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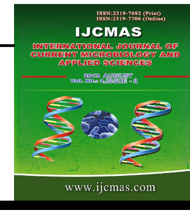

Review Article

Preserving Microbial diversity of Soil ecosystem: A key to sustainable productivity

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A B S T R A C T

To safeguard our future, it is imperative to understand the interdependencies of humans, and other species on our planet. This is high time to realise that soil resources are limited and scientific and rational political approach is to be developed to protect them by creation of holistic and sustainable practices in an energy and resource efficient manner. As a non-renewable resource soil and its protection is key for mankind's future, for sustainable delivery of agricultural goods - food, feed and fibres, and in some cases biofules - for a growing world population. The unsustainable use of soil in a realm of present scenario of global climate variability and warming, adds increasing pressure on the soil environment. Soil requires political initiatives for its protection that are considerate of these different threats and pressures. Exploration, evaluation and exploitation of microbial diversity is essential for scientific, industrial and social development wich is more pertinent to SAARC countries as it abounds in enormous wealth of available biodiversity.

Introduction

A global concerns focus on environmental protection and natural resource management. The sustainability of natural resources has taken central stage amongst researchers, the public and policy makers as a key issue in global change and biodiversity preservation. Need has risen to develop an understanding of microbial diversity responsible for variable reaction in different soil orders. There is need for deeper understanding of soil ecosystem function at the process level. Ecological approaches have primarily focused on the function of natural ecosystem where sustainability is viewed in terms of the maintenance and stability of ecosystem productivity and tightness of nutrient cycle. Biological aspect of soil fertility, are key feature of sustainable productivity, has not been fully explored because of great microbial biodiversity in soil ecosystem. A dwindling fertility of the soils necessitates the development of finer knowledge of soils.

Soil ecosystem

The present vibrant globe full of life has evolved from barren volcanic landscape around 1.5 billion years ago; motile microorganisms migrated to different environments under the influence of different factors. Soil formation on the earth was started through biomediation but the mere existence of microbial life was recognized only relatively recently in history, about 300 years ago, with Leeuwenhoek's invention of the microscope. The microbes execute most of the chemical transformation in the soil ecosystem.

The important ecosystem on the planet of ours is its excited skin commonly known as soil. Array of physical and chemical transformation operate in this to sustain all of other tropic levels in the biosphere. The physical complexity of the soil harbors soil microbes for harnessing essential resources. There is evidence that the importance of soil can only be understood when the relevant physical and biochemical approaches are integrated.. The porosity of soil is responsible for effective void ratio which determines the biochemical processes that govern the life on earth viz plant productivity, water movement, nutrient availability through enzymatic activity, and greenhouse gas efflux besides resisting impacts of pollutantants through bioremediation and buffering capacity making aquifer safe from pollutants.

The soils of the world have been categorized into soil orders because of their development in time and space in different predisposing factors. These soil orders have reorganization of soil microbial complex responsible for dynamic properties of soil. The soil microbial complex can be viewed efficiently after understanding the soil microbial diversity. Failure to understand such complexes and their interactions in soil, we may have to face negative repercussions.

Soil microbial complexes

A handful of soil contains billions of micro organisms, so many different types that accurate numbers remain unknown. At most only a few of these microbes would be known to us. A very little is known about soil microbiology and related soil biochemistry, despite it being a component of biology responsible for sustenance of life on this planet. The understanding of the composition of microbial communities in soil is complex. In 1931, Waksman believed that "a large body of information has accumulated that enables us to construct a clear picture of microscopic population of the soil" and in 1932 Bergey's manual clarified that no organism could be classified devoid of being cultured. However, the pure-culture approach in studying the microbial world seriously constrained the view of microbial diversity because most microbes defy cultivation by standard methods. Equations used to calculate species richness and evenness and diversity indices, which combine both richness and evenness, have been discussed by Kennedy & Smith (1998). Microbial diversity is measured by various techniques such as traditional plate counting and direct counts as well as the newer molecular-based procedures and fatty acid analysis. Molecular tools and perspective based on gene sequences are now alleviating these constraints to some extent. Even the early results are changing our perception of microbial diversity. The scientific and technical advances steadily drew attention to the uncultivable microbial world, but two discoveries needs to be mentioned here. The first was work on the diversity of soil bacteria, which demonstrate with DNA-DNA reassociation techniques that the complexity of the bacterial DNA in the soil was at least 100- fold greater than could be accounted for by culturing.

Importance of soil microbial diversity

Biodiversity is the "variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems". This chapter investigates soil biodiversity pertinent to excited skin of terrestrial system which gives way to the new technological explorations like discovery of soil bacteria for anticarcinogenic activity (The Telegraph 05 September, 2011). The soil environment is one of the most complex biological communities on earth and niche to an even larger share of biodiversity than tropical forests. Soil is beaming with a life, the fraction of the surface area covered by soil microbes is only about 1×10^{-6} which incidentally is same percentage of land area on earth that human covers.

Soil organisms are mostly small and inconspicuous, and therefore rarely enjoy public attention in contrast to birds, flowers or other large and eye-catching organisms and there is nothing similar for soil microfauna because these seem to be less facitating (Barrios, 2007)

Soil microbial diversity cannot be discussed in isolation because synthesis of solum is as a result of microbial mediated transformation .The determination of the composition of microbial communities in soil is complex and represents great biodiversity responsible for dynamic reactions in a soil ecosystem. The evolution of new species generates biological diversity, which is represented by the number of different species in an environment. The importance of biodiversity in the functionality of ecosystems was stressed by Agenda 21, a document from the United Nations Conference of Environment and Development, prepared in Rio de Janeiro in 1992. The document promoted scientific and international cooperation for a better understanding of the importance of biodiversity and its functions.

Soil ecosystem remains firmly at the foundation of human life. The intensive and extensive use of soil suggests that there is much to be discovered about soils with respect to the people. Soil ecosystem are least understood amongst all ecosystem. The microbial ecology of soil still poses a challenge to microbiologists attempting to establish the ways in which bacteria and fungi actively metabolise substrates, link into the food webs and recycle plant and animal remains and provide essential nutrients for plant.

Extraction and in Situ analysis of rRNA has enabled identification of active taxa, and detection of mRNA has provided an insight into the expression of key functional genes in soil. Recent advances in genomic analysis and stable isotope probing are the first steps in resolving the linkage between structure and function in microbial communities. DNA is responsible for encoding the physical characteristics of a microorganism. Differences in DNA sequences between organisms create genetic diversity. same species. This genetic diversity is able to manifest itself as biological diversity through the structure, organization regulation and expression of DNA. These effects determine how organisms develop physically, assimilate nutrients, interact with the environment, and even, in some cases, how they behave. It is these properties of genetic diversity that support the effective stability of natural environments. Multiple biological and non biological components interact through intricate nutrient cycling webs to create a microscopic and macroscopic global environment. This global environment can be imagined as a pyramid in which the entire structure depends on each of the small blocks that are used to create and support the larger structure. For this reason, it is often useful to examine the environmental impacts of small ecological components such as microorganisms. As noted above, microorganisms are believed to be the origins of life on the planet. This theory is supported by the fact that they display the highest degree of biological diversity.

Economic value of soil biodiversity

Soil biodiversity takes care of the management of soil health, structure and composition which in turn provides the needed base for successful plant life. However, various studies have been made to estimate the economic value of the different services soil biodiversity provides. Recycling of organic wastes is considered to be one of the most important uses of soil biodiversity. Mankind produces more than 38 billion metric tons of organic waste on a global scale annually. Were it not for the decomposing/recycling activity of soil organisms, much of the globes land surface would be literally covered with organic debris. The economic value (Table 1) of this service represents approximately 50% of the total benefits of soil biotic activity worldwide (>US$ 760 billion). (Gardi and Jefferey, 2009)**.**

Metagenomics

Soil Microorganisms have many of the same properties as more complex organisms such as amino acid biosynthesis and also has unique properties such as the ability to degrade waste products. As a result, the genetic and biological diversity, of microorganisms is an important area of scientific research to understand the biochemical processes in soil. Incidently, microbiologists are able to grow less than 1% of all microorganisms observable in nature under standard laboratory conditions leaving them unable to study more than 99% of the biological diversity in the environment. Metagenomics is a new field combining molecular biology and genetics in an attempt to identify, and characterize the genetic material from environmental. The genetic diversity is assessed by isolation of DNA followed by direct cloning of functional genes from the environmental sample. The 21st century has seen a shift in the focus of DNA analysis from individual genes to the genome the complete set of genes present in an organism. This is attributed mainly to large –scale sequencing efforts that have revealed the complete genomic sequences of many organisms, together with methods that allow for genome comparison and analysis, consquently scientists have entered an era marked by discoveries about the cell cycle, embryonic development, and eventually the creation of genetically modified organisms.

In the ensuing years, soil microbiologists need to put efforts in describing the phylogenetic diversity of soil niches and the next effort is to define the functions of these new phylotypes to determine whether they represented new species, genera, or phyla of soil microbes vis- a-

Table.1 World economic value of Soil Biodiversity

Activity	Involvement in soil biodiversity	Estimated world economic benefits $\times 10^9$ US dollars/year
Waste recycling	Fungi,Bacteria and Protozoan	760
Soil formation	Earth worms, ants, termites, fungi facilitate soil formation	25
Nitrogen fixation	BNF Bacteria	90
Degradation of chemicals	Soil microorganisms play a key role in degrading or modifying pollutants	121
Pest control	Soil provides microhabitats for natural enemies of certain animal species	160
pollination	Many pollinators (for instance bumble bees and solitary bees) have soil dwelling phase in the life history	200

vis their role in trophic levels for sustenance of soil fertility and productivity for the future generations .Rhizosphere is area which is hub of microbial dynamics

Rhizosphere

Soil microorganisms are involved in a wide variety of metabolic and physiological activities that influence the microhabitat. The plant root influencing soil volume where there is a high concentration of carbon with zone of intense microbial metabolic activity occurring is called the rhizosphere.

The rhizosphere can be categorised into three sections: the endo rhizosphere (interior of the root), the rhizoplane (root surface) and the soil directly adjacent and adhering to the root surface (Barea *et al.*, 2005). The volume of soil that is not directly influenced by the root is called the bulk soil. Bio chemical characteristics of the rhizosphere differ from those of bulk soil where as bulk soils show rather low in nutrient due to soil permeability and so supports limited microbial activity (Gryndler, 2000) in contrast to rhizosphere which is full of microbial activity and related processes.

Higher population of bacteria including *Azotobacter chrococcum*, *Beijerinekia* and actinomyctes from the rhizospheric soil of mycorrhizal plants (Bagayraj and Mengi, 1978) is observed because of root exudation (Barea *et al.*, 1975) in rhizosphere affects rhizospheric microflora.

There are several reports that indigenous soil microbes help either in establishing AM by supporting it directly or indirectly modifying soil niche. Bagyaraj and Menge (1978) investigated that synergistic host response unvolving *Azotobacter chrococcum* or P-solubilizing bacteria in addition to AM fungus.

Rhizosphere microbial communities can influence ecological processes such as nutrient bio mediated nutrient transformations (Bhat, 1990) Plant growth promoting rhizobacteria (PGPR) are typical beneficial organisms that are capable of influencing changes in rhizosphere functioning (Barea *et al.*, 2002; Azcón-Aguilar and Barea, 1992). Mycorrhiza induces the chemical and mineral composition of root exudates that are released into the soil (Azcón-Aguilar and Barea, 1992) which in turn affect microbial populations in the rhizosphere or rhizoplane (Barea *et al.*, 2002; Azcón-Aguilar and Barea, 1992). The total biomass of bacteria was to the extent of 50 per cent lower in mycorrhizal than non mycorrhizal plants (Christensen and Jakobsen, 1993). The term mycorrhizosphere is referred to as the zone of mycorrhizal colonisation in and outside the plant root (Andrade *et al.*, 1997). In general mycorrhizal fungi, through modifications to the plant root system, interact with beneficial soil organisms such as N2-fixing bacteria, P solubilising bacteria, fungi and root inhabiting nematodes. These interactions are important in the natural ecosystem for nutrient cycling (Gryndler, 2000). Transport of energy rich carbon compounds to the mycorrhizosphere or fungal exudation of stimulatory or inhibitory compounds. This effect referred to as the mycorrhizosphere effect (Johansson *et al.*, 2004).

G. mosseae affected the marked population of *Alcaligenes eutrophus* and *Arthrobacter globiformis* differently and the presence of *eutrophus* were barely detectable (less than 10 cfu g^{-1} dry soil) in non-AM soils but persisted well (10^4 g^{-1}) in AM soils. Number of a *globiformis* was more evenly distributed in all soils, but was highest in presence of AM roots (Anrade *et al.* 1998).

Gram positive and gram negative bacteria, *Arthobacter* sp. and *Pseudomonas* sp. was greatest in the low phosphorus soil but the bacterial population of fertilized P and AM soils were generally not significantly different. They also found that *G. mosseae* soil had the lowest gram negative bacterial population while *G. etunicatun* soil had the highest population of both gram positive and gram negative bacteria (Schreiner *et al.*, 1997).

Exploring rhizosphere for soil DNA

Microbial diversity of soil is affected by both the plant and soil types (Smith and Goodman, 1999) and serves as an important index of agricultural productivity (George *et al.*, 1995) and soil health. The impact of perennials on soil microbial diversity is more (Sharma *et al.*, 2008) especially in harsh climate.

Culture methods have been used for exploring rhizospheric microbes, but these methods are conventional that have limitations for evaluation because most rhizosphere bacteria are viable but non-culturable. Dilution-plate cultures have been used to study soil microorganisms (Hattori, 1976). and take several days until the results are obtained (Ohishi *et al.*, 2003). But conventional methods are insufficient to examine environmental microorganisms because of difficulty to distinguish between active and inactive microorganisms (Doi *et al.*, 2006). Moreover, most soil microorganisms are viable but non-culturable that cannot be detected as colonies in nutritional cultivation (Colwell *et al.*, 2000) and culture method can detect only 1 per cent of soil environmental bacteria (Amann *et al.*, 1995). Contrastingly, fluorescent direct counts showed that very small bacteria persisted inside soil particles after the optimized DNA extraction protocol was used. (More *et al.,* 1994) that necessitates a use of rapid and accurate method. Molecular biology is rapidly developing to cater the requirements of medical and environmental sciences. Soil microbial communities because of their immense phenotypic and genotypic diversity, are often difficult to fully characterize. Bacterial populations in top most layer of soil may be more than 10^9 cells per g soil (Torsvik and, Ovreas . 2002), and most of these cells are generally unculturable. A less than 5% the soil microbial biomass that have been cultured and studied in any detail are negligible fraction (Torsvik, 1990). To encompass this, direct DNA-based methods can aid in assessising the total microbial diversity present to overcome the limitations of cultivation-based studies. (Akkermans *et al.,* 1995, Ovreas and Torsvik, 1998).

DNA Extraction Methods

Soil represents one of the most difficult matrices for sampling DNA and extraction of DNA and methods selected should have broad application for normalization. For the analysis of microbial communities in soil samples, molecular biology methods require efficient and reproducible methods for the extraction of DNA. Different DNA extraction kits are available commercially and have also been modified it to lower the costs of these procedures. Efficiency of methods may vary because of varied physical and chemical matrix of the soil sample. (Park and Crowley, 2005). DNA extraction from sediments and soils in the initial endeavours, researchers used either cell extraction (recovery of cells from the soil matrix prior to cell lysis) or direct lysis within the soil matrix (Holben *et al.,* 1988; Ogram *et al.,* 1987; Steffan *et al.,* 1988).

The preciseness of molecular technique in soil microbial research is effective in obtaining representative extracts of nucleic acids from entire microbial communities in soils. Nucleic acid extraction methods, however, suffer from some limitations in the individual component steps, viz incomplete cell lysis, DNA sorption to soil surfaces, co-extraction of enzymatic inhibitors from soil, and loss, degradation, or damage of DNA (Miller *et al.,* 1999).

Estimation of DNA yield varied from 0.1 to 7 µg g^{-1} on dry weight basis in agriculture soils by using different methods while as in forest soils it varied between 0.1 to 35 µg g^{-1} soils. Further the recovery to the extent of 40-100 per cent in cultivated soils and 38-100 per cent in forest soils using different methods (Miller *et al.,* 1999).

Plant roots exudates (Jenny and Grossen-bacher, 1963) includes polysaccharides with amino and organic acids (Rovira 1969, Eastman and Peterson,1985) to provide a carbohydrate source to soil microorganisms (Jimenez *et al.,* 2003) that sustains diverse and large populations of microorganisms that are present in the rhizosphere. Bacteria in the rhizosphere influenced plant growth because of its involvement in chemical reactions in rhizosphere, where the influence can be beneficial, neutral, or deleterious (Russell, 1981; Morita 2000 and Sakai *et al.,* 2004). Microbial complexes in the rhizosphere are changeable with the quanity and quality of on plant root exudates (Rovira *et al.,* 1974; Kimuro, 1994 and Watt *et al.,* 2006a, 2006b) but temporal variation in the physicochemical factors of soils within each of those spatial microhabitats further increases the diversity of niches to sustain microbial diversity (Roesch *et al.,* 2007).

Compared to agricultural soils the forest soil is rich in microbial diversity though the reasons for this are not clear but needs to be explored to determine whether this result is generally observed in forest soils or otherwise undisturbed soils. Low temperature of the soil can be a factor enough to prevent rapid cell division and slows the process of speciation although recent work showed no correlation between mean average soil temperature and bacterial diversity (Fierer and Jackson, 2006) .But a few workers supports such a trend (Neufeld and Mohn, 2005). Akin to this, undisturbed sites may have a higher microbial diversity, relative to the agricultural areas, although recent work suggests that the inverse may be true (Fierer and Jackson, 2006).

On evaluation and optimization of DNA extraction and purification procedures for soil and sediment samples Miller *et al.* (1999) found that the DNA yields were greatest with the wetland sediment samples (range, 6 to 53 mg g^{-1} of dry weight), intermediate with the forest soil (4 to 35 mg g^{-1} [dry weight]), and smallest with the agricultural soil (1.5 to 7.9 mg g^{-1} [dry weight). In forest soil profile amount of both total and extracellular DNA directly extracted from each horizon of the soil profile showed a decreased trend with depth, ranging from 92.6 to 20.4 µg g^{-1} soils for the total DNA and from 41.1 to 2.2 µg g^{-1} for the extra cellular DNA (Agnelli *et al.* 2004). They found increases in extracted DNA with per unit Carbon in treatments that had lower fungal biomass. Marstorp *et al.* (2000) found a strong correlation between microbial biomass carbon and extracted DNA and opined that DNA could be used as a measure of microbial biomass. But Harris, 1994 found that DNA content of fungi per unit biomass is both lower and much more variable than that of bacteria and conclude that DNA content seems to be poor measure of biomass for fungi. Similarly, Leckie *et al.* (2004) compared chloroform fumigation extraction, phospholipid fatty acid and DNA methods to determine microbial biomass in forest humus and found no relationship between DNA concentration and the measurements of microbial biomass, may be due to the high fungal biomass in forest humus, as DNA concentration per unit biomass is much more variable for fungi than bacteria. Chaudhuri *et al.*(2006) extracted soil DNA by different methods and reported that except from indirect lysis, all DNA isolates, viz, by direct lysis, lysis by sonication as well as enzymatic lysis were pure and in good quantity i:e, 16.7 to 19.0 µg g^{-1} soil.

Climate change and soil biodiversity

Soil organic matter is a fundamental determinant of fertility of soils, contributing to nutrient sink and nutrient cycling, and buffering against adverse chemical impacts (Brady and Weil, 2008). Soil organic matter retains moisture, and stabilizes soil aggregates, facilitating aeration, root penetration and water infiltration, and reducing susceptibility to erosion besides enhancing biological activity in the soil (Uphoff *et al*., 2006). The cycling of carbon through biomass is vital to sustainable human–environment systems. The coupled cycling of carbon, nitrogen and other nutrients viz phosphorus and sulphur governs numerous ecosystem processes, including carbon sequestration in soil and vegetation. (Tongway and Ludwig, 1996).

Biodiversity loss is coupled with a management soil carrbon (Lal, 2004) which is derived from organic matter inputs, largely from leaf litter and root decay. Soil carbon stocks manifests losses due to decomposition of soil organic matter through action of soil fauna and microbes and physical export by leaching and erosion (Schimel et al., 1994). organic matter inputs to soil, are limited by moisture stress due to which carbon stocks in dryland soils tend to be around half that of soils in moist environments in the same temperature regime (IPCC,2006) which has a bearing on soil microbial diversity.

Direct and indirect effects on biodiversity is predicted (e.g. Theurillat and Guisan, 2001; Hughes, 2003; Meynecke, 2004) due to Climate change where as indirect changes include alterations in reproduction timing (Forchhammer et al., 1998; Winkler et al., 2002), changes in the habitat resources (Visser and Both, 2005), differing habitat use, e.g. soil niche site selection (Telemeco et al., 2009) and alterations in mortality rates (Chamaille-Jammes et al., 2006). The distribution of species is effectied by shifting the location of climates to which they are adapted (Penman et al., 2010). Thus, climate change will present significant challenges to those whose livelihood depends directly or indirectly on biodiversity.

Land management practices entailing deforestation, conversion from perennial to annual plant species, and heavy grazing effects soil carbon. Cultivated soils have low soil carbon, partly as a result of disturbance of soil aggregates, enhancing decomposition, but also due to disruption of plant growth which reduces organic inputs (Cowie et al., 2006). Loss of soil productivity due to erosion of fertile topsoil or soil salinisation reduces plant production and thus reduces organic matter inputs into the soil. The fragile microbiotic, or cryptogamic, crust comprised of lichens, liverworts, mosses, algae, cyanobacteria, bacteria and fungi that develops on soils that have been undisturbed by cultivation or heavy grazing (Eldridge and Greene, 1994). It also contributes significantly to nitrogen input and nutrient conservation (Eldridge andGreene, 1994), and contributes carbon to the soil organicmatter pool (Beymer and Klopatek, 1991).

Biodiversity initiatives

Indian scenario

The Indian subcontinent has a vast geographic area, varied topography and climate with the juxtaposition of several biogeographical regions boasts for one of the richest in the biological diversity in the world . India is recognized as one of the 12 mega diversity regions of the world. Nearly 72% of India's biowealth is constituted by fungi (~18%), insects (~40%) and angiosperms (~13%). Thus, India's contribution to the global diversity is around 8%. Various types of diverse microenvironments and unique ecosystems such as different soil orders, boiling waters, springs,deep sea vents, salt pans, acid mine drainage, cold environments are present in India that are home to diverse populations of microorganisms. It is interesting to note that extremely acidic soils (pH ~2.8) of Kerala are home to cyanobacteria. As many as 42 species were recorded in acidic soils of which 19 were recorded for the first time in Kerala and the presence of psychrophiles in Leh.

Hotspots are recognized on the basis of the presence of greatest number of endemic species and are the areas of high conservation priority because if unique species are lost they can never be replaced. The two major hotspots in the present scenario of India's biodiversity are the Western ghats and the North-eastern region former is tectonically active with approximately 17% of a set of 2500 species are likely to be microbial in this region, may be due to large nutrients efflux .There is increasing consensus, that protection of the soil biodiversity is a major way to maintain soil health.

Soil erosion deprives soil biodiversity and efforts are directed to enhance knowledge of these two sets of indicators using integrated systems approaches, agro-ecological approaches and integrated soil biological management practices. The use of integrative indicators relating not only the biophysical but also the socio-economics of the current land use practices must be pursued.Realizing the importance of soil Government of J and K passed the Jammu and Kashmir land improvement schemes act,1972(Act No.XXIV of 1972) on 21st November, 1972.An Act to provide for the making and execution of land improvement schemes for soil conservation, improvement of soil resources, prevention or mitigation for soil erosion ,protection of land against floods or drought, farm drainage or other works incidental to or connected with such purposes. Be it enacted by the Jammu and Kashmir State Legislature in the Twenty-third Year of Republic of India which envisages functions of a district land improvement committee besides others as

A District Land Improvement Committee may direct the preparation of a Land Improvement Committee for the whole or part of the notified areas within the district, which may provide for all or any of the following matters:-(a) prevention of soil erosion;(b) preservation and improvement of soil;(c) reclamation of waste land;(d) Improvement in the method s of cultivation including dry farming practices and extensionof cultivation;(e) Construction of earth and masonry works in fields, gullies and ravines.

But more efforts are required and many exercises are required to prevent about 6000 million tonnes of soil that is washed away into the sea, which in terms of NPK fertilizers amount to 5.37 million tones (Tiwari, 1983).

International scenario

Three major global environmental issues were recognized at the United Nations Conference on Environment and Development (UNCED) that took place in Rio de Janeiro in 1992: climate change, biodiversity and desertification. Each issue came to limelight as a specific international convention: the UN Framework Convention on Climate Change (UNFCCC), the UN Convention on Biological Diversity (UNCBD) and the UN Convention to Combat Desertification (UNCCD), respectively. The UNFCCC is supported by the Global Climate Observing System (GCOS. Recently, the Group on Earth Observations Biodiversity Observation Network has been established to help coordinate the many biodiversity observation systems.

In addition, the UNFCCC also benefited from the scientific advice and support of the Intergovernmental Panel on Climate Change (IPCC), which has been regularly issuing assessment reports on the the climate system, and the UNCBD now has a similar body, the International Platform of Biodiversity and Ecosystem Services

(IPBES). The UNCCD, in contrast, currently has neither a dedicated observing system nor a stable, long-term scientific advising body to provide relevant, reliable, accurate and timely information to the various decision makers, managers and stakeholders committed to the sustainable development of dry lands (Akhtar-Schuster *et al*., 20 11).

The need for a common strategy for the protection and sustainable use of European soil , the European Commission proposed the "Soil Thematic Strategy (COM (2006) and a proposal for a "Soil Framework Directive (COM (2006) in September 2006 was floated ,entailing common principles for protecting soils across the EU to protect soil with the emphasis that member States will instrumental in implementing the principles of the Framework and European countries enacted legislations to protect their soils,. Commission's proposed a ten-year work program.. The Soil Thematic Strategy is not a legislative proposal and is therefore not subject to a formal process of adoption though it has been already adopted by different institutions. However, the proposal for a Soil Framework Directive is subject to the decision procedure in accordance with Article 251 of the EC Treaty and both the European Parliament and the Council have to agree on a common text. The Commission in February 2010 issued a contributory report on 'Soil biodiversity: functions, threats and tools for policy makers', which reviews the state of knowledge of soil biodiversity, its functions, its contribution to ecosystem services and its relevance for the sustainability of human society.

Soil biodiversity is critical to sustain a wide range of ecosystem functions like biodiversity, water filtration and infiltration, soil stability and protection against natural disasters, and thus securing our landscape and natural heritage. Some of these services have a great social importance due the fact that soil is always owned by someone in world. Biodiversity in general has been gaining public awareness, with 2010 nominated as the "International Year of Biodiversity" and the agreement to set a new EU target for the protection of biodiversity. The new EU vision is to halt the loss of biodiversity and the degradation of ecosystem services (in the EU) by 2020, restore them in so far as feasible, while stepping up measures to avert biodiversity loss at the global level. A starting point on this, however, is a better understanding of what is soil, what is meant by soil biodiversity, and examples of different influences on soil, and this is what this report sets out to provide.

The international soil organizations have played a role for developing substantial soil management guidelines and information materials dealing with practical soil management issues, land evaluation, and soil mapping and monitoring the condition of soil of soil with some legally-based materials have been prepared by FAO which can set norms for national and international legal frameworks for soil. (Christy, 1972)

Connections between the Rio conventions

A synergy between the Rio Conventions have long been recognized though a little progress has been made in bringing these efforts together (Cowie et al., 2011 and Chasek et al., 2011). The efficiencies that might result from exploiting these synergies are immediate and overwhelming, and must be pursued (Verstraete et al., 2009a). In light of this impasse, other avenues to achieve coordinated assessments have been put forward that are intended to circumvent these obstacles. For instance, UNEP has suggested several alternatives that might be pursued for their global assessments (UNEP, 2009), but potential linkages to the assessments conducted or required by the conventions are not discussed.

A spatial and temporal scales for wider climatic, environmental and soil health variables are needed to be set invoving national, regional and international networks and systems for record and reference of soil biodiversity.

Sustainability and resilience

A primary role of biodiversity in ensuring the various functions performed by soil organisms, besides important role of genetic variability and functional diversity is to maintain these functions by resisting perturbations. Ecosystem resilience and the capacity to reverse degradation is important for soil scientists. Strategies can be adopted for reducing vulnerability to expected changes; fostering resilience to sustain desirable conditions in the face of perturbations and uncertainty; and transforming from undesirable trajectories when opportunities emerge befitting soil environments that are characterized by cycles of change (Chapin et al. 2010) Productive soil rely on spatial redistribution and transformation nutrients to achieve fertility to support growth of vascular plants (Tongway and Ludwig, 2005). Soil erosion has impact on soil biodiversity involved releasing and redistributing of nutrients that suppress dominating vegetation species, creating opportunities for colonising species. The spatial and temporal diversity in soil structure and species thus created supports a diversity of fauna and microorganisms. Diversity response to stresses amongst the organisms engaged in each function, imparts resilience to the ecosystem (Walker and Salt, 2006). Resilient ecosystems are the building blocks of sustainable, productive agro-ecosystems that is true with a variable soil biodiversity.

Degradation of soil coupled with biodiversity loss along with problems such as resource depletion, pollution, and urban expansion are symptomatic of society's general lack of understanding of natural processes. For resilience, management of soil ecosystem should cater to the adjustment of different variables in the system which shall ultimately help in promoting ecological resilience (Beddoe et al., 2009). Addis Ababa Principles and Guidelines for the Sustainable Use of Biodiversity (CBD, 2004), advocates adaptive management for sustainable use of local niche. Governance approaches also should be defined by its adaptive capacity; recognising that soil ecosystems are unpredictably variable, management must be able to withstand and adjust to shocks. Land management systems that protect topsoil, conserve and recycle nutrients, conserve and concentrate water for maintaining soil biodiversity are those that will maintain productivity in the soils (Cowie *et al*., 2007). Issues of soil complexity are there and solutions can be elusive However, all can agree that soil is of paramount importance and therefore strategies for its protection is needed that can be achieved by careful management by farmers, the public and policy-makers ,if we are to conserve the medium that supports our life, and helps us grow our future.

For millennia, diverse microorganisms have been responsible for taking part in the formation of solum and shaping this beautiful planet of earth. Soil biodiversity, which is the multitude of organisms living under our feet, has many important characteristics and functions and is the key to human survival and economic well being and provides a huge reservoir of resources . Diversity in microorganisms is essential to a sustainable biosphere, because this diversity is able to sustain nutrient cycling, production and consumption of terestrial gases that affect global climate, neutralize impact of pollutants and wastes and they can be exploited for biological control of plant and animal pests. Understanding of soil biodiversity shall aid in devising strategies to solve new and emerging disease problems through biotechnological interventions. New technologies, particularly in nucleic acid analysis, analytical chemistry, and habitat sampling and characterization of niche for the study of microbial diversity aided computer simulation on the cutting edge of science .Despite the acknowledged value of microorganisms, our knowledge of their diversity and many of their key roles in sustaining global life support systems is still in inception. Exploration, evaluation and exploitation of microbial diversity is essential for scientific, industrial and social development wich is more pertinent to SARC countries as it abounds by enormous wealth of available biodiversity. Therefore. Continued endeavor is required to describe and protect the unexplored resources for the preservation of natural ecosystems (Soil) and the future benefit of mankind. A necessity for framing knowledge bank with information systems and databases on soil biodiversity to persuade soil biological management according to type of farming system, climatic conditions, socio-economic context, spatial and temporal scales.

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