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Newsletter

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IN THIS ISSUE

Fourth International Conference on Plants & Environmental Pollution (ICPEP-4)

8-11 December 2010
Venue: NBRI, Lucknow, India

Organized by

National Botanical Research Institute (NBRI), Lucknow, India and International Society of Environmental Botanists (ISEB)

Number of delegates registered till 3 November 2010

Algeria	2	Japan	1
Argentina	1	Lesotho	1
Australia	1	Libya	1
Azerbaijan	2	Malaysia	2
Bangladesh	4	Nepal	1
Botswana	1	Pakistan	7
Cambodia	1	Philippines	2
Canada	2	Poland	3
Chile	1	Portugal	1
China	1	Qatar	1
Egypt	2	Romania	1
Finland	2	Saudi Arabia	1
Germany	1	South Africa	1
Ghana	1	Spain	3
Hungary	2	Thailand	2
India	488	Tunisia	1
Iran	15	USA	5
Israel	1	Yemen	1
Italy	3		

- Informative news, views and popular articles/write-ups on current environmental researches/issues are invited for
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- Enviornews is published quarterly on the first of January/April/July/October; and is supplied free to all members of ISEB
- Environews is also supplied in exchange for scientific literature published by reputed organisations.
- All correspondence should be addressed to : The secretary, International Society of Environmental Botanists, National Botanical Research Institute, Lucknow - 226001 (India).
- E-mail : isebnbrilko@sify.com, Website : http://isebindia.com

LETTERS

The ***Environews*** has enriched my environmental knowledge and created awareness for judicious use of nature gifts.

R.D. Chauhan
viveka1125@yahoo.com

It is pleasant to go through the recent issue of ***Environews***. All three articles published in this issue are a brief, integrated, focused and analytical account of the current aspects of the environmental issues. I congratulate authors and editors for such comprehensive input to the bulletin. I introduce a newly registered society, "The Society for Science of Climate Change and Sustainable Environment" to the fellow ISEB members, which may attract their attention. For details please contact me as I am the Secretary.

Rana P. Singh
Professor and Dean
School for Environmental Sciences
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For the last several years I have been reading ***'Environews'.*** I am holding the offices of Department of Science & Technology New Delhi (as Consultant) and Vigyan Prasar (as Hon. Director), yet I would request that in future copy of ***'Environews'*** be mailed at my following address so that it reaches me quickly.

Er. Anuj Sinha
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I am writing a book on biomedical waste disposal for educational purpose and for creating awareness among healthcare professionals about this issue. I need some matter from the article entitled "Hospital waste- An environmental hazard and its management" by Prof. Hem Chandra in ***Environews*** July 1999. A few things also need to be adapted as per requirement. Kindly allow me for the same. I will enlist thesource in the references.

Dr. Anantpreet Singh
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My name is Annie Simanski. I visited isebindia.com earlier today and I just wanted to congratulate you on a well presented, and informative web site. I found your website in dmoz. org/Regional/ Asia/ India/Regions/The_Northeast and would like to list your site on a similar section of our site, Peak Directory. Did you know, exchanging links would generate more traffic to both of our sites? Best of all it's free of cost. We simply ask for a link back from a page on your site. I hope you're interested because we have other quality linking opportunities to offer. Please include in your reply the details below:
Anchor Text, URL, Description: (Use up to 400 words), Links Page (where you will put a link to my site). I look forward to your response.

Annie Simanski
Annie-Simanski@PeakDirectory.com

It is with reference to your proposal to become our (ICBCP) as Patron member of your esteemed society. The matter was discussed in our General body meeting and it was decided to have following privileges to our ICBCP after becoming member-

- To have a small write up on ICBCP in your in environ news.
- To give the stall for selling of the ICBCP Proceedings etc., during international conference that is going to be held in December without any charges.
- To put an add paper (prepared by ICBCP) in the conference bag of the delegates.

Dr. Shashi Dhawan
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INTERNATIONAL CONFERENCE ON PLANTS & ENVIRONMENTAL POLLUTION (ICPEP-4)

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WELCOME NEW MEMBERS

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NEWS FLASH

- **D**r. P. C. Abhilash, a life member of ISEB, UGC- Dr. DS Kothari Post Doctoral Fellow, School For Environmental Sciences, Babasaheb Bhimrao Ambedkar University (A Central University)Vidya Vihar, Raibareli Road Lucknow-226025, (email: pcabhilash@gmail.com) has been selected for the NASI (National Academy of Science) -Young Scientist Platinum Jubilee Award 2010 in the area of Plant Science.

- **P**rof. C. K. Varshney has been made the Member, Expert Appraisal Committee for Mining Projects, Ministry of Environment and Forests, Government of India, New Delhi. He has also been made the Member Expert Committee DST, Government of India, to evaluate, review, recommend and monitor project proposals under Climate Change Programme.

- **P**rof. Harold A. Mooney has been named the recipient of the 2010 Volvo Environment Prize. He is a professor of environmental biology at Stanford University in California, USA, and senior fellow of the Institute for International Studies at Stanford. He is frequently quoted as a leading researcher in ecology and environmental sciences. At Springer he is one of the editors of the book series *Ecological Studies*. He is also co-editor of the books *Biodiversity and Ecosystem Function* and*Methods in Ecosystem Science*.
  The Volvo Environment Prize is an annual award given to people for outstanding scientific discoveries or inventions within the area of environment and sustainable development. The prize consists of a diploma, a glass sculpture and a cash sum of SEK 1.5 million (approx. EURO 150,000 or USD 200,000).

CARBON FOOTPRINTS FOR CLIMATE CHANGE MITIGATION

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Global warming is real and human beings are expected to get burns sooner or later if significant actions are not taken to control the rising temperatures immediately. The increase in temperatures is due to the enhanced greenhouse effect due to anthropogenic release of greenhouse gases (GHGs) into the atmosphere. Of these, the Kyoto gases i.e. carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6) are the biggest contributors. For this reason, relevant steps have been taken at local to national levels worldwide in the forms of carbon and energy taxes; adoption of alternative energy sources including wind, hydro, geothermal and nuclear energy; promotion of terrestrial, oceanic and geologic carbon sequestration; and generating funds for GHG mitigation projects through carbon market. It has become one of the most popular topics in the public domain. Contributions to the public concern towards the issue came from famous books like "The End of Nature (Bill McKibben, Random House, 1989)", The Two-Mile Time Machine (Richard Alley, Princeton University Press, 2000), "The Revenge of Gaia (James Lovelock, Allen Lane, 2006)", "Six Degrees (Lynas, Fourth Estate, 2007)" and movies like "An Inconvenient Truth"; activities of non government organizations and media covering political negotiations regarding the issue. Besides these, a renowned term which has played an important role in proliferating awareness regarding the individual responsibilities to limit GHGs and hence global warming, particularly in developed world is "carbon footprint" (CF). Originally as a part of "ecological footprint", CF was an estimate of biologically productive land and sea area required to absorb as much carbon dioxide as was generated during the lifetime of an individual, or an activity. In lieu its importance in greenhouse gas accounting and representations, CF became independent and increasingly popular although its native form entirely got modified. The definition of carbon footprint is still not uniform among the studies, however there is an apparent nexus that it refers to the amount of GHGs emitted into or removed from the atmosphere in terms of carbon dioxide equivalents, over a specified time period from a well defined set of activities for which the entity is responsible. For this relatively new concept, calculation methodologies are still evolving but it has proven assertive in taking mensuration of greenhouse gas emissions to households in an easily conceivable manner. Its use therefore has increased among the businesses besides encouraging personal carbon calculating facilities commercially. This article presents a brief introduction of carbon footprint, its
calculation and significance. An attempt has been made to analyze how commercial businesses have responded to this technique of emission quantification and representation.

Carbon footprint calculations

In order to estimate the net contribution of any activity to global warming, all the relevant GHG emissions or removals, whether they are direct or indirect have to be identified and accounted. In other words, it involves the complete life cycle assessment of the product or activity with respect to GHGs. To address complexities in such analyses, guidelines have been formulated. Important resources are GHG protocol of World Resource Institute and World business council for sustainable Development, Guidelines to National GHG inventories 1996 and 2006 of IPCC and ISO 14064 (part 1 and 2). Besides these, methods have been developed by government and non-government organizations, as well as by those involved in carbon foot printing business. UK DEFRA, USEPA, The Climate Registry, and Carbon Trust are few to name. There are three basic steps in CF calculation:

1. Identification of all relevant phases through which the product, event or activity has passed and with which GHG emissions are associated.
2. Estimation of GHGs emitted at each identified phase.
3. Calculation of net GHGs released or removed, in terms of CO_2-e (usually at 100 year time horizon).

Life cycle analyses helps identifying the relevant stages of the product, while emissions and removals are calculated through direct measurements or utilizing emission factors and models. Practically, only direct emissions (technically called Tier I) such as in transportation and fossil fuel burning in boilers, and emissions embodied in energy (Tier II) are included in CF calculations. For realistic estimates however, tier III i.e. emissions associated with use and disposal of a product should also be considered. Due to complexity and because neither these emissions are considered in carbon markets nor are mandatory under GHG accounting guidelines, this phase is left out in most of the studies. But as more and more carbon foot printing studies will calculate end use emissions, sector specific emission factors can be developed to cover broader boundaries with reduced chances of error.

Popularity of carbon footprint

There exists a long list of activities for which CF have been calculated. Be it an individual, our daily activities, consumer products, big events, organizations, cities and countries,

utilities or natural systems; CF is widely employed as a quantitative indicator of climate friendliness.

Hundreds of individual and household carbon calculators have surged the Internet, which yield CFs within minutes based on few inputs. Scientific comparisons indicate that these calculators yield variable results and hence it becomes difficult to select the appropriate one. Similarly, online calculators can yield CF of food and traveling, particularly the air travels. The business of carbon offsetting i.e. supporting GHG emission reduction or sequestration facilities financially has given a boost to such calculators. These calculators compel their customer to offset footprints. However, few of them are verified to make sure that emission reduction could not have occurred if not supported financially through offset sale. Offsets are usually generated through afforestation programs in the third world countries and supporting renewable energy options. Big events like conferences and sports events too get their CF calculated and take necessary actions to manage their CF. An example to quote is the forthcoming London Olympics 2012, for which CF calculations are going on. The estimated CF will be reduced as much as possible. FIFA world Cup 2006 was declared as carbon neutral through purchasing offsets for its CF of 1.0×10^5 t CO_2-e.

While the World Bank, UNO and UNESCO declared that they would calculate and reduce their CFs, educational institutions are not lagging behind. Carbon footprints of University of British Colombia and University of Pennsylvania have been estimated to be 8.2750×10^4 and 3.0×10^5 t CO_2-e respectively. These were calculated using the emission factors derived from respective resources, and it was found that for such institutions, emissions embodied in purchased electricity contribute the largest to CF. A scoping study has already been conducted to carry out carbon footprinting of schools in UK. For cities, states and countries, CF is being utilized to guide the areas of emission reductions. City of Seattle (7.013×10^6 t CO_2-e in 2000), The City of Vancouver, Canada (4.1983×10^7 t CO_2-e 2006), Hawaii (2.154×10^7 t CO_2-e in 2005) is few examples. UNDP estimated worlds per capita carbon footprint to be 4.5 t CO_2-e in 2004. It included only CO_2 emissions in CF calculation for nations and found United Arab Emirates leaving the biggest footprint with 34.1 tonCO_2 and smallest by India (1.2 t CO_2). The results were found inconsistent with another study carried out by Edgar and Peters (2009), who made use of a database "Global Trade Analysis Project" and considered other GHGs also. Highest CF and hence lowest carbon consciousness was reported for Luxembourg (33.8 t CO_2-e). Over consumptive behaviour of developed countries yields higher CF whereas developing countries are unable to afford emission control measures and cleaner techniques and substitutes. Even then, their CF has been found to be the lowest. Carbon footprint for Bangladesh, Mozambique and Uganda is estimates as 1.1t CO_2-e.

On the entire arena of getting prepared for fighting global warming, commercial businesses hold a unique position as the target points of the laws and governments when it comes to emission reductions and environmental protection, but are also equally prone to every change in society and public behavior. At the same time, they have to reap economic benefits from all the expected or induced changes. They have sensed that the future will definitely be carbon and energy constrained and therefore have started conforming accordingly. In Carbon Disclosure Project 2009, 475 corporate over the world participated to get their footprints calculated with 83 % revealing their emissions upto tier II only. However, total tier 3 emissions of 5.8×10^9 t CO_2-e outweighed the combined emissions of tier I and II (0.6 and 3.6×10^9 t CO_2-e, respectively). It indicates that emissions beyond tier II have the biggest share in CF except for few biggest known emitters including thermal power plants and cement manufacturing industries.

Consumer preferences have shifted towards the products with low carbon content. LEK consulting (2007) carried out a survey, which showed that 44% of the consumers preferred to buy products providing information about its CF and 43% preferred to the product with low CF immaterial of its higher price. Therefore, corporate are in a race to count and cut their CF. News Corporation and internet service provider Google announced to go carbon neutral whereas others including General Motors, Oil giant British Petroleum and Virgin Group, declared to invest in technologies that help reducing their GHG emissions. Regardless of the fact that natural processes contributing to GHG emissions are beyond our control, CF of devastation caused by hurricane Katrina on US coast and wildfires has also been estimated.

Importance of carbon footprints

The word 'CF' itself gives an indication that it shows something about the quantity of carbon or related species. Its obvious cognition makes it popular among the public as an indicator of one's contribution towards global warming. An aware citizen of the world therefore appreciates all possible measures that tend to reduce CF of humankind. This has resulted in fundamental changes in governance, people behaviour and businesses. It is clearly visible in the form of carbon taxes and tariffs, numerous researches going on to evaluate carbon sequestration options and rapidly growing carbon market. An important and substantial contribution of CF is that it has compelled businesses to look towards cutting their GHG emissions, whether or not the government imposes heavy taxes. It is due to the business motivation rather than environmental consciousness that is generated as more and more consumers tend to shift towards conservative lifestyle and buy more environment friendly goods and services. When an organization reveals and takes actions to limit CF, its image is improved besides adding to its

adaptation to expected stricter emission norms and getting benefits in form of incentives for limiting emissions.

Individual carbon foot printing facilities have generated huge money through sale of carbon offsets resulting in rise of carbon offsetting business that imparts a sense of carbon neutrality among its buyers. For this reason, voluntary carbon market has grown dramatically since 1989.

Ambiguities to be addressed

A vital point is that, CF has become immensely popular business tool and CO_2-e is now being looked as a commodity, although neither there is a standard method to verify and compare the CF calculations, nor is to determine the efficacy of carbon offsets. Variations in sources, rates and periods of emissions/sequestration amongst different processes and products or events make comparisons more problematic. There is a need of strict vigilance over the carbon markets and assets exchanged there. Similarly coherence in CF calculations is indispensable when it is related to money transactions. Standard guidelines make tier III optional, which is the known biggest contributor to total GHGs emitted. Methodologies to include these emissions are thus essential. CF of consumer products as well as in other carbon calculating facilities must clearly indicate the extent of emissions covered to avoid misleading interpretations. An initiative has been taken in the form of carbon labeling in some countries, but unless it too provides details of the life cycle stages covered in an understandable manner, its motive will be astray.

Conclusions

Contribution of CF for making GHG accounting illustrious at large scale is appreciable. It has compelled businesses to cut down their emissions even if not required so legally through raised public awareness towards eco friendly products. This reflects its strength if employed in a well regulated way. Although general public tends to calculate and reduce its CF for aroused sense of environmental consciousness, there is no control over carbon calculating and offset sale facilities. The business of carbon offsets is growing uncontested. This must be checked so as to generate money for actual reductions. As CF is still evolving, more studies are required in order to account for emissions and removals beyond tiers II and I for more representative estimates that will guide in better GHG management and control measures. In addition to these, there is an urgent need to disseminate information about how to interpret CF, among general public, so that merely what is shown to them doesn't mislead them.

TERRESTRIAL CARBON SEQUESTRATION THROUGH MINED LAND RESTORATION

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Introduction

The most important natural resource, upon which all human activities are based since time immemorial, is land. Man's inexorable progress towards development has, however, considerably damaged our land resource base. Further, land also suffers from various kinds of soil erosion, degradation and deforestation. Mining is one of the reasons responsible for extensive land degradation in India and worldwide. The mining spoils, literally termed as dumps that result from excavation and dumping create stark hostile conditions for vegetatal growth and establishment. Mine spoils represent very rigorous conditions because of low organic matter content, low organic carbon, deficiency of soil nutrients, unfavorable pH, either coarse texture or compacted structures of spoil materials. As a result, the vegetation cover in and around mines is usually greatly reduced. Regeneration through natural succession on such highly degraded sites is very slow and mostly results in a low diversity of plant communities. In the process of mines restoration, afforestation of spoils by suitable plant species supplemented with microbial Biofertilizers and certain mulches is a universally accepted technology. Afforestation of mined spoils not only serves the purpose of land restoration but also provides other very important ecological services like carbon sequestration and consequently greenhouse gas mitigation. Many research organizations and industries have been developing technologies to mitigate carbon dioxide (CO_2) concentrations. The available options include separation and capture of CO_2 from the energy system and sequestration in the deep ocean, sequestration in the geologic formations, sequestration in the depleted oil reserves, sequestration in the explored coal seam, and terrestrial sequestration in plants and soil. Out of many available technologies, afforestation approach is universally accepted due to its economic feasibility and practicability. Terrestrial ecosystems, which consist of vegetation and soils, are considered to be a major sink for carbon at present time. Carbon sequestration by plants is a natural process and does not require any specific sophisticated technological inputs. This article aims to discuss possibilities of carbon sequestration through afforestation approach of

restoration of mine spoils spread almost in all states of the country.

A brief on status of mining leases and wastelands in India

The status of mining leases as on 31.3.2007 indicates that 7,734 mining leases were under mining operations in the country in 23 states covering an area of 445,847 ha for 60 metallic and non-metallic minerals excluding lignite, coal, petroleum, natural gas, atomic minerals and minor minerals. During 2006-07, the state wise break up of leases indicates Andhra Pradesh is leading with 1,507 mining leases followed by Rajasthan (1,433), Gujarat (1,060), Madhya Pradesh (765), Tamil Nadu (461), Karnataka (455), Orissa (380), Jharkhand (323), Chhattisgarh (313), Maharashtra (262) and Goa (252).These eleven states together accounted for about 93% of the total mining leases in force.

Area wise, Rajasthan with 24% of mining lease area was ahead in 2006-07 followed by Orissa (14.89%), Andhra Pradesh (11.64%), Karnataka (8.30%), Jharkhand (7.80%), Gujarat (5.22%), Madhya Pradesh (4.66%), Goa (4.08%), Chhattisgarh (4.03%) and Maharashtra (3.82%). These ten states accounted for about 88.5% of the total mining lease areas in force and the remaining 11.5% was accounted for by the rest of the thirteen states. As on 31.06.2007, mineral wise, limestone ranks first with 1537 mining leases spread across the country covering an area of 106857.64 ha. Further, in addition to mined out areas there are a number of categories of lands lying unproductive and defined as wasteland. The estimates of extent of area suffering from land degradation vary from 38.40 Mha to 187 Mha National Remote Sensing Agency (now National Remote Sensing Centre) has estimated the extent of wastelands to be 63.85 Mha which is about 20% of the total geographical area. To harness the full potential of the available land resources and prevent its further degradation, wasteland development is of great significance. The problem of degraded land and its management is complex and multi-dimensional and its development requires a scientific, holistic and integrated approach.

Carbon dynamics in forests & plantations

The process of photosynthesis combines atmospheric carbon dioxide with water, subsequently releasing oxygen into the atmosphere and incorporating the carbon atoms into the cells of plants. Additionally, forest soils capture carbon. Trees, unlike annual plants that die and decompose yearly, are long-lived plants that develop a large biomass, thereby capturing large amounts of carbon over a growth cycle of many decades. Thus, a forest ecosystem can capture and retain large volumes of carbon over long periods. Forests operate both as vehicles for capturing additional carbon and as carbon reservoirs. A young forest, when growing rapidly can sequester relatively large volumes of additional carbon. An old-growth forest acts as a reservoir, holding large volumes of carbon even if it is not experiencing net growth. Thus, a young forest holds less carbon, but it is sequestering additional carbon over time. An old forest may not be capturing any new carbon but can continue to hold large volumes of carbon as biomass over long periods of time. Managed forests offer the opportunity for influencing forest growth rates and providing for full stocking, both of which allow for more carbon sequestration. Forest systems operate on a cycle of many decades and centuries, rather than annually or over a few years as would be the case with most crops and non-tree vegetation. As forest biomass expands, the amount of carbon contained in plant increases. As the biomass contract, the forest holds less carbon. In an unmanaged state, forests ebb and flow in response to disturbances in the natural system. Forest disturbance regimes are part of the natural ecological system, with wind, disease, fire and other natural, i.e., non-anthropogenic, events causing forest destruction and death. These events result in the release of carbon into the atmosphere but also are typically followed by the regrowth of the forest, which, in turn, begins a new process of carbon buildup in the forest. In some cases, these disturbances are catastrophic in that large areas of the forest landscape are disturbed, as with large wildfires such as are common in many pine and boreal forests. In other cases, the disturbances are highly localized, as with an occasional tree death due to disease or old age such as is common in many tropical forests. Carbon release is occasioned by the disturbance and often in the decay and decomposition of dead matter that follows. However, most natural forests have provisions for natural regeneration and regrowth, which, once again, captures carbon. Thus carbon is recycled in the forest ecosystem.

Afforestation Approach

Soil acts as a critical controlling component in the development of any ecosystem. Mine spoils are not suitable for both plant and microbial growth because of low organic matter content, unfavorable pH, and drought arising from coarse texture or oxygen deficiency due to compaction. The other limiting factors for revegetation of mine spoil may be salinity, alkalinity, poor water holding capacity, inadequate supply of plant nutrients and accelerated rate of erosion. Numerous studies have demonstrated that land restoration benefits from plantations because it allows jump-start succession. The catalytic effects of plantations are due to changes in under story microclimatic conditions (increased soil moisture, reduced temperature etc.), increased vegetational structure complexity, development of litter and humus layers and the soil physical and chemical environment and accelerating development of diversity on degraded sites. Plantations have an important role in protecting the soil surface from erosion and altering the accumulation of fine particles. They can reverse

degradation process by stabilizing soil through development of extensive root systems. Plantation of suitable species speed up succession that fulfills revegetation goal. Besides controlling leaching of nutrients through soil erosion increases plant diversity. Earlier studies indicated that well adapted plant species could be recommended to establish self-sustaining cover, which require little maintenance activities. In restoration, emphasis is given first to build soil organic matter; nutrients and vegetation cover to accelerate natural recovery process. Plantation can be used as a tool for mine spoil restoration as well as carbon sequestration.

Once plantation is established, plants increase soil organic matter, lower soil bulk density, moderate soil pH and bring mineral nutrients to the surface and accumulate them in available form. The plants accumulate these nutrients and re-deposit them on the soil surface in organic matter, from which nutrients are much more readily available for microbial breakdown. Once the soil characteristics have been restored, it is not difficult to form the full suit of self-sustained plantation on mined lands. Some of the plant species viz. *Jatropha curcas, Pongamia pinnata, Ailanthus excelsa* and *Withania somnifara* have been successfully tried on limestone mined out areas of Madhya Pradesh in India. These important biodiesel and medicinal plant species are suitably surviving and also have attracted different other shrubs, grasses and tree species to grow. A number of restoration ecologists have suggested many approaches for restoration of mined land; however afforestation approach is uniformly accepted. The major aims of restoration of mined spoils should be:

- Speedy development of vegetal cover capable of reducing erosion and pollution.
- To provide ecological site stability in terms of favorable soil environment

to support colonization of diverse flora and fauna

- Enrichment of soil nutrient levels, weathering of overburden materials and humification of organic matter.
- Bio-rejuvenation of soil system. Growth and survival of above ground and under ground flora.
- Creation of self sustaining ecosystem

Sequence of activities under afforestation approach

I. Studies on mined lands, overburden dumps and spoils

(a) Ecological survey of major vegetative association and natural succession

(b) Characterization of mine spoils and dumps and identification of limiting factors for plant growth

II. Stabilization of sites through mechanical measures

III. Selection of site-specific species suitable for the site

IV. Planting technique

V. Use of amendments – Application of biofertilizers, mulching, manuring, fertilization

VI. Conservation of Moisture and water harvesting

VII. Protection, Monitoring and Evaluation

Selection of site-specific species suitable for the site

For sustainable stability of the ecosystem selection of most suitable species is important. The basis of species selection is:

- Indigenous species of the particular eco-climatic or agro-climatic zone
- Ecological survey for identifying pioneering species of grasses, herbs, shrubs and trees
- Species trial in nursery

The selected species should be

- Capable of colonizing degraded areas
- Fixing atmospheric N_2 as well as conserving soil
- Capable of attracting birds and other faunal population
- Fast growing species should be given preference
- Preference should be given to indigenous one over the exotic

Benefits of Mines restoration

Mine reclamation, reforestation, and forest management may provide ecological and economic benefits. Environmental benefits include reclamation of sites and storage of carbon in trees and soil. Beyond carbon sequestration, environmental benefits also include improved air and water quality, enhanced of wildlife habitat, reduction in soil erosion, and increased recreational opportunities.

Air Quality:

Improvements in air quality generated by reforestation extend beyond the sequestration of carbon dioxide. Research has shown that reforestation benefits air quality in other ways. The leaf and needle surfaces of trees remove air pollutants such as nitrogen oxides, ammonia, and sulfur dioxide.

Wildlife Habitat:

Reforestation of land after surface mining has disturbed it can produce valuable wildlife habitat by planting trees. This will in turn generate forest litter, which is an important part of the food chain and enriches the soil. The tree canopy moderates temperatures of rivers and streams, which aids the survival of aquatic species. Providing habitat for endangered and threatened species is another potential benefit.

Erosion and water quality:

Reforestation can help remediate former mine lands by improving water quality. Tree roots stabilize mine land soil, which is susceptible to erosion. By stabilizing the soil, trees prevent sediment and nutrients from washing into nearby streams and rivers.

Phytoremediation:

Revegetating mining sites can be viewed as habitat improvement or the creation of a "living cap." In addition, depending on the type of contamination present and the type of trees planted, revegetation can simultaneously provide a phytoremediation contribution. Phytoremediation is the

contribution. Phytoremediation is the use of vegetation for in situ treatment of contaminated soils, sediments, and water. Phytoremediation has an advantage of being less costly than many remediation alternatives. However, the process requires considerable time and should be employed at sites where remediation can occur over a long period of time. It is important to recognize that planting trees for carbon sequestration purposes does not equate to phytoremediation. Depending on the type of trees selected, reforesting a former mine land to generate carbon credits may do nothing to extract or remediate any existing contamination at the site. However, some tree types may serve to phytostabilize the soluble metals in the ground water or soil as well as creating a more suitable soil.

Biodiesel production feedstock.

Apart from carbon sequestration and other environmental and ecological services; restoration of mined lands through afforestation may up to some extent provide India's one of the big challenges of energy production. Afforestation of mined lands by energy plants viz. *Pongamia pinnata* and *Jatropha curcas* may prove as efficient utilization of wastelands particularly in tropical and sub-tropical ecological settings. After initial establishment, these species require nominal maintenance, as both of the species are drought tolerant and well adapted to harsh climatic conditions.

Conclusion

While the debate over climate change continues, Government agencies, industry, and other organizations are pursuing proactive approaches to reduce atmospheric carbon, including carbon sequestration projects. Mine reclamation through reforestation and sustainable forest management can provide two major benefits. Financial benefits include revenue from new forests, job creation, and other impacts on local economies. Environmental benefits include storing carbon in the trees and soil, enhancing wildlife habitat, and improving air and water quality. Thus, restoration of mined lands through afforestation adds to the planet's net carbon storage and helps moderate global warming by slowing the growth of carbon emissions in the atmosphere. Adoption of afforestation approach of mined lands restoration by appropriate technology and plants species preferably oil yielding species of Biodiesel importance are strongly recommended. Technologies like application of biofertilizers and mulches may be of great help for establishment of plants on mined lands. In this way, the waste of mines may be converted in wealth of mines and the loss what the mining has made to the environment will be sufficiently compensated.

INDIA AS A MEGADIVERSITY NATION

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The United Nations has declared the year 2010 as the 'International Year of Biodiversity' and the theme for this year's environment day is "**Biodiversity: Connecting with Nature**" and India is one of the 12-mega diversity nation in the world. India is located in south Asia, between latitude 6^0 and 38^0 N and longitudes 69^0 and 97^0 E. Biogeographically, India is situated at the tri-junction of three realms Afro-tropical, Indo-Malayan and Paleo-Arctic realms, and therefore, has characteristic elements from each of them. This assemblage of three distinct realms makes the country rich and unique in biological diversity. Himalayas in the north, the Bay of Bengal in east, the Arabian Sea in the west, and Indian Ocean in the south bound the Indian landmass extending over a total geographical area of about 3029 million hectares. Two areas in India have been identified as megadiversity hot spot areas, which are western ghat forests and eastern Himalayan forests, but India as a whole country as megadiversity nation is remarkable in both species richness and endemism although it ranks 10^{th} position.

Why India said to be megadiversity nation

The large species richness and abundance are due to immense variety of climatic and altitudinal condition in country. These vary from the humid tropical Western Ghats to the hot desert of Rajasthan, from cold desert of Ladakh and the icy mountain of Himalayas to the warm cost of peninsular India and these includes ecosystem diversity is highest in the world, which represents forest ecosystems, grassland ecosystems, wetland ecosystems, coastal and marine ecosystems and the desert ecosystems. There are 10 Biogeography zones and 26 Biogeography provinces, which are representatives of all the major ecosystems of the world. The country constitutes only 2.4% of the world's land area, but having 11% of flora and 6.5% of fauna of the world. Approximately 65 per cent of the total geographical area has been surveyed so far. Based on this, over 46,000 species of plants which accounts for 15% of the known world plants in this 15000 species of the flowering plants, out of these 35% are endemic and located in 25 endemic centre and 588 genera of monocotyledons 22 are strictly endemic and 81,000 species of animals have been described by the Botanical Survey of India (BSI) established in 1890 and

Zoological Survey of India (ZSI) established in 1916, respectively. This list is being constantly upgraded, specially in lower plants and invertebrate animals. The families with high percentage of endemic species include Berberidaceae(98%), Saxifragaceae(92%),Ranunculaceae(72%),Rosaceae(70%),Melastomaceae(56%), Balsaminaceae(44%), Acanthaceae (38%) and Asclepia-daceae(32%). In addition to the above India also possess 40 species of insectivorous plants, 130 species of primitive plants, 130 species of parasites and 70 species of saprophytes There are about 15000 species of angiosperm, 65 species of gymnosperms, 1232 species of pteridophytes, 2850 species of bryophytes, 6990 species of algae, 2075 species of lichens, 14500 species of fungi and more than 850 species of virus and bacteria are found in India. It contains 1, 27,000 species of the world of which more than 45,000 species are plants and more than 80,000 species are animals. India contains about 75000 animal species out of which 80% are insects. In animals 62% of amphibians which majority is found in Western Ghats and 32% of reptiles are endemic. There are no clear estimation about marine biota in Indian continent. long coast line with 4, 52,468 sq. and extended economic zone of 20,13,510 sq. which are abundance of fish, crustaceans, corals, reptiles, seaweeds, molluscns and mammals. In India mangroves occur along the coastline comprising a total area of 6740 sq.kms; which is nearly 12% of the world's mangrove areas. The country also has four Coral Reef Areas located in Gulf of Mannar, Gulf of Kutch. Lakshadweep and Andaman and Nicobar Islands. The Western ghat in peninsular India, which extends in the southern states are treasures house of species diversity and has about 5000 species. It is estimated that almost one third of animals varieties found in India have taken in Western ghat of Kerala alone. The country is also one of the 12 primary centers of origin of cultivated plants and domesticated animals. It is considered to be the homeland of 167 important plant species of cereals, millets, fruits, condiments, vegetables, pulses, fiber crops and oilseeds, and 114 breeds of domesticated animals.

Endemic Species in India

India has many endemic plant and animal species. Among plants, species endemism is estimated at 33% having more than 140 endemic genera but no endemic families (Botanical Survey of India, 1983). Areas rich in endemism are northeast India, the Western Ghats and the northwestern and eastern Himalayas are hot spot. A small pocket of local endemism also occurs in the Eastern ghats. The Gangetic plains are generally poor in endemics, while the Andaman and Nicobar Islands contribute at least 220 species to the endemic flora of India (Botanical Survey of India, 1983). WCMC's Threatened Plants Unit (TPU) is in the preliminary stages of cataloguing the world's centers of plant diversity; approximately 150 botanical sites worldwide are so far recognized as important for conservation action, but others are constantly being identified (IUCN, 1987). Five locations have so far been issued for India: the Agastyamalai Hills, Silent Valley and New Amarambalam Reserve and Periyar National Park (all in the Western ghats), and the Eastern and Western Himalaya. Endemism among mammals and birds is relatively low. Only 44 species of Indian mammal have a range that is confined entirely to within Indian territorial limits. Four endemic species of conservation significance occur in the Western ghats. They are the Lion-tailed macaque *Macaca silenus*, Nilgiri leaf monkey *Trachypithecus johni*, Brown palm civet *Paradoxurus jerdoni* and Nilgiri tahr *Hemitragus hylocrius*. Only 55 bird species are endemic to India, with distributions concentrated in areas of high rainfall. They are located mainly in eastern India along the mountain chains where the monsoon shadow occurs, southwest India and the Nicobar and Andaman Islands. In contrast, endemism in the Indian reptilian and amphibian fauna is high. There are around 187 endemic reptiles, and 110 endemic amphibian species. Eight amphibian genera are not found outside India.

Species Diversity

India contains a great wealth of biological diversity in its terrestrial and aquatic areas. This richness is shown in absolute numbers of species and the proportion they represent of the world total.

India has many scientific institutes and botanical gardens and university departments interested in various aspects of biodiversity. A large number of scientists and environmentalist have been engaged in inventory, research, and monitoring. The general state of knowledge about the abundance and richness of the species is therefore fairly good.

Conservation strategies

The strategies for conservation and sustainable utilization of biodiversity for development of nation have comprised providing special protection to biodiversity rich areas by declaring them as national parks, wildlife sanctuaries, biosphere reserves, ecologically fragile and sensitive areas. Other strategies

Table 1: Comparison between the Number of Species in India and the World

Group	Number of species in India (SI)	Number of species in the world (SW)	SI/SW (%)
Mammals	350	4629	7.6
Birds	1224	9702	12.6
Reptiles	408	6550	6.2
Amphibians	197	4522	4.4
Fishes	2546	21730	11.7
Flowering Plants	15000	250000	6.0

include offloading pressure from reserve forests by alternative measures of fuel wood and fodder need satisfaction by afforestation of degraded areas and wastelands and creation of *ex-situ* conservations facilities such as gene banks. For example, the Tura Range in Garo Hills of Meghalaya is a gene sanctuary for preserving the rich native diversity of wild citrus and musa species. Approximately, 4.2 per cent of the total geographical area of the country has been earmarked for extensive *in-situ* conservation of habitats and ecosystems. The forest types according to Champion and Seth (1968) include tropical, subtropical, temperate and alpine. These are further divided into sixteen major types and 232 subtypes for conservation purposes. On the basis of these, the country has 13 Biosphere reserves, 604 protected areas (97 National parks and 507 Wildlife Sanctuaries), covering more than 5% of the land surface. The Indian Council of Forestry Research and Education (ICFRE) has identified 309 forest preservation plots of representative forest types for conservation of viable and representative areas of biodiversity. Out of these plots, 187 area in natural forests and 112 are in plantations. The results of this network have been significant in restoring viable population of large mammals such as tiger, lion, rhinoceros, crocodiles and elephants. Six Indian Wetlands have been designated as wetlands of International importance under the "Ramsar Conventions" and India has more than 2500 wetlands spread over an area of 4.1 Million hectare. India is also embodied with 64,122 Km. of rivers networking contrasting land forms like mountain ranges, plateaus and valleys, 1.94 Million hectare of reservoirs, 2.26 Million hectare of ponds and lakes, 1.47 Million hectare of brackish water and about 8060 Km. extensive coastline and 1.56 Million hectare of water logged lands in command area. These all water body conserves different type of flora and fauna. To complement *in-situ* conservation, attention has been paid to *ex-situ* conservation measures. According to currently available survey, central government and state governments together run and manage 33 botanical gardens. Universities have their own botanical gardens. There are 275 zoos, deer parks, safari parks and aquaria. A Central Zoo Authority was set up to secure better management of zoos. A scheme 'Assistance to Botanical Gardens' provides one-time assistance to botanical gardens to strengthen and institute measures for *ex-situ* conservation of threatened and endangered species in their respective regions. Programmes have been launched for scientific management and sensible use of wetlands, mangroves and coral reef ecosystems. Twenty-one wetlands, and mangrove areas and 4 coral reef areas have been identified for intensive conservation and management purposes. Mangroves conservation is one of the thrust areas of the Ministry of Environment and Forests.

The Ministry of Environment and Forests constituted the National Afforestation and Eco-development Board (NAEB) in August 1992. NAEB has evolved specific schemes for promoting afforestation and management strategies, which help the states in developing specific afforestation, and management strategies and eco-development packages for augmenting biomass production through a participatory planning process of joint forest management and microplanning.

Major central acts relevant to biodiversity include Forest Act, 1927, Wildlife (Protection) Act, 1972, Forest (Conservation) Act, 1980, and Environment (Protection) Act, 1986. The various central Acts are supported by a number of state laws and statutes concerning forests and other natural resources. The policies and strategies directly relevant to biodiversity include National Forest Policy amended in 1988, National Conservation Strategy and Policy Statement for Environment and Sustainable Development, National Agricultural Policy, National Land Use Policy, National Fisheries Policy, National Policy and Action Strategy on Biodiversity, National Wildlife Action Plan and Environmental Action Plan.

India's Biodiversity as a beauty

The eastern Himalayas from a humid region having high monsoon rain fall, milder temperature and less snowfall. The mighty mountains with their snow-pick and extremely rich forest exert a tremendous influence on the flora and fauna of the region. Arunachal Pradesh is a land of mighty rocks and luxuriant forests, gentle streams and raging torrents. It presents a breath-taking spectacle of nature in her glory, beauty of gorges and galaxy of ethnics people make the area as one of the best in the world. The mountain range in Sikkim, Arunachal Pradesh, Nagaland, Manipur, Tripura, Mizoram and the Dargling hills are symbol of celestial splendor where a good number of peaks rise well over 7000m, the highest being the Kanchinjongha 8335m which is very close to Mt. Everest, the world's highest peak.

Conclusion

In our opinion the biodiversity is not only genes, species, population, community and ecosystem only but also it refers to productivity, nutritional status, biocontrol, biofertilizers, bioenergy, breeding strategies, livelihood, lifestyle, endogenous knowledge with ex-situ and in-situ conservation. We have a lot of endogenous species of flora and fauna in all ecosystems which are important for developing countries particularly India where economic depend heavily on these resources. India's megadiversity is well-placed, cultural diversity, different religions, languages, traditions and festivals, Ayurveda, Unani, Homeopaths and Herbal preparations (cosmetics and Pharmaceuticals purposes). They are part of traditional biodiversity. Many crops like rice sugarcane, mango, jute, citrus, banana, bazra, jowar etc, arose in India and spread throughout the world and a large proportion of the Indian biodiversity is still unexplored.

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