. Wickham, D. H. Yankee, S. P. Timmins, K. B. Jones, and B. C. Jackson, "A Factor Analysis of Landscape Pattern and Structure Metrics," *Landscape Ecology* 10(1), 1995, 23-29.

[9]Debra P. C. Peters and Sarah C. Goslee, "Landscape Diversity," in S. A. Levin, *Encyclopedia of Biodiversity*, New York: Academic Press, 2001, 645-658.

[10]R. O. Bierregaard, Jr., T. E. Lovejoy, V. Kapos, A. A. Santos, and R. W. Hutching, "The Biological Dynamics of Tropical Rainforest Fragments," *Bioscience* 42, 1992, 859-866.

fragmentation, is much higher in tropical region than the temperate zone,[11] probably due to higher species composition of sensitive species in tropics. Since the habitat requirements of 'sensitive' species are specific to the area, size and surrounding characters,[12] fragmentation is having direct impact on the survival and establishment of communities.

13. Protected Area

A protected area is defined as a geographically defined area, which is designated or regulated and managed to achieve specific conservation objectives. The land in the protected areas has certain legal provisions, which facilitates the management of protected areas. The protected areas have figured very prominently in biodiversity conservation efforts around the world. India's strategies for conservation and sustainable utilization of biodiversity in the past have comprised of providing special status and protection to biodiversity rich areas by declaring them as National Parks, Wildlife Sanctuaries, Biosphere Reserves, Ecologically Fragile and Sensitive Areas, etc. It has helped in reducing pressure from reserve forests by alternative measures of fuel wood and fodder, by afforestation of degraded areas and wastelands, creation of *ex situ* conservation facilities such as gene banks for eco-development.

14. Sustainable Forest Management

Sustainable Forest Management (SFM) is the management of forests according to the principles of sustainable development. Management of both natural and planted forests is essential to achieving sustainable development. It is a means to reduce poverty, reduce deforestation, halt the loss of forest biodiversity, reduce land and resource degradation, and contribute to climate

[11]I. M. Turner, and R. T. Corlett, "The Conservation Value of Small Isolated Fragments of Low Land Tropical Rain Forest," *Trends in Ecology and Evolution*, 11, 1996, 330-333.

[12]G. T. Bancroft, A. M. Strong, M. Carrington, "Deforestation and Its Effects on Foresting Birds in the Florida Keys," *Conservation Biology* 9, 1995, 835-844.

change mitigation. Forests play an important role in stabilizing greenhouse gas concentrations in the atmosphere while promoting sustainable development. Thus, forests have to be seen in the framework of the multiple dimensions of sustainable development. Important environmental, social, and economic ancillary benefits can be gained by considering forestry mitigation options as an element of the broader land management plans.

Sustainable forest management uses very broad social, economic and environmental goals. A range of forestry institutions now practice various forms of SFM and a broad range of methods and tools are available that have been tested over time and space. A definition of SFM was developed by the Ministerial Conference on the Protection of Forests in Europe (MCPFE), and has since been adopted by the Food and Agriculture Organization (FAO). It defines sustainable forest management as:

> The stewardship and use of forests and forest lands in a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity, vitality and their potential to fulfil, now and in the future, relevant ecological, economic and social functions, at local, national, and global levels, and that does not cause damage to other ecosystems.[13]

In simpler terms, the concept can be described as the attainment of balance – balance between society's increasing demands for forest products and benefits, and the preservation of forest health and diversity. This balance is critical to the survival of forests, and to the prosperity of forest-dependent communities. For forest managers, sustainably managing a particular forest tract means determining, in a tangible way, how to use it today to ensure similar benefits, health and productivity in the future. Forest managers must assess and integrate a wide array of sometimes conflicting factors – commercial and non-commercial values, environmental considerations, community needs, even, global

[13]<www.foresteurope.org/docs> (3 December 2014).

impact – to produce sound forest plans. In most cases, forest managers develop their forest plans in consultation with citizens, businesses, organizations and other interested parties in and around the forest tract to be managed. The tools and visualization have been recently evolving for better management practices. Because forests and societies are in constant flux, the desired outcome of sustainable forest management is not a fixed one. What constitutes a sustainably managed forest will change over time as values held by the public change.

15. Conclusion

Sustainable forest management is essential for the survival of life. Tropical deforestation and its impact on environment is a major concern in the present scenario. An ecosystem approach is to be adopted in forest management practices. Habitat analysis and measurement of landscape elements using modern technologies like remote sensing and GIS are essential components in forest management. Forest fragmentation status is to be studied critically. Criteria and indicators for sustainable forest management is to be developed and current protected area concept is to be strengthened. The current status of the forest biodiversity, setting of forest management standards, decentralization of management practices, weightage for environmental services rather than economic evaluation, etc. are other options to be practiced.

Criteria and indicators are tools which can be used to conceptualize, evaluate and implement sustainable forest management. Criteria define and characterize the essential elements, as well as a set of conditions or processes, by which sustainable forest management may be assessed. Periodically measured indicators reveal the direction of change with respect to each criterion. Criteria and indicators of sustainable forest management are widely used and many countries produce national reports that assess their progress toward sustainable forest management. There appears to be growing international consensus on the key elements of sustainable forest management.

Seven common thematic areas of sustainable forest management have emerged based on the criteria of the nine on-going regional and international criteria and indicators initiatives.

The seven thematic areas are:

i. Extent of forest resources
ii. Biological diversity
iii. Forest health and vitality
iv. Productive functions and forest resources
v. Protective functions of forest resources
vi. Socio-economic functions
vii. Legal, policy and institutional framework

This consensus on common thematic areas (or criteria) effectively provides a common, implicit definition of sustainable forest management. Sustainable forest management was recognized by parties to the Convention on Biological Diversity in 2004 to be a concrete means of applying the Ecosystem Approach to forest ecosystems.[14] The two concepts, sustainable forest management and the ecosystem approach, aim at promoting conservation and management practices which are environmentally, socially and economically sustainable, and which generate and maintain benefits for both present and future generations. Growing environmental awareness and consumer demand for more socially responsible businesses helped third-party forest certification emerge in the 1990s as a credible tool for communicating the environmental and social performance of forest operations.

[14]Jean-Louis Weber," Ecosystem Natural Capital Accounts: A Quick Start Package," *Technical Series 77*, Montreal: Secretariat of the Convention on Biological Diversity, 2014, 248.