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ABSTRACTS AND SOUVENIR

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ECOSYSTEM DIVERSITY AND CARBON SEQUESTRATION
Some Issues Confronting Humanity

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Terrestrial ecosystems are in perilous state. Aquatic ecosystems too are turning inhospitable. Industry and transport sectors are turning the environment increasingly less hospitable. Agriculture sector too is not environment-friendly and contributing in one way or the other to the worsening on our environment. Balance in photosynthesis by green plants and breathing by animals is at stake with accumulation of carbon dioxide (CO_2) to a critical level, and further set to cause greater concerns about the state of our biosphere, of our planet and of our lives.

Not only does the increased concentration of free CO_2 happen to be a matter of concern, methane (CH_4), nitrous gas (N_2O), CFC-12 (CCl_2F_2), HCFC-22 ($CHClF_2$), perfluoromethane (CF_4), sulphur hexafluoride (SF_6) are the other greenhouse gases which are increasing at an alarming rate.

Capacities of the Earth's ecosystems to sequester CO_2 are squeezing rapidly. Carbon sequestration, of course, offers potential solution to the vital issues of global warming and climate change confronting the humanity today.

The Ecosystem Diversity

Ecosystem diversity is crumbling at an alarming rate. A glimpse of deforestation would reveal it. We are losing about 11 million to 17 million hectare of forests in the whole world (http://www.kidsforfuture/ourfuture/000032.html 2006), i.e., little less than one hectare to about five hectare per second. We thus can imagine the rate of CO_2 concentrations released into the atmosphere thanks to depletion of the ecosystem capability to sequester CO_2 as a result of callous anthropogenic activities. Again, "dead forests" are also being increasingly witnessed. These are the forests which are getting destroyed even without being cut down. They are dying due to acid rain. And, should the temperatures continue to rise thanks to global warming, more ecosystems are likely to vanish. If these trends continue, days are not far when this green planet of ours would turn brown.

In June 1992, the world community gave birth to the Convention on Biodiversity. One hundred and sixty-seven countries of the UNO signed the Convention. The Convention on Biodiversity came into force on December 29, 1993. As the best evidence of this crucial Convention's comprehensiveness is found in Article 1, which outlines the Convention's objectives, viz. Crattiger *et al.* (1994):

- the conservation of biodiversity at the genetic, species and ecosystem levels;
- the sustainable use of its components; and
- the fair and equitable sharing of benefits derived from the use of genetic resources.

These objectives embody the realization that biodiversity is a cross-sectoral issues with biological, ecological and socio-economic considerations. The Convention on Biodiversity should be regarded as one of the landmark events in the history from the viewpoint that the world community put its fingers on the pulse of life, intactness of life systems and, of course, the very principle of sustainability of biosphere and of the living planet. The Convention has been of phenomenal importance on account of its emphasis placed on approaching biodiversity conservation from a development perspective. Although virtually no, or only little values seem to have been attached with the obvious linkages between biodiversity conservation and carbon sequestration enhancement. A further emphasis on this important phenomenon of life vis-à-vis biodiversity conservation would be in favour.

India is one of the fewer mega diversity centres and has natural credit of two hot spots. We are endowed not only with very rich species and genetic diversity but also with unique ecosystem diversity. This ecosystem diversity in India ranges from tropical rain forests to wetlands to deserts, from alpine meadows to temperate forests to subtropical forests, from glacier-fed rivers to forest-fed rivers, from glacial lakes to vast open oceans, and the likes.

An spectacular body of literature on the diversity of ecosystems is available. However, their potential capabilities of carbon sequestration remains a less addressed issue. An assessment of the carbon sequestration capability of different types of ecosystems would impart a new dimension to the ecosystem/ natural resource/ forest management. This strategy would greatly help mitigating climate change or global warming with carbon-sequestration-oriented ecosystem management as the indispensable strategy.

The Greenhouse Gases

Carbon dioxide (CO_2), methane (CH_4), nitrous gas (N_2O), CFC-12 (CCl_2F2), HCFC-22 ($CHClF_2$), perfluoromethane (CF_4), sulphur hexafluoride (SF_6) are the greenhouse gases that are playing havoc. While CFC-12 (CCl_2F_2), HCFC-22 ($CHClF_2$), perfluoromethane (CF_4), sulphur hexafluoride (SF_6) existed at zero level in the pre-industrial age, the carbon dioxide, methane and nitrous oxide gas had only as low as 278000, 700 and 275 ppbv industrial concentrations in that age. Fossil combustion, land use conversion and cement production were attributable to exceedingly high release of carbon dioxide. Fossil fuels, rice cultivation, waste dumps and livestock have been the major contributing factors of methane increase. Fertilizer, industrial processes and combustion have led to substantial increase in the concentration of nitrous gas. Liquid coolants and foam are responsible for CFC. Liquid coolants have also contributed to HCFC. Production of aluminum is largely responsible for perfluoromethane. Dielectric fluid gave rise to sulphur hexafluoride.

Amongst all the greenhouse gases, CO_2 is the most responsible one for the warming of Earth's environment, which can be blamed for more than 60 percent of the cause of greenhouse effect. Methane is at second place that is responsible for about 20 percent of this effect. Chlorofluorocarbons, the third most damaging agents, cause about 10 percent of the greenhouse effect.

India's greenhouse gases inventory suggests that Energy & Transformation Industries contribute nearly 29% to the greenhouse gases, other industries 12%, transport about 7%, industrial processes 8% and about 22% from agriculture (15% from enteric fermentation and 7% from rice cultivation). Considerably large CO_2 emissions are generated from households. In addition to breathing, we contribute to CO_2 production (and other greenhouse gases) while watching television, turning on lights and refrigerators, air-conditioners, cooking, etc. Our elevated living standards and expensive lifestyles and production of greenhouse gases and pollutants virtually go hand-in-hand.

The Greenhouse Effect and Climate Change

The earth's climate is driven by a continuous flow of energy from the sun. The earth must send this energy back to sun in the form of infra red radiation. Green house gases in the atmosphere, however, block this radiation from escaping directly from the surface of the Earth. Concentration of the green house gases is increasing thanks to anthropogenic activities. As a result, since 1800, levels of CO_2 have risen by over 30%. This increase over last 200 years is three times larger than that occurred in the earlier 10,000 years. Climate models predict that the global temperature will rise by about 1.4 - 5.8°C by the year 2100.

Carbon dioxide gas makes up only about 0.03% of the air, but it acts as the "earth's sweater". And this "sweater" is becoming thicker due to which the earth is becoming warmer.

When there is global warming, there are numerous problems not simply that air is too hot. The world is experiencing more typhoons, hurricanes and storms because of global warming (http://wwww.kdsforfuture.net/ourfuture/000022.html 2006). If this trend continues, this much rise in the global temperature would be catastrophic for life systems. The possible consequences of global warming and climate change would be effect on glaciers and stream flows, very adverse effects forest ecosystems, flora and fauna, agriculture, and on society as a whole. Decline in winter rain fall and spell of drought during summer and increase in monsoon rainfall, etc. might also be experienced.

An overall picture of the global climate change can be summed up as follows (IPCC 2001):

ΔT over the 20th Century	$+0.6\pm0.2^0$C
Rate of ΔT increase since 1950	$+17^0$C/decade
Sea level rise over 20th Century	+0.1-0.2 m
Change in precipitation	+0.5-1%/decade

Extreme events	+2-4%

Climate change is already proving a cataclysm for the humanity. Earth's warming climate is estimate to contribute to more than 150,000 deaths and five million illnesses every year and, according to the World Health Organisation (WHO), this toll could double by 2030. Climate change is driving up rates of malaria, malnutrition and diarrhea throughout the world. Worst outbreak of dengue fever in South Asia is also attributable to warmer temperatures. WHO data also reveal that rising temperatures disproportionately affect poor countries that have done little to create the problem. The regions most at risk from climate change include the Asian and South American coasts aalong the Pacific Ocean, as well as the Indian Ocean coast and sub-Saharan Africa. Climate-sensitive diseases are more prevalent there because those regions are most vulnerable to abrupt shift to climate. Large cities also are likely to experience more severe health problems because they produce what scientists refer to as the urban "heat island" effect (Eilperin 2005).

What is Carbon Sequestration?

Earth's gradually but steadily becoming warmer is one of the grimmest and gravest issues humanity on earth has ever faced in the recorded history. An environment of optimism nevertheless prevails. CO_2 and other greenhouse gases cause havoc only when they are freed in the atmosphere. Carbon can be sequestered into ecosystems and excess of its can remain sunk where it should be. It can be fixed into plant biomass or in soil.

Carbon sequestration is the mechanism through which global warming and climate change could be controlled to a great extend. What is then carbon sequestration, the buzzing word of the day?

It can be defined as the capture and secure storage of carbon that would otherwise be emitted to or remain in the atmosphere, or to keep carbon emissions produced by human activities from reaching the atmosphere, by capturing and diverting them to secure storage. It is through this process that agriculture and forestry practices remove CO_2 from the atmosphere.

Scenario 1: Carbon Sequestration in Indian Soils

With a large land area and diverse ecoregions, there is a considerable potential of terrestrial/ soil carbon sequestration in India. A study by Rattan Lal, Director of the Carbon Management and Sequestration Centre at the Ohio State University (2004) would reveal that of the total land area of 329 million hectares (Mha), 297 Mha is the land area comprising 162 Mha of arable land, 69 Mha of forest and woodland, 11 Mha of permanent pasture, 8 Mha of permanent crops and 58 Mha is other land uses. The soil organic carbon (SOC) pool is estimated at 21 Pg (petagram = Pg = 1 x 10^{15} g = billion ton) to 30-cm depth and 63 Pg to 150-cm depth.

The soil inorganic carbon (SIC) pool, according to Lal's (2004) estimates, is 196 Pg to 1-m depth. The SOC concentration in most cultivated soils is less than 5 g/kg compared with 15 to 20 g/kg in uncultivated soils. Low SOC concentration is attributed to plowing, removal of crop residue and other biosolids, and mining of soil fertility. Accelerated soil erosion by water leads to emission of 6 Tg C/y.

Lal (2004) further relates that important strategies of soil C sequestration include restoration of degraded soils, and adoption of recommended management practices (RMPs) of agricultural and forestry soils. Potential of soil C sequestration in India is estimated at 7 to 10 Tg C/y for restoration of degraded soils and ecosystems. Potential of soil C sequestration in India, according to Lal (2204), is estimated at 7 to 10 Tg C/y for restoration of degraded soils and ecosystems, 5 to 7 Tg C/y for erosion control, 6 to 7 kg C/y for adoption of RMPs on agricultural soils, and 22 to 26 Tg C/y for secondary carbonates. Total potential of soil C sequestration, thus, is 39 to 49 (44±5) Tg C/y.

Scenario 2: Carbon Sequestration Potential of Indian Forests

The forests are the most important terrestrial ecosystems from the point of view of carbon sequestration. The forestry sector not only sustains its carbon but also has the potential to absorb carbon from the atmosphere.

M. Lal and Roma Singh of the Centre for Atmospheric Sciences, Indian Institute of technology, New Delhi have attempted to estimate carbon sequestration potential of Indian forests. India has maintained approximately 64 Mha of forest cover for the last decade. Lal and Singh (2004) maintain that rate of afforestation in India is one of the highest among the tropical countries, currently estimated to be 2 Mha per annum.

The annual productivity has increased from 0.7 m^3 per hectare in 1985 to 1.37 m^3 per hectare in 1995. Increase in annual productivity, according to Lal and Singh (2004), directly indicates an increase in forest biomass and hence higher carbon sequestration potential.

The carbon pool for the Indian forests is estimated to be 2026.72 Mt for the year 1995, as per the estimates of this case study. Estimates of annual carbon uptake increment suggest that our forests and plantations have been able to remove at least 0.125 Gt of CO_2 from the atmosphere in the year 1995. Lal and Singh (2004) further assume that that the present forest cover in India will sustain itself with a marginal annual increase by 0.5Mha in area of plantations and that we can expect our forests to continue to act as a net carbon sink in future.

Global Response

Carbon Trading

Let us rewind to Kyoto Protocol. Kyoto Protocol was signed in 1997; came into force since 16 Feb 2005. It was ratified by more than 130 countries. All countries were required to reduce their greenhouse gas emissions by 5% – from 1990 levels – by 2012 or pay price to those that do. The idea was to make developed countries pay for their wild ways with emissions while at the same time monetarily rewarding countries with good behaviour in this regard (http://www.goodnewsindia.com/index.php/Supplement/ article/320/ 2006). It is also a mechanism to enable Annex I parties to "purchase" GHG emission reduction from projects in developing nations. Annex I parties include the industrialised countries who have specific commitments to reduce greenhouse gas emissions under the 1992 United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol. The only exceptions are Turkey and Belarus which are in Annex I but do not have reduction commitments under the Kyoto Protocol.

A commodity Certified Emission Reduction (CER), equivalent to 1 ton of CO_2 is proposed. When a project activity in Annex 1 does better than "Business as Usual" scenario the emission reduction over that level is translated into CER.

The World Bank has built itself a role in this market as a referee, broker and macro-manager of international fund flows. The scheme has been entitled Clean development mechanism (CDM) in 2000, which is a flexible mechanism that creates a "Market Based Instrument", which 'commoditizes' environmental performance over business-as-usual. CERs accrue each year after the project performance is "verified" through a pre approved methodology (http://www.goodnewsindia.com/index.php/Supplement/ article/320/ 2006).

The purpose of the clean development mechanism (CDM) is defined in Article 12 of the Kyoto Protocol to the United Nations Framework Convention on Climate Change. The CDM has a two-fold purpose: a) to assist developing country Parties in achieving sustainable development, thereby contributing to the ultimate objective of the Convention; and b) to assist developed country Parties in achieving compliance with part of their quantified emission limitation and reduction commitments under Article 3. Purpose of clean development mechanism: Emission reduction, Application of geo-engineering, Forestry options, Carbon storage in wood products, Introduction of carbon credits.

Sinks/sequestration

"Sinks" and "sequestration" are the generic names given to projects that soak up and store carbon in biomass such as trees, formally known as Land Use Change and Forestry projects (LUCF). In general, afforestation is the planting of trees on land that historically has not had tree cover, while Reforestation is the planting of trees on land that was cleared *before* 1990, the base year from which most emission reductions under the Kyoto Protocol are measured.

The amount of credits from CDM sinks projects that can be used by an industrialised country to meet their Kyoto target is limited to 1% of their total emissions in their *base year* (usually 1990) multiplied by 5 (1% for each year of the first commitment period which is 2008-2012).

References

Burhenne-Guilmin, F. and Glowka, L. 2004. An introduction to the Convention on Biological Diversity. In: Krattiger, A.F., Mc Neely, J.A., Lesser, W.H., Miller, K.R., Hill, Y.S. and Senanayake, R. (eds.) *Widening Perspectives on Biodiversity*. p.15-18. IUCN, Gland, Switzerland and Cambridge, U.K., and International Academy of the Environment, Geneva, Switzerland.

Eilperin, J. 2005. WHO's climate warning. *The Wall Street journal*. November 18-20, 2005.
http://www.goodnewsindia.com/index.php/Supplement/ article/320/. 2006
http://wwww.kdsforfuture.net/ourfuture/000032.html. 2006. It's getting hot.
http://wwww.kdsforfuture.net/ourfuture/000032.html. 2006. The Earth is turning brown.
IPCC. 2001. *Climate Change 2001*. WMO and UNEP.
Lal, M. and Singh, R. 2004. Carbon sequestration potential of Indian forests. *Environment Monitoring and Assessment*, 60(3): 315-327.
Lal, R. 2004. Soil carbon sequestration in India. *Climatic Change*, 65 93): 277-296.

FOREST ECOSYSTEMS AND CARBON SEQUESTRATION IN INDIA

J. B. Lal

Introduction

Forest is both a source and a sink of carbon dioxide. However, the relationship between forest systems and carbon sequestration on one hand, and deforestation and carbon emission on the other, is not only complex but variable. In India where geographical variability of forest systems is immense to find the precise equations to describe the relationships is much more difficult. The forest ecosystems in India vary from moist alpine to wet evergreen. There are as many as 16 major type groups of forests, 3 in alpine zone, 3 in temperate, 3 in sub-tropical, and 7 in tropical. These 16 groups are further divided in 221 ecologically stable vegetation types (Lal, 1989). A forest type is defined as "a unit of vegetation which possesses broad characteristics in physiognomy and structure sufficiently pronounced to permit its differentiation from other such units". The definition certifies that a forest type qualifies as a distinct ecosystem.

The Two Basic Reactions

The two basic reactions that link the atmospheric carbon dioxide with living plants are photosynthesis, i.e.,

$$6CO2 + 6\ H_2O + \text{Solar Energy} = C_6H_{12}O_6 + 6O_2$$

and, its opposite, respiration, or oxidative metabolism, i.e.,

$$6O_2 + C_6H_{12}O_6 = 6CO_2 + 6H_2O + \text{Heat.}$$

Photosynthesis and respiration are vital activities not only in plant ecology, but also in human ecology. Photosynthesis fixes the carbon energy, and respiration uses most of that energy, and the balance is the net primary productivity (NPP) of a vegetational unit. The primary production from forests is 49% of the total production from land (Lal, 1995). Whittaker and Likens (1973) estimated the NPP from various forests as follows:

Forest ecosystem type	NPP (Mean) g/square meter/year
Tropical evergreen	2200
Tropical deciduous	1600
Temperate evergreen	1300
Temperate deciduous	1200
Shrubland	700
Alpine	140
Desert and semi-desert	90

Forest and Climate Change

Forests affect the climate and in turn are influenced by the climate. Forests are crucial element of climate change in their capacity as carbon emitting source through deforestation and degradation, and a carbon sink through reforestation and afforestation. Simulated models suggest that about 30 % of global forest will experience big changes in composition and structure if carbon dioxide level doubles from pre-industrial level.

The impact of climate change will be much more on temperate forests than on tropical ones.

NPP of Forests and Atmospheric CO_2

NPP of various forests is important to the humans not only for matter and energy, but also, as the recent observations and researches prove, for its role in stablising carbon dioxide concentration in the atmosphere and checking the consequent global warming. The carbon dioxide concentration in the atmosphere has been steadily rising from about 290 ppm (part per million) in the latter half of the nineteenth century to over 358 in 1994, to over 370 ppm at the beginning of 21st century. The steep rise in the carbon dioxide concentration in the atmosphere leading to global warming, dangerous not only to humans, but to all kinds of life, is attributable mainly to two factors: first, exponential increase in burning of fossil fuel, and secondly, rapid decrease in earth's forest cover.

The addition of carbon-dioxide to the atmosphere on account of fossil fuel burning is estimated at 5×10^{15}g C/yr (Lal, 2005). The additional input of carbon dioxide on account o f deforestation, has not been estimated with any degree of certainty. As a matter of fact, in establishing a correlation between deforestation and carbon emission so many variables have to be taken into accounts that precise estimates are, indeed, very difficult. Various evaluations, however, suggest a figure of 2.8×10^{15} g C/yr for carbon emission on account of loss of forest cover. Addition of the two figures, gives the figure for total carbon emission as 7.8×10^{15} g C/yr.

If working out of emission figures is difficult, the exercise in relation to 'carbon sink' is virtually confounding. Of the estimated carbon emission in the world, only

3.8×10^{15} g C/yr accounts for the rise in atmospheric carbon dioxide. What are the sinks for the balance of 4.7×10^{15} g C/yr. Estimates vary enormously. If one estimate puts oceans as top most sink, the other puts them at the bottom. Whatever may be the situation, the role of terrestrial ecosystems, especially of forests, is significant, and their carbon assimilating capacity needs to be thoroughly researched upon.

Forestry Situation in India

FAO defines forests as ecosystems with a minimum of 10% crown cover of trees and/or bamboos, generally associated with wild flora, fauna, and natural soil conditions, and not subject to agricultural practices.

Deforestation in the Indian as well as in the international context refers to a change of land use with the depletion of tree cover to less than 10%. The change in a forest crop on account of the lowering of the crown density with the consequent lowering of the productivity is termed degradation. Unfortunately, degradation is mostly not assessed.

In India, the biennial report brought out by Forest Survey of India (FSI) since 1987 give the figures of forest cover in the country in various years based on the interpretation of satellite imagery. FSI has adopted the same definition of forests as FAO. It classifies forest with crown density of 40% or more as 'dense', with less than 40% as 'open'.

Forest Cover in India

Category	Forest Area in million hectare			
	1987	1993	1997	2003
Dense	36.14	38.56	36.72	39.06
Open	27.66	25.03	26.13	28.77
Mangrove	0.40	0.42	0.48	Not assessed separately
Total	64.20	64.01	63.33	67.83

It would appear from the table given above that the forest cover in country was nearly static in nineteen-nineties, and has increased with the turn of the century.

This statement is only technically true. True in the sense that the area of forest lands with crown density of 10% or more has stayed close to or over 64 million hectare. These figures, however, do not reflect degradation. Even if the crown density of a forest reduces from 90% to 60%, and growing stock to two-third, the assessment would indicate only status quo. That degradation is taking place and on account of, first, consumption of firewood in excess of sustainable level of production, grazing in forest beyond carrying capacity, and recurring fires. The annual consumption of firewood in the country was estimated at 235 million cubic meter by the author in1987 (Lal,1989), and at 270 million cubic meter by FAO in 1994. The gap in consumption and sustainable production of firewood was estimated at 152 million cubic meter by the author (Lal, 1995), and at 147 million cubic meter by FAO.

The current growing stock of wood in forests is estimated by FSI (2003) at 4,781 million cubic meter. FSI also estimated the growing stock of trees outside forests, and the figure for this stock is 1632 million cubic mete

Carbon Emission in India

Even assuming that on account of a little more efficiency in use, the firewood consumption has not increased in the country since FAO made the estimate, the country is emitting 85 million tons of carbon by burning wood. Since each ton of carbon emitted into the air results in 3.7 ton of carbon dioxide, the country has been adding about 315 million tons of carbon dioxide annually.

The average of various estimates of carbon emission on account of fossil fuel burning works out at about 450 million tons. Thus the total of carbon dioxide released in the country annually on account of fossil fuel burning and firewood consumption is about 765 million tons. The country may plan to sequester carbon in as near quantity to this figure as possible.

Carbon Sequestration in Forest Biomass

We stated earlier that the growing stock (woody biomass above the ground) in the forests of the country is estimated at about 4781 million cubic meter equivalent to 1484 million tons of carbon. This figure, however, represents only a fraction of living phytomass; this does not include foliage, shrubs, herbs, and other ground flora and the root. The annual increment on this quantity, i.e., potential stem wood productivity is worked out by the author at 92 million cubic meter, corresponding to 29 million tons of carbon.

Potential stem-wood productivity of India's forests

Region	Forest Cover (million cu.m.)	Potential productivity (cu.m./ha/yr)	Total potential productivity (million cu.m./yr.0
1. Western Himalaya	5.38	2.21	11.89
2-Eastern Himalaya	6.46	2.03	14.85
3-North-East	7.33	1.66	12.17
4.Western Coast & Andaman & Nicobar Islands	1.95	3.85	7.51
5-Deccan	15.90	1.35	21.46
6.Central India	17.49	1.05	18.36
7.Gangetic Plain	4.75	0.80	3.80
8-Indus Plain	1.44	0.41	0.59
Total	60.70		90.63

Alpine, semi-desert forests and mangroves are not included in the calculations. If they are included, total potential productivity would be about 92 million cubic meters.

If we use the mean NPP figures worked out by Whittaker and Likens (1973) and multiply by forest cover figures estimated by FSI (2003), the net primary production of India's forests works out at about 1010 million cubic tons of dry matter (DM) per annum corresponding to 460 million tons of carbon.

The NPP thus worked out is many times higher than stem-wood productivity worked out by the author. This is because of the fact that 50% of total NPP is lost in saprobe respiration, and 10% in animal respiration (Lal, 1989). Only 40% forms the accumulated dry matter (DM). And of accumulated DM all is not living phytomass, i.e., wood and leaves. It also includes litter and carbon accumulated in soil. In tropical forests, on average, the break-up of phytomass is:

Wood stem	57%
Wood root	20%
Leaf	5%
Soil carbon	16%

On the basis of the break-up indicated above, the estimate of portion of NPP accumulated in stem-wood in India's forests works out at 104 million tons. If we reduce it by 10% to account for shrub wood, the figure comes down to 93.6 million tons. That this figure is more than 3 times higher than the figure estimated by the author indicates that country's forests suffer from immense biotic pressure, and are in far from ideal ecological situation. Nevertheless, it can be safely assumed that afforestation or reforestation made over an hectare of land would, on average, sequester 1.5 tons of carbon.

The Strategy

Before we suggest a strategy, we should take into account the following:

- Mature communities are more stable, but immature communities, i.e., seral stage forests and plantations, are more productive, i.e., store more carbon.
- As said before India can be divided in as many as 8 physiographic zones. In a more refined division (as done by FSI in its 2003 Repprt) it can be divided in as many as 14 physiographic zones.
- India has many as 221 forest types. Each type plays quantitatively a different role in carbon sequestration.

Considering these statements, and taking into account facts mentioned earlier, the following strategy with 6 components is suggested to check the rise of carbon concentration in the atmosphere:

First, to use firewood more efficiently, and increase the present level of thermal efficiency which is only 8% to a minimum of 25%. This would reduce our firewood consumption to one- third of the present quantity, and we would emit 60 million ton less carbon in the air.

Second, the protected area in the country be increased from 14 to 20 million ha. The measure is likely to increase annual carbon sequestration by 4 million tons.

Third, we afforest a minimum of one million hectare in a year to secure additional sequestration of 15 million tons of carbon.

Fourth, we have virtually ignored the scientific management of fourth bio-productive system, viz. grassland (the other 3 systems are cropland, forest, an dfisheries).

If we manage 12 million hectares officially recorded as pastures, scientifically, we would secure additional sequestering of 6 million tons of carbon.

Fifth, wherever possible, integrated land-use systems such as agri-silviculture, silvi-pastoral, and agri-silvi-pastoral be adopted to make more efficient use of land resource.

Sixth, forests be protected more earnestly from excessive grazing, and recurring fires.

If the strategy succeeds, a net carbon fixation of 30 million tons by forests and allied systems could be achieved.

References

FAO. 1994. Year Book of Forest Production

FSI. Forest Survey Reports, 1987, 1991, 1997, 2003

Lal, J. B. 1989. India's Forests: Myth & Reality, Natraj Publishers, Dehra Dun

Lal, J. B. 1995. Forest Biomass & Carbon Sequestration in India. Journal of Tropical Biodiversity, Vol. 2; No 1.

Lal, J. B. 2005. Economic Tools & Institutional Framework for Forest Development Planning. IBD, Dehra Dun

Whittaker, R. H., & Likens, G. E. 1973. Carbon in the Biota. US Dept. of Commerce.

MICROBIAL DIVERSITY AN INDICATOR OF SOIL ORGANIC CARBON STATUS DURING REDEVELOPMENT OF HUMID SUBTROPICAL PERTURBED ECOSYSTEM

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The study makes an attempt to observe the relationship between the microbial diversity and soil organic carbon status during hill agro ecosystem redevelopment after perturbation in Dimoria Block and Tribal Belt of Assam. The experiment was laid during 2003-2006 on the mid hills, which are disturbed repeatedly after every 4-years by *jhum kheti*. Soil physico-chemical and hydraulic characteristics, plant community analysis, microbial diversity and microbial biomass carbon were estimated at 0-20cm of soil depth during the study and compared with a nearby forest ecosystem considered sacred by the Karbi (a traditional community of Assam). Soils in both the abandoned jhum fallow and the nearby forest ecosystem were acidic and sandy loam. Significant relationship was observed between microbial diversity and soil bulk density. Soil temperature was higher in the jhum fallow when compared with the forest ecosystem. The wilting point and the field capacity in cm^3cm^{-3} of the soils in the jhum fallow and the forest ecosystem was 0.09 and 0.21 and 0.12 and 0.46, respectively. Soil moisture content was lower in the jhum fallow and it might be one of the reasons for recording less microbial diversity in the perturbed ecosystem. Soil organic matter content in jhum fallow increased as fallow period increased but still the values were statistically lower when compared with the forest ecosystem. Microbial diversity steadily increased as the plot was left fallow after *jhum kheti*. It was interesting to observe statistically significant linear relationship between the soil organic carbon and microbial diversity during ecosystem redevelopment. The study suggests that microbial diversity is linked to, among other properties, soil organic carbon one of the important parameter for increasing soil fertility during redevelopment of the degraded ecosystems. Therefore, microbial diversity can be used as a biological indicator to determine the recovery of soil fertility in the repeatedly perturbed ecosystem in the humid tropics.

ECOSYSTEM DIVERSITY AND CARBON SEQUESTRATION: SOME CONSIDERATIONS

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In order to balance our Ecosystem, following measures can be taken:

1-Measurement of pollutants this should be done periodically so that we can apply controlling measures to it. Like carbon from industries, waste water, lowering of oxygen in the atmosphere.

Effluent from electronic industries: These are the main cause of chlorofluorocarbons in the atmosphere**.** Export of carbon from surface to the rivers and to the ocean and fate of excess nutrients entering the ocean, pollutants bound to sediment particles that result in degradation of habitat.

2-Test Equipments: Oxygen and carbon dioxide testers: one of the equipment is Roast analyzer. In recent years, electronic testers have become available for analyzing flue gases. Some of the advantages with electronic equipment that they provide an immediate and continuous readout by simply inserting a probe in it. The most economical testers for carbon monoxide and specific pollutant gases use disposable chemical available now a days. Similarly to measure smoke we can use a filter on a pump where its blackness can be compared with original data and one optic densitometer which measures the shine of light that falls on it and compares it when there is no smoke.

3-Continuous monitoring and management: of pollutants and pathogens is necessary to protect human health.

4-Treatment of polluted water: is done in the following manner:
1-Primary treatment-fine screening ,clarification, grease treatment.
2-Secondary treatment-Aerobic:Biofiltration,activated sludge.
3-Tertiory treatment:clarification,U.V.Disinfection,Filtration,Microfiltration, Reverse Osmosis.

5-Using Satellite Imagery: land slides, marine and costal areas can be seen from Satellites. Satellites can be used to locate Innovative Forest Management Practices like deforestation we use this management in which one area is selected and its database of image change is collected. This can be done with the help of forest management institutes. This practice has given good results in the region of Nepal.

6-Ecosystem mapping: Satellite images, remote sensing software are used for this.

7-Polling the Oceans: counting the number of animals in the oceans is a daunting task.NOAA(National oceanic and atmospheric administration)has this responsibility and presently provides information on the abundance and geographic distribution of nearly 1000 species of fish, marine mammals, and sea turtles in U.S. marine waters. Living marine resource managers are precipitously increasing demands for ecological data. Some of the more promising technologies in marine ecosystem surveys are.1-active acoustics 2-passive acoustics 3-optical technology 4-autonomous underwater vehicles 5-LIDAR (Light Detection and Ranging) systems.

8-**Material and methods**: Using Global positioning (GPS) system we can locate an area. Using Image Processing, Vegetation can be recorded with digitized video data, Images can be taken for vegetated area and non vegetated areas .Threshold values can be applied to enhance those images.

9-**Forecast of weather and ocean conditions:** affect people's daily life as well as viability of every coastal business. To forecast weather conditions following measures are taken:

a-**Instruments:** to measure wind ,currents ,temperature , and particle concentration because this gives us a measurement of environmental change at the surface of ocean.

b-**Observatiories:**Instruments and sensors are there to measure the temperature and currents deep under the sea .These instruments are connected through wireless and internet to the observatories.

10-Design and implementation of Biodiversity indicator system: Here temporal and spatial analysis of biotic and abiotic data is taken using remote sensing and geographical information systems. Both ecological and socio-economic indicators are calculated for local conditions and summarized in a simple way: the state, pressures and changes in biodiversity in the region. On the one hand, we use a landscape ecology approach to calculate indicators of vegetation cover and forest fragmentation in terms of landscape metrics such as number of patches, mean patch size, mean shape index or mean nearest neighbor distance. On the other hand, we used indicators of human influence such as demographic pressure, quality of life and economic activities indicators. We analyze the changes in forest cover in terms of human pressure using these indicators. Indicators are quantitative measures or expressions designed to provide clear information about something of interest in a simple and communicative way. Research can be promoted towards this.

11-Disturbance, Life History, and Optimal Management for Biodiversity: Both frequency and intensity of disturbances in many ecosystems have been greatly enhanced by increasing human activities. As a consequence, the short-lived plant species including many exotics might have been dramatically increased in terms of both richness and abundance on our planet, while many long-lived species might have been lost. Such conclusions can be drawn from broadly observed success ional cycles in both theoretical and empirical studies.

So using Science and Engineering in mixed sense can protect our Ecosystem Biodiversity.

ROLE OF BIO-FERTILIZERS TO MITIGATE ENVIRONMENTAL PROBLEMS

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When human population was small and technology was in its infancy, environment could easily absorb human and industrial wastes. With increase in human population and great advancement in technology in the recent past, the waste materials have multiplied in amount as well as in kind, and this has resulted in contamination of environment. Environment pollution is now one of the most pervasive problems of our society. The flow of pollutants to our air, soils and water is so rapid that our present efforts in managing pollution are barely enough to stay even; surely not enough to make the improvements that are needed. All these, in turn, lead to an increase in the pollution levels. Considering the ill-effects of various chemicals on soil environment and human health, alternative technologies used to be generated for increased productivity. In recent years, greater emphasis is being given to Integrated Plant Nutrient Supply System. Bio-fertilizers being eco-friendly and traditional organic nutrient sources, such as FYM, Compost, Oil cakes etc., form an important and indispensable component of the integrated plant nutrient management. Bio-fertilizers are inputs containing micro-organism which mobilize nutrient elements from non-usable form to usable form through biological processes. They are cost-effective and renewable source of energy during their production, improve crop growth and quality of the products by producing plant hormones, enzymes and organic acids, help in sustainable crop production through maintenance of soil productivity. The present investigation was carried out under field conditions at Vegetable Research Farm, Hill Campus, and G.B.P.U.A. & T. Pantnagar. Results revealed that inoculation of *Rhizobium Leguminosarum* + *Pseudomonas striata* significantly increased the nodulations, growth, yield and quality parameters of the crop.

ECOSYSTEM DIVERSITY AND CARBON SEQUESTRATION

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There is no unifying theme in terrestrial ecosystem analogs to physical properities of water. Rather, the variety of climates the diversity of all lithosphere, and heterogenisity of terrestrial biotic communities all conspire to give rise to such a variety of themes and they are woven together in nature to give an enormous diversity of biotic communities and terrestrial ecosystem. An ecosystem includes all the organisms interacting themselves and with the physical environment, so that a flow of energy leads to a clearly defined trophic structure, biotic diversity and material cycle with in system. Several changes comes in the biosphere time to time, one of them storage of carbon is emerging problem in the environment. This level is continuously increasing by storage of carbon from different sources-like industrial smoke, refrigerator gases and deposition of heavy polymers.

Atmospheric levels of CO_2 have risen from preindustrial level of 280 parts per million (ppm) to present levels of 375 ppm. Evidence suggests this observed rise in atmospheric CO_2 levels is due primarily to expanding use of fossil fuels for energy. Predictions of global energy use in the next century suggest a combined increase in carbon emissions and rising concentrations of CO_2 in the atmosphere unless major changes are made in the way we produce and use energy-in particular, how we manage carbon. One way to manage carbon is to use energy more efficiently to reduce our need for a major energy and carbon source –fossils fuel combustion. Another way to increase our use of low carbon and carbon free fuels and technologies nuclear power and renewable sources such as solar energy, wind power and biomass fuel. A newest way to manage carbon is through carbon sequestration, refers to the provision of long term storage of carbon in the terrestrial biosphere, underground, or the oceans so that the buildup of carbon dioxide(the principle greenhouse gas)concentration in the atmosphere will reduce or slow. New efforts are made to minimize this problem of CO_2 storage in the biosphere-Sequestering Carbon in Underground Geological Repositories, enhancing the Natural Terrestrial Cycle, Carbon Sequestration in the Oceans and Biotechnological approach of exploration of microbes by genome sequencing. Socio-economic and eco-friendly efforts would be more effective in the direction of healthy life of each and every one. Ecosystem diversity interacting with basal life would carry a marvelous achievement for humen welfare.

EFFECT OF LIVESTOCK PRODUCTION SYSTEM IN THE ECO-SYSTEM OF NEPAL

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Livestock have a strong linkage with agricultural production system. Livestock utilize crop residues, and plant biomass material from forest and grazing land area and provide manure and draft power for crop cultivation. Livestock production in relation to arable land and animal per person are large by Asian standard, where about 5.87 heads of ruminants are found in one hectare of cultivated land. This indicates a strong pressure of livestock on cultivated land for feed supply.

Rangelands comprise about 1.6 million hectare which is 12% of total land area of country; are important source of forage for livestock. Over 55% of the rangeland found in Nepal is in the alpine or steppe environment, which is gradually degrading due to over grazing. Forest and shrub land is an important source of fodder and livestock bedding. Regular collection of green fodder has given rise to the degradation of forest. At present government policy of handing over of forest area to the local community has undertaken significant protection of the forest. Trampling by livestock causes soil compaction and soil erosion. Soil compaction reduces water infiltration capacity, and consequently increases surface runoff.

Erosion occurs naturally in high mountains and hills on the steep slopes mainly due to overgrazing of livestock. The major reasons are overgrazing and poorly managed arable land. Soil loss is estimated at an annual 20-50 MT per hectare, in critical areas upto 200 mt may be lost, where loss of 1 mm top soil removes 10 kg N, 7 kg P, and 15 kg K in the surface land. According to the estimate of World Research Institute (WRI) in 1990, Nepal's anthropogenic addition to the Co_2 flux in 1987 was 6.9 million mt of carbon and per capita consumption was about 0.4 mt carbon. Although the volume of addition of carbon in the atmosphere is negligible, it a high time to take various precautionary measures to prevent the emission of carbon and minimize its volume in the atmosphere there by adopting better livestock management practices, cultivation of fodder crops including legumes and proper management of rangelands and forests.

CARBON SEQUESTRATION TO SOIL: FOR BETTER SOIL HEALTH AND SUSTAINABLE CROP PRODUCTION

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Terrestrial carbon sequestration is the process through which carbon dioxide (CO_2) from the atmosphere is absorbed by trees, plants and crops through photosynthesis, and stored as carbon in biomass (tree trunks, branches, foliage and roots) and soils. The term "sinks" is also used to refer to forests, croplands, and grazing lands, and their ability to sequester carbon. But, a rapid depletion of soil carbon stock, as an outcome of high input based intensive agriculture, deforestation, land degradation, change in land use pattern and fossil fuel combustion has drawn attention of the scientists worldwide. Soil organic matter is a major terrestrial pool of carbon. It is a dynamic soil property, sensitive and responsive to ecosystem performance. It is the most important factor related to long-term soil productivity. Thus, carbon sequestration in soil, not only reduces the effects of global atmospheric pollution by CO_2, but at the same time improves the prospects for along term of solution to the world food problem. Soil organic matter content is the prime indicator of the sol quality or soil health. Soil quality is “The capacity of a specific kind of soil function within natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation (Karlen *et al,* 1997b). Sustaining soil quality is the most effective method for ensuring sustainable crop production. because it interacts with other numerous soil components affecting water retention, aggregate formation, bulk density, pH, buffering capacity, cation exchange capacity, mineral sorption of pesticides and other agrichemicals, colour, infiltration, aeration and activity of soil microbes.

No single soil and crop management strategy can be developed and implemented to change biotransformation processes and soil storage of carbon. Practices must be tailored with respect to inherent soil, climatic, management, and social constrains. This would help ensure an economically viable, environmentally safe, and socially acceptable form of sustainable agriculture. Some estimates show that between 400 and 800Tg yr^{-1} of C could be sequestered globally in agricultural soils through judicious management. According to IPCC Third Assessment Repot, at the global level about 100 billion metric tons of carbon over the next 50 years could be sequestered through forest preservation, tree planting and improved agricultural management which would offset 10-20% of the world's projected fossil fuel emissions. Soil management practices sequestering carbon to soils include more complex crop rotation, especially those with high residue crop, reduced tillage, intensive use of cover crops and use of variety of organic amendments. These management practices in various combination and variations increases C input, decrease C output, harm pests living in soils and encourage beneficial organisms. Conservation tillage on croplands, conservation or riparian buffers, modification to grazing practices and biofuel substitution are other practices for the purpose of C sequestration.

ASSESSMENT OF PHOTOTOXICITY OF COSMETICS INGREDIENT USING *E.COLI* AS AN ALTERNATE MODEL

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In recent years phototoxicity has received due to attention in view of increasing use of several chemical compounds for variety of human use and increase of UV- radiation caused depletion of ozone layer in stratosphere. Attention should also be paid on interaction of various kinds of chemical compounds and UV- radiation with an alternate model as micro-bial flora. The cosmetic products are known to have different groups of chemical compounds, some of them may toxic or less toxic but may become more toxic after absorption of solar radiation and act as photosensitizer. The photosensitizer shows phototoxic response either by direct interaction with targeted molecule or by generating reactive oxygen species (ROS).These reactive oxygen species are main culprit of many skin and other cutaneous problems. In this study we used E.coli as a laboratory model for screening the phototoxicity of cosmetics ingredient. As *E.coli* gives the reproducible, reliable & rapid results because of its fast generation time. There may be presence of insoluble as well as soluble ingredients in the cosmetics routinely used by living beings.

We used Insoluble ingredients as impregnated on filter paper disc by white acacia gum before screening the phototoxicity of cosmetics ingredient and for soluble ingredients we used dimethylsulphaoxide (DMSO) as an ideal solvent. By preparing the solution of soluble ingredients in the solvent, used this solution on wells present in the petriplate containing *E.coli* as replica plating based on the technique known as “Gel Diffusion Assay”. We analyzed the effect of UV-A, UV-B exposure dose dependent studies. For this we choose randomly some insoluble and some soluble compounds from variety of compound present in the cosmetics. We also compared our results with dark control or unexposed. In other study we have given synchronous effect of UV-A, UV-B & visible light having dose equivalent to sunlight.

In the mean time we have also analyzed the amount of UV-A, UV-B and visible radiation reaching on earth in month of July and August. The graphical representation shows a wide range of climatic variation.

This analysis will definitely prevent to use such phototoxic chemical compounds which are widely used now a days by various cosmetic industries.

IMPACTS OF CLIMATE CHANGE ON AGRICULTURE

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In large part of Asia, agricultural production is mainly dependent on the vagaries of monsoon. Studies indicate that there are large-scale climatic variations at micro-regional level in different parts of Asia. The causes of these regional climate changes vary from global to region level. It is evident that there was, there is and there will be climate variability at global, regional and local levels. Over the last 200 years, human activities have resulted in emissions of greenhouse gases, (primarily CO_2), which have altered the composition of the atmosphere and caused an 'enhanced' greenhouse effect. As a result, earth's temperature is rising which, in turn, is changing the climate patterns. Studies indicate that if no corrective measures are taken, the atmospheric temperatures may increase by 1.4 to 5.8^{o} C by the year 2100 (IPCC 2001). This will have serious impacts on day-to-day life. Likely impacts of climate change on agricultural productivity in India is causing a great concern to the scientists and planners as it can hinder their attempts for achieving household food security. Despite the limitations, sequestration of carbon in soil organic matter has a role to play as part of a raft of measures to mitigate climate change. In addition to carbon mitigation, the measures leading to soil carbon accumulation generally have a positive influence on soil quality and have wider environmental benefits.

MITIGATION OF ENVIRONMENTAL AND SOCIO-ECONOMIC IMPACTS OF GLOBAL WARMING AND CLIMATE CHANGES BY CARBON -SEQUESTRATION TECHNOLOGIES

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The present elevated levels of carbon dioxide in the atmosphere (about 375 ppm) is the direct consequence of indiscriminate use of fossil fuels and other anthropogenic acivities since the advent of industrial period. The United Nations' Intergovernmental Panel on Climate Change (IPCC) has predicted that if the present trend continues, there could be an increase of 1-3.5 degrees C in the global mean temperature, by the end of this century. The resultant global warming has been projected to change regional climates which would have many-fold effects on hydrological cycle, natural ecosystems, biosphere biodiversity, ocean levels, forest and agricultural productivity, human settlements, health, and other activities of modern human civilization.

Presently an array of processes and technologies are being developed all over the world to mitigate the adverse impacts of global warming and climate changes. These fall into two broad categories: (a) technologies to reduce carbon dioxide emissions in the atmosphere-coal gasification, alternate fuels, renewable energy resources, modifications in industrial processes etc, transport systems, architectural designs, for more efficient energy use, and (b) carbon –sequestration technologies aimed a capturing of atmospheric carbon dioxide and its deposition in various types of sinks in relatively inactive or passive forms. Various types of carbon –sequestration processes are being investigated viz, (i) promoting biomass production in natural ecosystems by enhanced photosynthetic activity of forests, and oceans, (ii) carbon –sequestration in soils by increased humification , and decreased heterotrophic carbon loss (net increase in soil organic matter), (iii) modifications in management practices of agro-ecosystems (rangelands, cultivated lands, forest ecosystems etc. for incresed soil organic matter , (artificial sequestration such as carbon dioxide capture and deposition in ocean basins, under-ground geological formations and mineral sequestration etc. Factors and management practices which promote carbon sequestration and conservation in agro-ecosystems are discussed.

Finally, the application of techniques of genetic engineering, tracer technology, nano-technology, tissue culture in quantitative measurement and enhancement of C-sequencing is discussed.

DECOLOURIZATION AND DETOXIFICATION OF ANAEROBICALLY TREATED DISTILLERY SPENT WASH BY *ASPERGILLUS NIDULANS* VAR. ECHINULATUS AND *ASPERGILLUS FUMIGATUS* IN SEQUENTIAL BIOREACTOR

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There are 285 distilleries in India producing 2.7 billion litres of alcohol and generating 40 billion litres of wastewater annually. The proportion of wastewater, generally known as spent wash is produced as a result of fermentation and distillation of molasses. It is acidic in nature having very high BOD (40,000-50,000 mg/l), COD (10,000-125,000 mg/l), and high colouring material. Colour of spent wash may be due to sugar like caramels, melanoidins and decomposition product such as hydroxyl methyl furfural. The massive quantity untreated effluent can cause considerable stress on the water bodies leading to widespread damage to aquatic life. Physicochemical treatment methods have not been found satisfactory. Therefore, five fungi were isolated from sediment core and effluent of distillery effluent, in which *Aspergillus nidulans* var. echinulatus and *Aspergillus fumigatus* reduced 40 % colour after 3 days. Parameters optimized in different carbon, nitrogen sources, and pH, indicated maximum removal of colour in sucrose (0.2%), sodium nitrate (0.1%) and pH 3 by both fungi. Taguchi method by Qualitek-4 indicated more than 60% reduction in colour by fungi after 3 days. The mechanism of metabolic capability and physiological and ecological relationships evaluated based on catabolic enzymes indicated presence of peroxidase and oxidase enzymes in fungi responsible for decolourization of anaerobically treated distillery effluent. The result of the study indicated increase in biomass of microorganisms which was concomitant to the removal of colour. The effluent was further applied for the detoxification study by germination of wheat seed in petri plates at laboratory scale, exhibited significant viability and vigor in growth of the seedlings after treatment of effluent. The result was further substantiated by comet assay test, which exhibited reduction in toxicity after treatment by fungi, and indicated possible application of anaerobic and aerobic method in combination at pilot and scale-up stage of distillery effluent treatment.

ENVIRONMENTAL SERVICES EMANATING FROM THE HIMALAYAN MOUNTAINS
Valuation against the Backdrop of Eco-philosophy and Chasing the Goal of Global Happiness

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The emerging concept of environmental services appears to be opening Pandora 's Box for the globalizing humanity. For the rapidly expanding business sector that harps on every aspect of nature, be it a product of a function, this concept is to prove as cornucopia of profits for a few. Some well-known NGOs, institutions and intergovernmental organizations are involved in "environmental services" and there are numerous projects and examples. These organizations are building up an environment for spinning dollars out of the ill-conceived idea of commoditization of nature. This article critically examines the serious consequences of such developments. The concept neither aims at conserving the natural resources for future nor fetches a ray of hope for the larger section of humanity. Also, it does not hold any promise for the fast dying planet. It rather contributes to create a mess and hopelessness for humanity. The concepts of natural capital and environmental concepts are closely allied. Himalayan mountains are now becoming hinterlands for those who want reckless exploitation of the mountains' natural functions in the name of "services". This sort of monitory valuation does not have ethical and aesthetic considerations. Fixing monitory value for each "service" and/ or non-consumptive aspects of nature is neither possible nor desirable. The globalization processes in the beginning gave way to putting price tag on any thing that came in our way. This now has culminated into the process leading to even fixing prices even for the functioning of planet's ecosystems. The author makes an attempt for valuation of the functions of natural ecosystems, especially those in the Himalayan mountains, against the backdrop of eco-philosophy. Eco-philosophy advocates and lives for life-giving, life-enhancing and life-sustaining values and for economic setting on the strong foundation of ecology. Eco-philosophy enlightens us to heal the damaged ecosystems and revive the tormented planet. Mountains send happiness to the globe. Mountains' own happiness would enhance the happiness of the world. In today's world of collapsing natural systems and dwindling economic bases leading to chaos, turmoil, uncertainty and unsustainability, attaining the goal of global happiness should be an imperative of our times.

PUBLIC AWARENESS ABOUT APPROPRIATE AGRICULTURAL PRACTICES FOR CARBON SEQUESTRATION: ISSUES & APPROACHES

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Rapid increase in atmospheric temperature of the world is a matter of grave concern today than ever before. Global warming has disastrous consequences-Sea ice is melting both in Antarctica and Arctic. Ninety eight per cent of the world's glaciers are shrinking. The sea level is rising at three times its historical rate. Rising heat waves, droughts and wild fires have profound effect on human health and well being. The tragic deterioration can be attributed to both accelerated industrialization and human interventions including agriculture. Carbon sequestration in soils can be increased through new strategies and appropriate agricultural practices. Most developing nations can take initiative in this regard through appropriate policies and their strategic communication to the stakeholders. Increasing depletion of soil organic manure over the last years due to conventional system of ploughing before every crop is not taken as serious by the farmers. There is need to delineate them and convince the public about conservation agriculture, agroforestry, retention of residue on the soil surface and allied practices. The challenge to persuade farmer is affected adversely due to traditional wisdom about advantages of ploughing. Ignorance about extent of damage and its consequences are other blocks.

Thus there is urgent present need to decide national strategy for public awareness about helpful agricultural practices for carbon sequestration. Existing government institutions NGO's and academic organizations should work hand in globe to take up massive extension and communication activities. Capacity building of personal and farmers will go a long way in identification and implementation of use agricultural practices. Carbon sequestration can be used as a toll for poverty alleviation and community level efforts may be made by participating organizations. Formation of farmers associations conducting demonstrations, forming networks and economic validation of the practices should help immensely in creating consensus among policy makers, practitioners and farmers. The problems need not only scientific solutions but also matching social appeal and political will to implement them. Global Warming will affect the whole globe, let us develop strategies to tacle them together.

LIVESTOCK-ENVIRONMENT INTERACTIONS IN MIXED FARMING SYSTEMS IN THE HIMALAYAN MOUNTAINS
Implications for Carbon Sequestration

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Unlike in the fastest growing industrial production of livestock species like pork, poultry and (feedlot) beef and mutton in the industrialized countries and also in developing countries to a great extent, livestock-environment interactions are very positive. Rangelands, forests, grasslands, croplands and many other marginal lands and open spaces are managed primarily livestock production. Numerous routes right from the foothill/ plains up to alpine meadows in the Greater Himalaya and from alpines to the plains are demarcated for the movement of livestock in the mountain region. Millions of buffaloes, cattle, goats and sheep are the main ruminant species that are maintained and interact with the mountain environment. Contributions of these livestock in terms of products and services (milk, meat, wool, manure, draught power, transportation, nutrient recycling, contributions to ecological integrity of agro-ecosystems, etc.) are phenomenal to the land-based economy of the livestock-dependent mountain communities.

The livestock production-oriented management of regenerative natural resources in the mixed mountain farming systems is conducive to the inherent mountain features, such as marginality, fragility and heterogeneity. Greenery and livestock have been the natural allies throughout the course of farming system evolutions. Enhanced resilience and reduced vulnerability of the fragile ecosystems is one of the natural outcomes of this dynamic interaction. The nutrient flows mediated by livestock rearing, which include nutrient transfer from uncultivated forest/ range/ marginal/ abandoned lands/ open spaces (road and river sides, etc.) to croplands and nutrient cycling into the croplands is the concrete contributions of livestock-environment interactions to the ecological integrity of the agro-ecosystems in the mountains. Ecological integrity of a system is the precondition for the effective sustainable processes of carbon sequestration in a system. Livestock-environment interaction in the traditional mixed farming systems in mountain areas, therefore, has positive implications for carbon sequestration. A better and sound resource-ameliorating management of this interaction would further help enhanced levels of carbon sequestration.

IMPACT OF CLIMATE CHANGE ON CROP PRODUCTIVITY

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Climate change will affect crop productivity directly because of increased atmospheric CO_2 concentration and green house gases and indirectly through stratospheric ozone layer depletion. Increased CO_2 level could increase photosynthesis and water use efficiency. However, high temperature and green house gases will modify rainfall, evaporation, runoff and soil moisture storage and will adversely affect crop growth and productivity. The increased amount of ultra-violet (UV) radiation due to depletion of stratospheric ozone layer will exert its deleterious effect on crop growth and productivity by destruction of chlorophyll and reducing photosynthetic rate. To cope up with change in regional climate due to climatic changes, agriculture may have to adopt some changes. These adjustments will depend on future development in technology, demand, prices and national policy.

ECONOMIC ISSUES AND MECHANISM FOR ENHANCING OF CARBON SEQUESTRATION IN INDIA

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Carbon sequestration is the process through which agriculture and forestry practices remove carbon dioxide from the atmosphere. The term “sink” is also used to describe agriculture and forestry land that absorb CO2 the most important global warming gas emitted by human activities. The forest ecosystem has potential to capture and retain large volumes of carbon over long periods as trees absorb carbon through photosynthesis process. A young forest, when growing rapidly, can sequester relatively large volumes of additional carbon roughly proportional to the forest’s growth in biomass. A mature forest acts as a reservoir, holding large volumes of carbon even if it is not experiencing net growth. Forest management can thus have an influence on carbon sequestration. Present estimates indicate that with appropriate policies the carbon pool in the terrestrial system could increase by up to 100 GtC by the year 2050 compared to the level of carbon that would be sequestered without such policies (IPCC, 2001). This is equivalent to about 10 to 20% of projected GHG emissions from fossil fuel consumption during the same period. Reducing deforestation, expanding forest cover, expanding forest biomass per unit area, and expanding the inventory of long-lived wood products are some of the activities that could help global community realizing the carbon sequestration potential of forest to mitigate global climate ecosystem. Sequestration activities can help to prevent global climate change by enhancing carbon storage in trees and soils, preserving existing tree and soil carbon, and by reducing emissions of CO2, methane (CH4) and nitrous oxide (N2O). Increasing the quantity of the carbon sequestered or stored in soils and bio mass is an alternative to reduce the emission of carbon and other greenhouse gases in an overall strategy change and its negative economic and environmental effects. Changes observed in the agricultural land category have been minimal since 1970, and have almost stabilized in India. Though there has been no marked increase in the land area under the agricultural sector, the yield per hectare for the total food grain in the country has increased from 0.872 t/ha during 1970–71 to 1.6 t/ha during 1996–97 As a result, the food grain production has increased from 82 million tons (mt) during 1960–61 to an all-time high of nearly 212.9 mt during 2001–02. The total food grain requirement of India is expected to increase to about 269 mt by the year 2010. At present, increase in area for food grain production is constrained by biophysical factors such as soil, climate etc. Over the last three centuries, forests have decreased by 1.2 billion hectares i.e. 19% and grasslands by 560 million hectares. This has resulted due to an increase in croplands. Area under the forests in 1950s was approximately 40.48 mha. It marginally increased and reached up to 63.92 mha during 1970s, 64 mha during 1980s and is almost constant since then. India has nearly 19.1% of its land area under forests. This excludes land under tree plantations. About 43.11% of land area is devoted to croplands. The remaining 113.535 mha accounts for land in forest, fallows, restored forest and degraded land.

ROLE OF BIO-FERTILIZERS TO MITIGATE ENVIRONMENTAL PROBLEMS

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Advances in modern agriculture to meet the increasing food grain demands have adverse effects on environment. When human population was small and technology was in its infancy, environment could easily absorbed human and industrial wastes. With increased in human population and great advancement in technology in the recent past, the waste material have multiplied in amount as well as in kind, and this has resulted in contamination of environment. During the past green revolution period, the Indian Agriculture has became a kind of agriculture in which numerous chemicals like pesticides and commercial fertilizers are being used in producing crops. This has resulted in deterioration in soil health in terms of microbial biomass and whole rhizosphere is getting polluted. Nutrients imbalance, fast depletion in soil fertility and continuous deterioration of physical properties of soil are some of the added disadvantage of chemical agriculture. Fertilizers play a key role in increasing agricultural production. Continuous, increased and imbalanced use of chemical fertilizes, has caused alarm regarding possible side effects in relation to environmental pollution in different states to our country. Repeated use of chemical fertilizers without adding adequate amount of organic manure is causing the soil to become more and more hard and impervious to water**.** It is quite evident that though we require more food to feed our huge population for which more and more crop production is vital but not at the cost of polluting the environment, which in turn will cause health hazard. It is true that crop production cannot be sustained with inorganic fertilizers used in indiscriminate way resulting in pollution of soil and water, Further; it is true that we cannot achieve the target of producing more and more crop year after year with the use of only organic manure. Therefore, integrated nutrient management, conservation of natural resources and emphasizing soil based practices.

It can be concluded that to boost up the yield of the crop on sustainable basis without effecting environment, liberal application of organic manure, in addition to need based application of inorganic fertilizers are essential.

CARBON DIOXIDE EMISSION FROM THERMAL POWER PLANTS AND ITS SEQUESTRATION STRATEGIES

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Climate change (greenhouse effect) occurred as a consequences of anthropogenic activities like combustion of fossil fuels, deforestation etc. Worldwide about one third of all carbon dioxide emissions come from fossil fuels energy sources which are used for electricity generation. Since thermal power plants have the highest density of CO_2 emissions in terms of mass area per unit of time, so they provide appropriate focus as a control target. Over the past 150 years, the increased use of fossil fuels have been responsible for growing emissions of anthropogenic CO_2 (CO_2 from human activity). Under the business as usual scenario, carbon dioxide emissions have been estimated and have been observed to increase fourfold during 1990–2020. From 1950 to 1999, India experienced dramatic growth in fossil-fuel CO_2 emissions averaging 5.8% per year and has become the world's fifth largest fossil-fuel based CO_2-emitting country. In the present research communication the CO_2 emitted during electricity have been studied. Further the projections for the coming decade have been presented. India is striving hard to control its carbon emission though still India do not have any forcible compliance as per IPCC and Kyoto protocol. Indian have ratified Kyoto protocol and is a signatory party to UNFCC. Atmospheric CO_2 Emissions reduction techniques which have been discussed in detail. CO_2 sequestration is one of the best CO_2 reduction method. CO_2 sequestration is the safest and long term strategy to capture and store carbon dioxide from atmosphere, it have been studied in Indian context, in the present communication.

STRATIGES FOR ENHANCING CARBON SEQUESTRATION

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In the interplay of the soil and the atmosphere, the soil can be both a contributor to and a recipient of the impacts of climate change. In the past, land management has generally resulted in considerable depletion of soil organic matter and the release into the atmosphere of gases like carbon dioxide, methane, and nitrous oxide. Global climate change, to the extent that it occurs, will strongly impact on all soil processes .The carbon sink capacity of the world's agricultural and degraded soils is 50 to 66% of the historic carbon loss of 42 to 78 gigatons of carbon. The rate of soil organic carbon sequestration depends on soil texture and structure, rainfall, temperature, farming system, and soil management. Agricultural soils provide a prospective way of mitigating the increasing atmospheric concentration of CO_2. Strategies to increase the soil carbon pool include soil restoration and woodland regeneration, no-till farming, cover crops, nutrient management, manuring and sludge application, improved grazing, water conservation and harvesting, efficient irrigation, agroforestry practices, and growing energy crops on spare lands. Both the quantity and the quality of soil C inputs influence C storage and the potential for C sequestration. Changes in tillage intensity and crop rotations can also affect C sequestration by changing the soil physical and biological conditions and by changing the amounts and types of organic inputs to the soil. At this time, the task of soil management should be to restore soil organic carbon in order to enhance soil structure and fertility and to help counter the atmospheric greenhouse effect. An increase of 1 ton of soil carbon pool of degraded cropland soils may increase crop yield by 20 to 40 kilograms per hectare (kg/ha) for wheat, 10 to 20 kg/ha for maize, and 0.5 to 1 kg/ha for cowpeas. As well as enhancing food security, carbon sequestration has the potential to offset fossil fuel emissions by 0.4 to 1.2 gigatons of carbon per year, or 5 to 15% of the global fossil-fuel emissions.

MANAGEMENT OF ECOSYSTEMS AND LIVELIHOODS FOR CARBON SEQUESTRATION IN INDIA

J. S. Bali

Too many people striving for too high a standard of living and pursuing the so called “rates of growth and “aping the unsustainable life styles “of the West are destroying the natural regulatory powers of the Earth. Fossil fuels used for energy for home heating and transport in individual cars have taken out too much carbon stored safely by the earth and can today be held to be 70 per cent responsible for greenhouse effect and consequent climate warming. How many people can live on this earth without hazard to the ecosystems depends upon our choice of sustainable lifestyle and society. Development of women and care for their health and education would lead to lowering of their fertility rate by their own choice. Coercive methods would fail. Ecosystem management in India has to take care of both, the concerns of people’s livelihoods and carbon sequestration, in order to be successful in our country. The model of Bioindustrial Watershed Management is suggested. It will address issues of four P’s: Protection of Environment, Ecology and Biodiversity; Production of food and bio -fuels from plants and animals in a sustainable manner; Processing of the bio-produce in people-owned plants in the watershed itself and an enabling favourable Policy regime. When people‘s incomes are thus enhanced and farming is made profitable, there will be less pressure on the forests and village common property resources. More technology and capital will flow to the rural areas. Forests and grasslands would be rejuvenated. Lastly, there is no hope for mankind unless dependence on fossil fuels is reduced and atomic energy takes the central place.

CARBON SEQUESTRATION: GLOBAL WARMING MITIGATION THROUGH IMPROVED CARBON ECONOMY LINKED WITH PHOTOSYNTHESIS

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The coal is one of the world's cheapest fossil fuel energy resources, but the gases produced by the coal are causing global climate change resulting in global warming. It will affect our health, natural balance, agricultural yields, and the future of coming generation as well. It has already been statistically estimated that one ton of CO_2 gets produced when we burn ca. half a ton of coal. The Kyto Protocol made CO_2 reduction mandatory among 124 counties. Most have already accepted the accord. Because the burning of fossil fuels adds ca. 5.4 billion metric ton (bmt) of carbon each year to the atmosphere, and deforestation further adds another 1.6 bmt annually, increasing the concentration of CO_2. Human activities also emit CFCs, ozone, methane and nitrous oxides. However, CO_2 has received a lot of attention with respect to global warming, because 50-60% of anthropogenic greenhouse effect is attributed to this gas. It has grown up exponentially, with an annual current rate of increase ca. 0.5% (approaching) 370 ppm) with the prediction that it will reach ca. 450 ppm by the year 2050. The atmospheric carbon concentration has been rising steadily since the industrial revolution due anthropogenic production of CO_2 through burning of the fossil fuels. The level of CO_2 is approaching ca. 370ppm by now from ca. 285 ppm, with an enhancement of CO_2 in the last 150 years.

The biological CO_2 mitigation occurs through all green plants. However, forest trees contribute up to 70% of terrestrial carbon sequestration, and are a major sink for $CO_{2.}$ globally to maintain and sustain their growth dynamics. Particularly C_3 plants have shown a positive sign through improved scrubbing of CO2 enzymatically using photosynthetic enzyme ribulose 1,5 bis phosphate carboxylase (rubisco) encoded by chloroplast genome (cpDNA). Its active sites have strong differential competition between CO_2 and O_2. The higher availability of CO_2 induces better carbon sequestration/ mitigation through photosynthesis, associated with the loss in photorespiration. Thus, photosynthesis may be either up or down – regulated depending on the environmental conditions. Hoever, if carbon emission continues, our most likely adjustment would be to live with it, otherwise a planning is to be framed in time to reduce emission changes for land management and expected energy use as well. Thus biological CO_2 mitigation for improved carbon economy and learning to adapt with its higher atmospheric availability in relation to climate must go parallel.

ROLE OF PLANT TRANSCRIPTION FACTOR-DOF (DNA BINDING WITH ONE FINGER ONLY) IN ENHANCING NITROGEN USE EFFICIENCY AND ITS IMPLICATION IN ORGANIC FARMING

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Nitrogen deficiency in agricultural systems is a worldwide problem. It is true of the Indian scenario as well. In India, soils of more than two hundred districts have been reported to be poor in nitrogen status. To increase crop productivity per unit area and agricultural production to meet the demand of the ever-increasing population, which may touch the 1.3 billion mark by 2025 AD, millions of tons of nitrogenous fertilizers are applied to the soil. These are accompanied by other major and minor nutrients depending on the health status of the soils. Two crops, viz., wheat and rice, which form the staple diet of teeming millions, consume 70 percent of the fertilizers. There is likelihood of change in this pattern of utilization due to diversification of crops, export orientation and emphasis on agro-processing. For wheat and rice, the utilization efficiency of nitrogenous fertilizers under field conditions is around 50-30 percent, respectively. This poor nitrogen use efficiency is of great concern. Burgeoning population of world need crop genotypes responding to higher nitrogen and showing direct relationship to yield with use of nitrogen inputs. However, for fulfilling the high global demand of organic produce requires the low responsive genotypes with greater nitrogen use efficiency and grain yields.

Nitrogen use efficiency (NUE) at the plant level is its ability to utilize the available nitrogen (N) resources to optimize its productivity. This includes nitrogen uptake and assimilatory processes, redistribution within the cell and balance between storage and current use at the cellular and whole plant level. In terms of agriculture, it is the optimal utilization of nitrogenous manures or fertilizers for plant growth, yield and protein content, as atmospheric nitrogen gas is not utilized by higher plants, except symbiotic legumes. A number of management strategies to improve the efficiency of utilization of nitrogenous fertilizers include applications of different types of fertilizers, their mode of application, avoiding runoff, mitigation of losses from soil and plants, use of slow-release fertilizers, nitrification inhibitors, use of organic manures, green manuring of legumes in cropping systems, correction in their imbalanced use and integrated nutrient management. While the amount of N available to the plant can be improved by using sustained-release fertilizers, split applications, minimizing fertilizer losses and other nutrient management. While the amount of N available to the plant can be improved by using sustained-release fertilizers, split applications, minimizing fertilizer losses and other nutrient management and crop management and crop management strategies, the inherent efficiency of the plant to utilize available N-inputs for higher productivity needs to be tackled biologically.

Since, overuse of inorganic nitrogenous fertilizers is hazardous to the environment- unused fertilizers is washing off fields into rivers, poisoning coastal waters and causing acid rain. Therefore, the creation of crops with nitrogen efficiency is agriculturally important and might pose a big challenge for molecular breeding. Marker assisted selection of genotypes responding to low and high nitrogen inputs will enable us to enhance agricultural productivity and production of organic produce. This in turn, led to the identification of novel nitrogen responsive genes and their *cis* and *trans* acting gene elements.

Nitrogen assimilation in plants requires not only inorganic nitrogen (nitrate and ammonia) but also the carbon skeleton (2-oxoglutarate, oxaloacetic acid and citrate) that produced through sequential reactions from photo- assimilated carbohydrates. The levels of carbon and nitrogen metabolites mutually influence each other, implying the intimate link between carbon and nitrogen metabolism. Therefore modulation of carbon skeleton production might be an alternate approach to improve nitrogen assimilation in plants. However, because a number of enzymes are involved in carbon skeleton production, it is not practical to intensify the pathway supplying carbon skeletons by the transfer of individual genes for respective enzymes. Thus utilization of transcription factor might be powerful approach to modification of metabolism for generation of crops having superior characteristics with improved nitrogen utilization efficiency and improved nutritional quality of grains because a single transcription factor frequently regulates coordinated expression of a set of genes for respective pathways. In terms of finding a global target for manipulation of nitrogen use efficiency (NUE), recent studies revealed that Dof (DNA binding with one finger only) transcription factor acts as master regulator in the expression of photosynthetic genes and thereby improving nitrogen assimilation of crop plants. The potential of the marker regulator has been visualized for enhancing the biomass and turn yield parameter in cereal grains. Therefore, Dof could be utilized for development of crop varieties having high nitrogen use efficiency and increased protein content of grains under both high nitrogen and organic farming conditions. Thus transgenic crops having Dof gene will promote organic farming.

ECO-TOURISM AS A STRATEGY FOR BIO-DIVERSITY MAINTENANCE

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'Bharat', the land is known for the rich cultural and natural base. There are a great number of wild flora and fauna inhabiting in this pious piece of land. This richness is expressed in various natural sites in the form of national parks, sanctuaries and bio-reserves. Also, apart from being a means for the germplasm conservation, these sites serve as the major attraction for tourists. People, who reside in and around such areas, cherish the pleasant experience from these natural resources. In turn, they find out the ways for providing joy and gay to the visitors in the form of goods and services. To support this warmth and hospitality of the local people, the Indian tourism has introduced the concept of eco-tourism, which is a growing sector in the global present.

Eco-tourism is typically defined as 'travel to destinations where the flora, fauna and cultural heritage are the primary attractions'. Fundamentally, 'eco-tourism' means making as little environmental impact as possible and helping to sustain the indigenous populace. It also encourages the preservation of wildlife and habitats when visiting a place. It encourages going back to natural products in every aspect of life. It aims to bring an ecological balance that has both environmental and social connotations.

Eco-tourism focuses on respect for local cultures, wilderness adventures, volunteering personal growth and learning new ways to live on our vulnerable planet. Eco-tourism includes the participation of local and indigenous communities in planning, development and operation contributing to their well-being. It interprets the natural and the cultural heritage of the destination to visitors. Ecotourism minimizes the adverse effects of conventional tourism on the natural environment and enhance the cultural integrity of local people. It is a unique way to sensitize people with the beauty and fragility of nature.

EMISSIONS TRADING AND CARBON TRADING FOR CARBON SEQUESTRATION

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Economic growth!! What does it mean? In economic terms economic growth occurs when nation's real output is growing faster than rateof growth of population, but we often fail to understand that this economic growth comes at a cost, the cost which is paid in terms of rising pollution, deteriorating natural resources and this is the matter of concern in the countries all over the world. So, inorder to reduce the pollution and emmission of Green House Gases (GHGs) the countries have adopted various policy measures which areas follows.

Emissions trading (or cap and trade) is an administrative approach used to control pollution by providing economic incentives for achieving reductions in the emissions of pollutants. The Kyoto Protocol is an agreement made under the United Nations Framework Convention on Climate Change (UNFCCC). Countries that ratify this protocol commit to reduce their emissions of carbon di oxide and five other greenhouse gases, or engage in emissions trading if they maintain or increase emissions of these gases. Carbon credits are a tradable permit scheme. They provide an efficient way to reduce greenhouse gas emissions by giving them a monetary value. A credit gives the owner the right emit one tonne of carbon di oxide. Credits can be exchanged between businesses or bought and sold in international markets at the prevailing market price. There are currently two exchanges for carbon credits: the Chicago Climate Exchange and European Climate Exchange and in near future China is going to set up Asia's first carbon credit exchange.

CARBON SEQUESTRATION ON AGRICULTURAL LANDS: SUSTAINABILITY AND ENVIRONMENTAL SECURITY

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In the terrestrial system carbon is mainly held in vegetation and soil. Aquatic bodies like oceans also stocks large volumes of carbon, as does the atmosphere. Soils contain about three times more C (1500 Pg of C to 1 m and 2500 Pg of C to 2 m depth) than vegetation (650 Pg of C) and twice as much as that present in the atmosphere (750 Pg of C; USEPA, 1995). Additionally, fossil fuels, e.g., coal, petroleum, and natural gas contain large amounts of carbon which are released upon combustion. Soil is the biggest reservoir of carbon. Soils can be a source or sink for atmospheric CO_2 depending upon the land use and management practices. The conversion of natural habitats to cropland and pasture, and unsustainable land practices such as excessive tillage frees carbon from organic matter, releasing it to the atmosphere as CO_2 and thus soil acting as a source whereas the photosynthetic activity, through which the plants convert CO_2 into organic forms of carbon such as sugars, starch and cellulose; as a sink. The soil organic carbon (SOC) pool to 1m depth ranges from 30 tons/ha in arid climates to 800 tons/ha in organic soils of temperate regions. The predominant range of SOC is 50-150 tons/ha. The conversion of natural habitats to agricultural ecosystems has resulted in depletion of SOC pool by 60 and 75 per cent in soils of temperate and tropics, respectively. The depletion of SOC pool generally takes place speedily when the decomposition rates are higher than the rates of carbon added to soil. Severe loss of SOC leads to deterioration of soil quality, biomass productivity and also affects the water quality. An overall impact of depletion of SOC levels may be exacerbated by projected global warming (Lal, 2004).

Soil organic carbon is central to the global carbon cycle and its dynamics are mainly dictated by the soil management practices which influence the physical, chemical and biological properties. Due to enhanced and intensive cultivation practices the organic matter level in soils is declining over the period and also contributing to the increased concentration of CO_2 in the atmosphere. The soil unfriendly or intensive management practices expose the soil to accelerated erosions leading to declined sustainability and subsequently the degradation of soils. During pre-industrial era air contained about 270 ppm CO_2 concentration while the current concentration has reached to 372 ppm increasing @ 1.5 ppm every year. Burning of coal and oil has a major influence on atmospheric CO_2. The increased concentration of CO_2 leads to global warming and climate change influencing the overall environment. This effect can be reversed up to certain extent by transforming the atmospheric CO_2 to SOC employing the good management practices in agriculture. This would result in increased SOC stock *vis-a-vis* sustainability. Carbon trading concept will provide an opportunity of additional income to the farmers in addition to the rejuvenation of the wastelands/ degraded lands and improve the environment. Therefore, to combat the increasing concentration of CO_2 in atmosphere a holistic system approach is warranted for the sustainability of the agricultural soils and environmental security.

BIOREMEDIATION POTENTIALITY OF MICROORGANISM FOR REMOVAL OF CHROMIUM AND PENTACHLOROPHENOL IN TANNERY EFFLUENT

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Chromium (III) and pentachlorophenol are used as tanning and biocides respectively in tanneries. Five morphologically different fungi were isolated from leather tanning effluent in which *Aspergillus niger* had higher potency to remove chromium. The bacterial consortium developed in presence of minimal salt medium and pentachlorophenol as sole carbon source in the chemostat indicated higher utilization of pentachlorophenol (PCP) and adsorption of chromium by *Acinetobacter sp.* (PCP3). In sequential bioreactor where tannery effluent treated initially by bacteria followed by fungi reduced chromate (90%) and PCP (67%), where as in another set of bioreactor in which effluent was treated initially by fungi followed by bacteria reduced chromate (64.7%) and PCP (58%) after 15 days. The high performance liquid chromatography (HPLC) data indicated degradation of PCP into intermediary metabolites (Tetrachlorohydroquinone) by *Acinetobacter sp* bacterial strain.

HUMAN PSYCHOLOGY ON CONSERVATION OF BIODIVERSITY FOR SUSTAINABLE DEVELOPMENT

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"Forests are the temples,
Trees are the altars,
Animals are the deities and
We are the priests serving them!"
-Henry Skolinowski.

Man lives as a member of natural communities. He is directly and indirectly dependent upon plants for sustenance. He dwells in very intimate association with other animals, plants and with other men. He is fully involved in the intricate complex of mutual relationships that runs through all of nature. *Carl Sauer* calls man as a social and technical animal; his place in nature is peculiar because of the artificial environments he is able to create. Man-made features of environment almost universally mediate the relation between individual humans and rest of the nature.

What does biodiversity means to human race?

The Oxford Advanced Learners Dictionary gives the meaning of biodiversity as the existence of a large number of different kinds of animals and plants which make a balanced environment. Biodiversity refers to the variety and variability among living organisms, the genetic diversity they contain, the assemblages they form and the ecological complexes in which they occur. This is auto-sustainable and self-regulating if there are no man-made perturbations. The natural world is a far different place now than it was about 10000 years ago. Different natural ecosystems on the planet have been affected and modified by the human populace. While it may be argued that the industrialized nations, having enjoyed the fruits of unthinking exploitation of nature, have now suddenly become environmentally conscious and are obstructing the developing nations in their march towards material progress. However the for long term interests of the earth and human species, environment management must be taken seriously by one and all.

India faces environmental challenges on two fronts: *poverty* as well as *economic development*. Poverty and population pressures, clearly result in overuse of land, water, forests and other resources without thought of future- for ***who wants to think of the coming generations, when it is so difficult to survey today?*** Uncontrolled economic development, urbanization and Industrialization are equally responsible for deforestation, overuse of groundwater systems and pollution of natural resources. It was only in the 1970s that the Indian government took the matter of environment seriously. In June 1972, the Stockholm conference of human environment propounded the concept of "ecodevelopment", implying a process of ecologically sound development for positive management of the environment for human benefit. It was the same year that a committee was set up in India under the initiative of the then prime minister, Mrs.Indria Gandhi to coordinate environmental issues.

The call for conservation

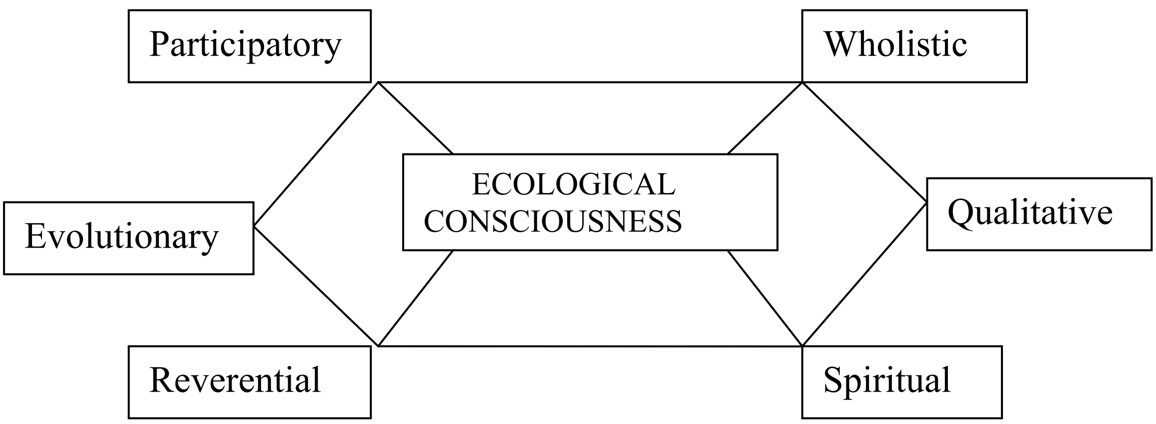
"***Conservation is a race between catastrophe and right utilization***" In attempting to accelerate the evolutionary process wisely, we must be one with it and should serve it! By thoughtless reduction of the complexities of nature to naïve simplicities of reductionism science, we serve no one but the angel of death. The purpose of the laboratory of nature is to enhance what is, not to reduce it; to create diversity, not homogeneity. Over exploitation, which undermines this diversity and which creates smothering homogeneity is nothing short of the process of self-lobotomisation.

"What we are today comes from our thoughts of yesterday. And our present thoughts build our life of tomorrow. Our life is the creation of our mind" ***-Dhammapada***

Now to seek fulfillment and realization on earth, through our own effort, is an admirable project. The trouble begins when we amass too much power with which we destroy natural habitats and by which we become so intoxicated that we forget our place on this planet. In the absence of higher values and wisdom concerning human destiny, the amassing of power is a very dangerous thing as it leads to unbridled arrogance and inevitably hubris.

Ecological consciousness Vs Technological consciousness

Ecological consciousness is the synthesis as it marks a return to the spiritual without submitting to religious orthodoxies and as it seeks social amelioration and justice for all without worshipping physical power and without celebrating the aggressive nature of the human person. The forerunner of the ecological consciousness is the *ecological movement* and *humanistic psychology*. In their respective ways they are against the temper of the mechanistic age. Both have emphasized wholism and the irreducibility of large complex wholes of their underpinning components- *ecological habits* and *human persons*. These movements are a challenge thrown to a rationality of the mechanistic system of technological consciousness.



Conclusion

"What is most needed today is the revision of the ends,
Which all our efforts are meant for sure."
-***Schumacher***

The healing of our environment requires the healing form of thinking and the form of mind geared to healing not to exploitation. A healthy and complete human is a micro-universe, which is wholistic and qualitative, where there can be no doubt**.** The human being who seeks meaning beyond the triviality of consumption is on some kind of spiritual path- there can be no doubt as well. So let us join our hands for a noble cause, to pass on ***the Green Earth and the Blue Sky- the colours of success***, to our next generation as we inherited from our ancestors. It is of course our duty too.

WORKABLE STRATEGIES FOR ENHANCING CARBON SEQUESTRATION

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Introduction

In this world, which has never ending demand of fossil fuel, food, and other requirement, which is directly or indirectly related with carbon emissions, has raised concern over last few years. Atmospheric levels of CO_2 have risen from preindustrial levels of 280 parts per million (ppm) to present levels of 375 ppm. The reason being the expanding use of fossil fuels for energy. And why shouldn't be? When man realized that over utilization of natural resource is posing threat to his existence in the form of global warming, he started searching solutions for it. Nature has its own mechanisms of maintaining equilibrium but once the limits are surpassed nature has its own way to balance the equilibrium in the form of earth quakes, tsunami, global warming and many more which only nature knows.

Time has come to recognize the potential of problem and adopt means so as to combat it. One solution, which is emerging and is in its birth stage, is carbon sequestration. Carbon sequestration refers to the provision of long-term storage of carbon in the terrestrial biosphere, underground, or the oceans so that the buildup of carbon dioxide concentration in the atmosphere will reduce or slow. We can adopt three ways to reduce carbon content in atmosphere.

1. By using energy more efficiently to reduce our need for a major energy and carbon source—fossil fuel combustion

2. By increasing our use of low-carbon and carbon-free fuels and technologies (nuclear power and renewable sources such as solar energy, wind power, and biomass fuels)

3. Carbon sequestrations

Decreasing carbon content in the atmosphere through Carbon sequestration is slow process but is highly effective in long run.

Various areas where carbon sequestration can be adopted and practiced are as follows

1. Sequestering Carbon in Underground Geologic Repositories

2. Carbon sequestration of the terrestrial biosphere through CO_2 removal from the atmosphere by vegetation and storage in biomass and soils.

3. Enhancing the net oceanic uptake from the atmosphere by fertilization of phytoplankton with nutrients, and injecting CO_2 to ocean depths greater than 1000 meters.

4. Sequencing the genomes of microbes that produce fuels such as methane and hydrogen or aid in carbon sequestration.

Enhancing the Natural Terrestrial Cycle

1. Formation of soil organic matter in unmanaged and managed terrestrial ecosystems; including wetlands will initiate carbon sequestration

2. Crop rotations, reduced or no-tillage practices, organic farming, and cover crops will increase total microbial biomass and shift the community structure toward a more fungal-dominated community, thereby enhancing the accumulation of microbially derived organic matter (MOM.) in soil. This will further contribute to Carbon sequestration

3. Reducing soil erosion and enhancing Soil air CO_2 concentrations though effective soil management practices and use of mulches, green manuring and the like.

4. Converting rainfed agriculture back to native vegetation will also contribute towards Carbon sequestration.
5. Change from conventional tillage (CT) to no-till (NT) can sequester 57 ± 14 g C m^{-2} $yr^{-1.}$

6. Increasing area under forest and pasture will further enhance carbon sequestration

7. Increasing the net fixation of atmospheric carbon dioxide by terrestrial vegetation with emphasis on physiology and rates of photosynthesis of vascular plants.

8. Retaining carbon and enhancing the transformation of carbon to soil organic matter;

9. Reducing the emission of CO_2 from soils cause by heterotrophic oxidation of soil organic carbon; and

10. Increasing the capacity of deserts and degraded lands to sequester carbon.

Carbon Sequestration in the Oceans

1. The enhancement of the net oceanic uptake from the atmosphere by fertilization of phytoplankton with micro- or macronutrients, will add to carbon sequestration.

2. The direct injection of a relatively pure CO_2 stream to ocean depths greater than 1000 meters will also enhance carbon sequestration. Sources of CO_2 for direct injection might include power plants, industries or other source

Sequencing Genomes of Micro-organism for Carbon Management

The genomes of microbes that either produces fuels such as methane and hydrogen or that aid in carbon sequestration will be sequenced. This will enable the identification of the key genetic components of the organisms that regulate the production or capture of these gases.

The above workable strategies if given due consideration can, become major contributing factors for enhancing carbon sequestration. However limitations are always there. And above mentioned strategies too had limitations .The success will depend on their proper management.

ECOSYSTEM DIVERSITY AND SUSTAINABILITY: TOWARDS MIDDLE PATH

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The inherent resilience in nature and the inevitably ubiquitous constancy of subtle or drastic alterations tend to subsume, even counter-balance the various human interventions in the form of resource-utilization in the course of civilizational ascension. Ecological biodiversity implies coexistence of multiple, often divergent forces and organisms. The crux of the problem lies in the prevailing development premise that most of the natural resources are for the exploitation and utilization of human beings. There are diametrically opposing perspectives to perceive the issue. One view often implies irrational and unsustainable exploitation of even depleting bio-physical resources for short-term gains causing long-term ecological damage. This seemingly realistic view is essentially pessimistic critically blaming human efforts of growth for ecological problems amounting to self-flagellation. The other more optimistic view counters the first one with the argument that such an idea amounts to amentia or non-recognition of human intelligence, creativity and ingenuity generating a wide range of astounding techno-scientific and aesthetic milestones, multidimensional achievements and search for sustainable alternatives. In reality, human beings are still continuing their struggle for survival in the face of adversities and uphill challenges. It is, however, wiser to follow a middle path as some human efforts bring in certain desirable (or culturally approved) and intended (or institutionally mandated) consequences while others undesirable and unintended ones. The former is more functional to ecological sustainability while the later may be malfunctional in their effects. Variations in terms of temporal (periodic), spatial and situational dimensions have to be accorded due cognition that itself nullifies any premise having universal applicability.

The former pessimistic perspective has a brighter side as it highlights the risk to natural balance and thereby, cautions the intellectual, economic and political leaders to form policies and make endeavours attuned to sustainability of the planet earth securing it for the coming generations. It does not belittle the onward march of human specie as it can not simply be wished away, but moderation is required in utilization of depletible resources while focusing on rational exploitation of non-depletable ones. The whole issue, however, is too complex and varied to be analyzed and comprehended simplistically. It is related to the techno-scientific advancements creating more comforts and amenities on the one hand, and concomitant ecological degradation and depleting bio-physical resources on the other. The middle path is a saner approach that focuses on the continuation of positives and avoidance of negatives in terms of sustainability.

LOCATION RESPONSIVE WHEAT GENOTYPES FOR RAINFED AND IRRIGATED CONDITIONS OF UTTARAKHAND HILLS

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Uttarakhand hill area has diversified conditions with 90% area as rainfed and only 10% irrigated. The yields under these situations are very low. This ecosystem is so diverse and unpredictable that varieties identified as high yielding at research station give comparable results at farmer's field and times perform much worse than their indigenous/ local varieties. Hence 9 varieties were tested at hill campus research block and 5 on farm locations for their sustainability to such an ecosystem. Trial were conducted during Rabi 2002 and 2003 at the campus and village Sawali Malli, Hanswangaon, Sawali Talli, Birkot and Mandai, Crop was sown in the month of November and harvested in the month of May during both years under the ecosystem on farmer's field served as local check. Out of 9 wheat genotypes tested for their adaptability for rainfed and irrigated conditions of Uttarakhand hills. Improved varieties VL-616, HS-240 and HS-365 recorded highest grain yield 27.70, 27.60, 24.15 q/ha. with net monetary return Rs. 10649, 9849 and B, C ratio 1.79, 1.73 respectively in rainfed conditions, whereas PBW-343 and VL- 616 recorded highest yield of 33.6 and 30.5 q/ha. with net monetary return 14215, 12749 and B, C ratio 1.94, 1.83 respectively in irrigated conditions. The yield increases 84% and 102% in comparison to local varieties in rainfed and irrigated conditions.

WORKABLE STRATEGIES IN A COASTAL WETLAND ECOSYSTEM IN SEQUESTERING CARBON DIRECTLY BY GEOLOGIC REPOSITORIES AND PHYTOPLANKTON FERTILIZATION

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The higher rates of Carbon sequestration in salt marshes, soils of tidal salt and lower methane emissions makes coastal wetlands more valuable C sinks than other ecosystems in a warmer world. With rise in sea level owing to global warming, landward expansion of coastal wetlands in gentle topography shall provide potential sink of atmospheric carbon dioxide. This terrestrial wetland carbon pool, globally stores 44.6 TgC/yr ; with an average Carbon sequestration of 210 g CO_2 m^{-2} yr^{-1}.

Urbanization and Industrialization of coastal areas with 40% offshore oil production from Indian Ocean Coastal states has called for capturing gases after combustion and reinjecting them into subsurface settings where they will be retained for geological period of time. CO_2 is removed directly from natural gas, point source (Sleipner process), by an active amine process and injected by pipeline system into permeable in use and abandoned oil reservoirs. It is added by sorption in residual shale and sludge. The use of CO_2 for enhanced oil recovery is the only known large scale use where CO_2 has an economic value that may be significant compared to the deposition costs. Elevated CO_2, enhances plant biomass in mangroves.

Sustainable fisheries release micro and macro nutrients in coastal water, helpful in fertilization of phytoplanktons, primary member of foodchain. Pure CO_2 stream is also released in coastal water depths. Bioshield of mangrove, casuarinas, salicornia, laucoena, atriplex, palms, bamboo, halophytes are carbon sinks. Workable strategies to maintain integrity of coastal ecosystem necessary to secure preservation of life support system and avoid drainage of wetland by conversion to agricultural and forest patches have been dealt with.

CARBON SEQUESTRATION ON AGRICULTURAL LANDS: SUSTAINABILITY AND ENVIRONMENTAL SECURITY

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All biogeochemical cycles and existence of life on the earth are dictated by the element carbon. In all ecosystems the processes such as photosynthesis and respiration both store and emit carbon back to the atmosphere. In the terrestrial system carbon is mainly held in vegetation and soil. Aquatic bodies like oceans also stocks large volumes of carbon, as does the atmosphere. Soils contain about three times more C than vegetation and twice as much as that present in the atmosphere. Large amount of the carbon is also locked in fossil fuels which get released upon combustion. The anthropogenic activities such as industrialization, fossil fuel combustion, deforestation, wood and residue burning, intensive cultivation, non-friendly soil cultivation practices etc. are leading to the increased concentration of CO_2 at an enhanced rate.

Soil is the biggest reservoir of carbon which dictates the sustainability of agricultural lands. The soils can act as source or sink for atmospheric CO_2 depending upon the land use and management practices. The soil organic carbon (SOC) pool shrinks speedily when the if the decomposition rate exceeds the rate of carbon additions to soil. Severe loss of SOC leads to deterioration of soil quality, biomass productivity and also affects the water quality. The sustainability of soil can be enhanced through the transformation of atmospheric CO_2 to the long lived stable form in the soil and plants *vis-à-vis* increasing SOC content i.e. sequestration. The large land area and varying eco-regions offers a tremendous potential of soil carbon sequestration in India. The agricultural soils of India have the lowest SOC stocks as compared to other Asian countries. The intensive cropping coupled with imbalanced fertilizer use, especially nitrogen alone; lead to declined SOC concentration irrespective of soil types and cropping systems.

Carbon sequestration in soils is a climate-change mitigating strategy. This has the potential to combat and reduce the CO_2 level in atmosphere and to slow down the global warming and mitigate climate change. The carbon sequestration provides an array of benefits to the soil, crop and environment, biodiversity, prevention of and desertification in addition to combating global warming and climate change. The practices which enhance biomass production, add increased amount of below ground biomass to the soil, slows decomposition rates, enhances activity and species diversity of soil flora and fauna, improves soil fertility, strengthens the mechanisms of elemental cycling, and takes care of the soil and water are the good management practices. The good management practices comprising efficient land use, diversified cropping, conservation tillage, efficient nutrient management, afforestation/ agro-forestry, administered grazing, erosion control, use of cover crops and rehabilitation of degraded soils lead to the more carbon sequestration. To combat the increasing concentration of CO_2 in atmosphere a holistic system approach is warranted for the sustainability of the agricultural soils and environmental security.

FOREST BIODIVERSITY: A BOON TO SUSTAINABILITY

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Forest ecosystem has potential to capture and retain large volumes of carbon over long periods as trees absorb carbon through photosynthesis process. A young forest, when growing rapidly, can sequester relatively large volumes of additional carbon roughly proportional to the forests growth in biomass. A mature forest acts as a reservoir, holding large volumes of carbon even if it is not experiencing net growth. They play an important role in the global carbon cycle and consequently in regulating the global climate system. Two main features of forests define this role. First, the world's forests accumulate a major part of the planet's terrestrial ecosystem carbon. Second, forests and wetlands are the two major land cover classes that are able to provide long-term sequestration of carbon. Accumulation of carbon in wood and soils results in a more significant share of total net primary productivity being stored in the long term than in other land cover classes and can represent as much as 10–15% of net primary productivity. Deforestation in the tropics has the greatest impact on the carbon cycle of any land use and land cover change. It is reported that land use change (mostly deforestation) is the source of 1.6 +/ - 0.8 billion tons of carbon per year. Forest management can thus have an influence on carbon sequestration. Improving the condition of forests and their contribution to human well-being is an important and urgent task, both nationally and internationally.

CONSERVATION & UTILIZATION OF MOUNTAIN BIODIVERSITY THROUGH TISSUE CULTURE FOR MEDICINAL PLANTS

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Experts have devoted concerted research efforts over thirty years for *in vitro* growth of plants of interest particularly morphine, steroids, and other drugs related plants beside, agriculturally important products like pyrethrins, azadrictin, brassinosteroids etc and commodities like tobacco, mints, ginseng are worth mentioning. Many other potential enzymes and biomolecules are being noticed in micro and defined conditions all over the globe. Since a large number of such plants are located in Himalayan hill, Bhawar and Tarai regions and approximately two third different medicinal plant species in use are collected from the region. Harvesting from the wild is causing heavy pressure on natural population resulting in loss of genetic diversity, habitat destruction, increasing vulnerability and local extinctions. These plants also represent a large gene pool resource, which can be effectively harnessed for their application in food, agriculture and medicine. However, a serious attempt to bioprospect these plants to their beneficial application have been still lacking. Presently rapid development in hill region, threat to loose this vast wealth hidden in biodiversity of this region has been imposed. However, *ex situ* preservation efforts are on through tissue culture/root culture. Demands for these bioresources have surpassed the regeneration capacity of the system. The excessive use of rare plant resources is putting a pressure of management of these resources for human welfare in time to come otherwise many of them will be lost further. Therefore, some efforts in plant resource planning utilizing tissue culture, biochemistry and molecular biology tools are being practiced with a view for sustainable management of important bioresource in context of socio economic reasons.

ALTERNATE USE OF BIOMASS FOR THE SUSTAINABLE DEVELOPMENT

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The Mankind has been interested in exploiting the natural resources for the fulfillment of their needs without fixing the standard limit to depletion of natural resources or ecology/ environmental cost. In fact, any economic activity that continues without a healthy balance between ecology and environment shall result in unsustainable nature of development. In most of the regions, due to over exploitation of forests and continuing application of wood as fuel is blooming increasingly uncertain .Therefore to meet the energy demand of the majority of the livings is possible through the alternate use of the biomass which is available in the abundant quantity in our country. The potential of the biomass for the study area is calculated with the help of quadrat method. Realizing the importance of biomass resources in the energy scenario to meet the energy demand at the village level the gasification was the most appropriate options due to the fact that the other alternatives have their own limitations like biogas can not replace directly the petroleum diesel due to their high carbon content, high amount of hydrogen sulphide gas and handling problem besides their bulky structure. But such type of limitation does not exist with gasification technology. The density of the different types of tree varied 0.48 to 3.68, abundance 1.28 to 5.82 and frequency percentage were observed between 28 to 84. the different type of trees/shrub were observed 729 per hectare. The dry biomass is obtained 8.4 kg/tree/year, thus the estimated forestal dry biomass was 3130 tonnes is available in the study area. Out of this 2190 tonnes forestal biomass were surplus and can be available for producer gas technology. The potential of producer gas from crop residues and forestal biomass was reported $1.48X10^3$ GJ and $5.69X10^3$ GJ.

IMPACT OF ARTIFICIAL FEEDING ON BROOD DEVELOPMENT OF APIS MELLIFERA

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The present experiment was carried out during July to October, 2004. Twelve colonies of *Apis mellifera* with langstroth beehive made-up of Toon wood were selected. The various strength of the colonies viz. 4, 6, 8 and 10 frames, were taken as the treatments each with thre replications. Each colony was fed with sugar syrup 50% on alternate days up to first fortnight of October. The dearth period for honeybee at Pantnagar commence from June onwards to first fortnight of October. It was observed that there was significant difference I the brood development of colonies fed with *sugar syrup* as compared to control colonies.

CLIMATE CHANGE AND KYOTO PROTOCOL: GLOBAL AND INDIAN CONCERNS

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The biggest contributor of frequent incidence of extreme weather is mainly release of Green house gases (GHGs) and aerosols which change the climate and one of the most important global environmental challenges with repercussion on agriculture production, natural ecosystem, hydrological cycle, energy balance and public health. As is now well known, anthropogenic sources of number of gases and aerosols are affecting the green house effect, leading us into a future of uncertain global climate. The UN Conference on Environment and Development (UNCED) in 1992 led to Framework Conventions on Climate Change (FCCC) with a commitment to "prevent dangerous anthropogenic interference with the climate system", is a climate treaty that lays groundwork for nations to stabilize concentrations of greenhouse gases (GHGs) at a level that would prevent dangerous interference with the climate system. In 1997, for stabilizing GHG concentrations and adhering to sustainable development principles, Kyoto Protocol was drawn up, which imply that ratified countries must make efforts to reduce their GHGs emission or engage in emission trading if they are not able to bring down their emission to acceptable levels. To mitigate climate change by reducing emission of green house gases and aerosols, meeting rural energy needs, protecting the environment and generating gainful employment, a shift is needed towards environmentally sustainable technologies and promotion of renewable energy, forest conservation, reforestation, water conservation etc. India, as a developing country with nearly two-thirds of population depending directly on climate sensitive sectors, the cost of not addressing climate change or not to promote any mitigation or adaptation strategies, may have very uncertain implication on its socio-economic development and early action are therefore needed as a protective measures. Environmental conservations towards sustainability are not a luxury concept but must have to adopt in sacrifice with current economic growth for better future, particularly in context of developing countries.

CARBON A MATERIAL FOR TWENTY FIRST CENTURY: PROSPECTS AND PROMISES

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Recently, one of the important challenges before the Environmental scientists is to check the content of carbon, especially carbon dioxide in our environment for sustainable and safe future. But if one look at carbon from a material scientist point of view, it is a very promising electronic material and may play an important role in the development of society to which we owe our existence. The present paper reviews the potential application of carbon as a next generation material, most suited for fabrication of electronic devices. In nature carbon exists in two allotropic (crystalline) form sp^3 bonded Diamond and sp^2 bonded Graphite. Further, carbon is a most flexible atom when it comes to bonding. This flexibility of carbon makes it a backbone of bio-molecules and fabrication at nanoscale. Recently, due to ultra fabrication technologies and characterization techniques material scientists harnessed carbon into clusters like Buckyballs (C_{60}), also atom by atom fabricated sheets/ribbon of carbon atoms called Graphene are now possible. These clustered and atom by atom fabricated structures of carbon have shown amazing electronic and optical properties to make these materials a candidate for carbon based electronic material to replace Silicon in the electronic industries in near future. Therefore, the present paper deals with the review of the recent developments of free carbon that exists in nature as an established electronic material with future prospects.

OCEAN AND CARBON SEQUESTRATION: A REVIEW

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The oceans are an integral and responsive component of the climate system with important physical and biogeochemical feedbacks to climate. Oceans on Earth are phenomenal in causing and mitigating the climate relating changes. A review of studies would reveal that the average surface temperature of the planet has increased over the 20th century by about 0.6^0C. The other noteworthy scenarios include considerable decrease in snow cover and ice extent. Global average sea level has risen and ocean heat content has increased, which sends ominous signals. The world scientists are unanimous that the increase in atmospheric greenhouse gases is linked to this warming. Internal variability within the climate system and external factors (both natural and anthropogenic) are the key factors for this change. There has been a considerable change in Earth's global carbon cycles so much so that it as become a matter of utmost concern for humanity. The major changes at global scale that hang in front of our eyes might include escalating temperature, increases in severe weather events, and an ever-shifting and currently unpredictable pattern of droughts, floods, starvation, and disease. Managing the global cycles of Earth's key elements is the real challenge humanity faces today. Oceans of the Earth present an answer to the most challenging situation. Enhancing the ocean's natural capacity to absorb and store atmospheric CO_2, either by inducing and enhancing the growth of carbon-fixing plants in the surface ocean, or by speeding up the natural, surface-to-deep water transfer of dissolved CO_2 by directly injecting it into the deep ocean is one of the key issues that needs to be resolved effectively by ensuring participation of world's communities and public systems.

HIMALAYAN CONSERVATION AND DEVELOPMENT

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Introduction

The Himalayan eco-system is one of the most important and most threatened of life support systems on earth. In the shadow of the Himalayas, live more than 150 million people; some of them the poorest in the world. The rivers which arise in the Himalayas and flow down into the wide Indo – Gangetic plain, support agriculture which sustains these people. The population pressure and land and its mounting demand for fuel and fodder has already denuded areas of the Himalayan ranges – the life line of India. The rate at which the forests are disappearing is much faster that the rate of afforestation.
My love for the Himalayas dates back to the year 1938 when I went to foot to the famed Amarnath Caves. My earliest contact with the mountain system in north – western India goes back even earlier for I was born in a foothill area surrounded by hills and mountains. My professional contact, however, began in the fifties when I was working in the Soil Conservation Department of the Damodar Valley Corporation (DVC).

During my FAO tenure, I had more occasions to work in the mountainous areas in Iran, Bulgaria and many other countries.

In 1975, However, I first started working on Himalayan Programme as FAO Chief of the Regional Asia Bureau. I felt that here is a need for close co-operation between the Himalayan countries as the Himalayas serve as source of floods and indirectly of droughts in the sub-continent. In October 1980, I visited Himachal Pradesh and brought to the notice of the Planning Commission, the state of the Himalayas as really crumbling and bleeding profusely. The Planning Commission in the person of Dr. M.S. Swaminathan organized the Himalayan Eco – Development Task Force which discussed, for over one year, what to do about it and brought out a report of the Task Force in March 1982. This report which was submitted to the Prime Minister highlighted the action programmes which included some of the activities of the Department of Environment and others and especially the proposal for a Himalayan Environment and Development Institute to be started in the Seventh Five Year Plan.

My association with the National Land Resource Conservation and Development Commission (1984-85) gave me more opportunities to work in this direction. I emphasized that all these activities especially in the Himalayas and elsewhere in the country for conservation and development of the soil resources cannot be undertaken by the Government alone. The need for greater involvement of people also through non – governmental organizations then become evident. It is against this background that the programme for Himalayan Eco-System Development was initiated at the Centre for Policy Research which hosted this programme and through which contacts were made with many NGOs in western, central and north – eastern Himalayas. An operational plan was prepared by the end of December 1984 which suggested that an

NGO meeting be organized March 1985 to work out a programme, and develop a strategy for large-scale involvement of NGOs, youth groups, universities, colleges and schools, the Territorial Army and other non – governmental and voluntary agencies for concerted efforts in saving the Himalayas.

The Himalayan mountain area is approximately 523,000 sq.kms (16.13% of the land surface of India), the Himalayan sediment areas, that is the areas which are directly fed by the Himalayan rivers and which form the Indo – Gangetic and Brahmaputra Plains, including 726,000 sq.kms or 22.26 percent of the total area. Thus the grand total of the Himalayan region is 1,249,000 sq.kms or 38.4 percent of the land resources area of India. In the Himalayas and foot hills live about 150 million people, and about 300 million people live in Himalayan mountain area and Himalayan Sediment Area. It is important that a comprehensive effort to protect the production base in the Indian Himalayas and plains by reducing soil losses and by preserving the ecological balance be made urgently. The most important task of the programme is to develop and apply or stimulate application of a technical package of practices for watershed management to develop or strengthen an appropriate infrastructure (Government has since established a Himalayan Institute for Conservation and Development in the Seventh Five Year Plan) to further improve the social, political and public policy on environmental issues in the Himalayas.

The Technical measures for conservation and development are essentially:

(a) Tree planting and reforestation
(b) Water harvesting
(c) Terraces and other engineering structures
(d) Agronomic, grassland and pasture development and other socio – economic measures for conservation and management of the soil.

The youth groups, the academic institutions, the People's Organisations and interested and qualified NGOs are essential as an additionally of effort to what government is already doing for the conservation and development of Himalayas.

The Plight of Himalayas

Why Himalayas?

The Himalayas have exercised a great influence on the environmental conditions of northern India and the people living in the Indo – Gangetic Plains. It has prevented the monsoon winds from crossing over to Tibet and forced them to precipitate most of the moisture on the Indian side in the form of rain and snow. It has also acted as a formidable barrier range and presented free migration of the fauna and flora as well as human culture across it. The complex geological history of the Himalayas and the tectonic stress which heaved up this range – geologically the youngest in the earth's history – have contributed to the aggravation of the earth's dynamic process of weathering, erosion, mass wasting, seismicity, and so on, which affect and modify the natural environment. The developmental activities of man in the area, like the construction of high dams, exploration for minerals and mining activity in conjunction with the quest for arable land have intensified these dynamic process – commonly referred to as geological hazards. The human interference often gives these dynamic processes catastrophic proportions, leading to disasters and irreparable damage to the natural balance of the eco-system. It is therefore, necessary to acquire a better understanding and appreciation of the natural dynamic processes of the earth and a better integration of man and his activities into his environment so that the natural balances of the eco-system of the Himalayas is not destroyed.

Brief Descritpion of Himalayas and Statistical Overview

The Himalayas represent the youngest mountain range, having been uplifted about 60-70 million years ago. It is also geologically a very complex range, and its origin is not yet clearly understood. With the development of the means of communications in the region, many of its remote parts have now become accessible and are being systematically investigated and habituated due to pressure of population. These developmental activities have interfered with the natural eco-system of this range and caused deterioration in the environment by aggravating the natural dynamic processes of the earth. These dynamic processes are already in a more active state in the region because of the certain geological, geo-dynamical, weathering, erosion and seismic processes.

The developmental activities in the Himalayas have to face the challenge of these geological hazards and in some cases the developmental activities, such as the impounding of large reservoirs of water, tunneling operations and the addition of silt load of rivers by road cutting lead to the intensification of the natural dynamic process.

Though the knowledge about the fragility of the Himalayas is well known, the developmental activities did not take into account this aspect. The vast Himalayan region that extends from Jammu and Kashmir in the west to Arunachal Pradesh in the east has been under severe deforestation due to various developmental activities. The following tables provide Himalayan area statistics, extent of sedimentation of major reservoir in the country and the extent of damage caused by floods during the years 1953 – 1981

Table 1: Himalayan Land Resources

(Part 1: Himalaya Mountain Area)

Sl. No.	Name of Land Resource Region	Area Square Kms	Percentage of the Land Resource Area (India)
1	Northern Himalaya Snow Clad Region	116,000	3.56
2	Northern Himalaya Alpine Grass and Meadow Region	98,250	3.02
3	Northern Himalaya Forest Region	131,750	4.08
4	North Eastern Himalaya Alpine Grass + Meadow region	16,000	0.05
5	North Eastern Forest Region	161,000	4.97
	Total	**523,000**	**16.13**

(Part 2: Himalayan Sediment Area)

The areas which are directly fed by the Himalayan rivers indicated.

Punjab – Haryana Alluvial Plains Region	101,250	3.10
Upper Genegetic Alluvial Plain Region	200,000	6.15
Lower Gangetic Alluvial Plain Region	145,500	2.41
Assam Valley Region	88,500	2.73
Rajasthan Desert Region	191,000	5.87
	726,250	22.26
Grand Total of Himalayan Region	**1,249,250**	**38.39**

Table 2: Sediment data of major / Himalayan reservoirs

Sl. No.	Reservoirs	Years of Improving	Annual rate of silting in ha m /100 Sq.km	
			Assumed	Observed
1.	Bhakra	1959	4.29	6.10
2.	Panchet	1956	2.41	10.00
3.	Maithon	1956	1.62	13.10
4.	Mayurakshi	1956	3.61	16.56
5.	Nizamagar	1931	0.29	6.55
6.	Matatila	1958	1.43	4.38
7.	Lower Bhawani	1953	NA	4.19
8.	Shivakisagar	1961	NA	15.24
9.	Tungabhadra	1953	4.29	6.54
10.	Hirakud	1956	2.52	3.57
11.	Gandhisagar	1960	3.61	3.71
12.	Nachkund	1956	3.90	2.57
13.	Ramganga	1974	4.29	18.20
14.	Kangsabati	1965	3.27	3.76
15.	Ghod	1996	3.61	15.40
16.	Dantiwada	1965	3.61	5.14
17.	Ukai	1971	1.47	10.90
18.	Tawa	1974	3.61	6.38
19.	Beas Unit II	1974	4.29	14.30
20.	Narmada	Under Construction	1.55	5.62
21.	Mahi Stage II	- do -	1.29	8.17

	Unit	Total 1953 – 81	Maximum In one year	Average / Year
Total area affected	M ha	235.6	19(1978)	8.1
Total population involved	M	795.0	70(1978)	27.4
Damage to Crops	M ha	104.0	10(1978)	3.7
	US $ M	7,200.0	1,030(1978)	248.3
Cattle lost	Thousand	2,826.0	618(1979)	97.4
Human lives lost	Thousand	40.0	11(1997)	1.4
Damage to public utilities	US $ M	3,200.0	582(1981)	110.3
Total damage to crops, houses and public	US $ M	11,800.0	1,700(1978)	406.9*

Table 3. The damage caused by floods during the period 1953 – 1981

Present Efforts to Save Himalayas

Eco – Development Camps

The Eco Development Camps Programme was undertaken by the Department of Environment during 1981-82. The main objectives of the programme are:

(2) to create an awareness in the student and non – student youth and the society about the basic ecological principles and environmental management;
(3) to enable student and non – student youth to identify and analyse the root cause of the ecological problems, particular related to human activities and the biosphere;
(4) to involve student and non – student volunteers in solving ecological / environmental problems at national and regional levels;
(5) to create general awareness about the seriousness of the problems of environment in the community and an atmosphere of acceptance of measures being undertaken to meet the situations and
(6) to develop the spirit of national integration among the youth.

The activities initiated by the volunteers in these camps included digging of pits and tree plantation, undertaking preplantation operations like nursery bed preparation, trenching and fencing and so on. Programmes aimed at promotion of alternative sources of energy like biogas, solar energy are also undertaken. Major emphasis is laid on creation of awareness of environmental problems through field demonstrations, seminars, symposia and so on. Given below are DOE's financial eco – development activities in the country as a whole including the Himalayan areas.

Setting up of Ecological Task Forces

The idea of utilizing ex – servicemen for the restoration of the ecological balance in the Himalayas and other hilly regions has been put forward in the Himalayan Tasks Force and even earlier. The concept of Eco – Developmental Task – Forces of Ex – Servicemen is on the general pattern of Territorial Army. Units were given operational shape soon after the formation of the National Eco – Development Board in the Department of Environment. The Task – Forces are raised to undertake ecological restoration work in the environmentally fragile / degraded areas especially in difficult and unapproachable terrains. The Director General, Territorial Army (Ministry of Defence) is actually responsible for the Eco Task Force.

Eco – Task Force in Uttar Pradesh / Uttranchal – 127 Infantry Battalion (TA)

The creation of the first Eco – Development Task Force was approved by the National Eco-Development Board in its Second Meeting held in September, 1982 for deployment in the Shahjahanpur Block (Shivaliks) U.P. The Task Force comprises 200 ex-servicemen with the strength of 42 at headquarters. The Task Force became operational in January, 1983. The Task Force has done a commendable job with the following main features:

1. Plantation of trees;
2. construction of check dams;
3. treatment / construction of gully – plugs;
4. construction of jeepable tracks,
5. eradication of weeks; and
6. fodder collection.

The Task Force has completed the job assigned to it and is ready to be deployed for reclamation of mined areas on Mussorie slopes for which a detailed project report has been prepared calling for increased working hands immediately. The strength of this Task Force, is therefore, being increased by adding one more company of 200 jawans, without augmenting the Headquarter strength.

Eco – Task Force in Himachal Pradesh

Considering the magnitude and intensity of denudation in Himachal Pradesh Himalayas, especially in Lahul – Spiti and Kinnaur districts, the Department of Environment had proposed the creation of a Task Force for deployment in the high altitude, cold desert region of Himachal Pradesh, Availability of suitable species of planting material for that region was, however, a constraint which has been overcome by setting up four nurseries to supply an adequate number of suitable varieties of sapling to the Eco – Task Force when it is made operational in Himachal Pradesh.

Accordingly, an allocation of Rs. 10,203 lakhs had been made in March, 1984 to the State government for the establishment of nurseries. These nurseries are being raised. Meanwhile on request of the state government the Task Force may be raised immediately and planting material diverted in the short run from their existing high altitude nurseries. Accordingly, a Task Force has become operational in Himachal Pradesh with effect from January 1985.

Task Forces During the Seventh & Subsequent 8,9,10 Plan Period.

-Work by Soil Conservation Department (Ministry of Agriculture) in Priority Catchments.
-Integrated Watershed Management in the Catchments of Flood Prone Rivers and Control of Shifting Cultivation.

-Work by the Forestry Departments (Ministry of Agriculture and now Ministry of Environment and Forest)
-Work and Recommendations of the National Land Resources Conservation and Development Commission.

The important initiative taken comprises:

- Envigouring Conservations Society, its chapters and special work on Bioindustrial Watershed (Prof J.S. Bali Has promoted this program since last over 20 years and now time has come for promoting it intensively)
- Several other state chapters & state Departments like in H.P. & J & K and some North East States have been formed.
- A Task Force for the 11th 5 year plan has been formed which is working under the leadership of Dr. R.S. Tolia, former Chief Secretary, Uttranchal.
- Several NGO have started program of Tree Planting such as HIMCON and emphasis is given on Fruit Planting so as to increase the nutrition and income generation of the farmers and orchardist.

  A brief video was, presented during the talk

MIPF – Mountain India Peoples Forum

Mountain are many things to may people; home of the Gods, sacred place of pilgrimage, natural resources repositories, biodiversity treasure groves, aesthetic landscape and much more; but the most important aspect is, that they are home to many people of diverse cultures. ¼ people of the mountains are at the center of concerns in all endeavors. The work of the Mountain India People's Forum will be directed towards securing a better quality of life for people living in the mountain areas who are often marginalized and ignored. The Forum will work for enhancement of material, environmental, social, cultural and spiritual well-being and active engagement of mountain people in civil societies / institutions.

It is estimated that mountains make up a quarter of the world's landscape and are home to at least $^{1}/_{10}{}^{th}$ of the worlds people. An additional 2 billion people depend on mountains for much of their food, hydro-electricity, timber and mineral resources. About half of the worlds people, as well as surprisingly large share offers biological diversity, rely on mountain watersheds for fresh water. Upto 80% of the planets fresh surface water comes from mountains. Yet in the deliberations of the governments and organizations worldwide, the fate of the mountains has been largely ignored.

Findings from all over the world show that expanding economic pressures are degrading mountain ecosystems, while confronting mountain people with increasing cultural assimilation, debilitating poverty, and political disempowerment. The fact that many people are ethnic minorities or outside the dominant cultures of the plains, and smaller in number, leave their regions poorly represented in the centers of political or commercial power where much of their fate is determined.

India has many mountain and hill tracts. The longest and the highest are the Himalayas which sweep across the north and north east part of the country. Towards the west and flowing into the desert state of Rajasthan are the Aravallis. The Vindhya ranges mark off the northern part of the country from its southern part. The Western Ghats and the Sahyadris follow the west coast and in the south of the countrylie the Nilgiris and the Annamalai hills. The East coast of India is flanked by the Eastern Ghats. High or low, the hills and mountains are inhabited by people who have remained to a large extent outside the mainstream of development.

MOTI – Millions of Trees International

Concept – "Millions of Trees" International is working for a healthy world and healthy humans. It is a non-profit organization working for creating awareness, facilitating tree plantation with the vision to synergize human life with nature for a healthy and happy future. Its motto is "Save the Earth for Healthy Life."

We know the whole life of trees is to serve the humanity with their leaves, flowers, fruits, branches, roots, shade fragrance, sap, bark, wood and also their ashes and coal. A tree that lives for 50 years recycles Rs. .4 lakhs worth of fertility and soil erosion control, serves Rs. 10 lakhs worth of air pollution control, creates Rs. 5.3 lakhs worth of food and shelter for birds and animals, besides providing flowers, fruits and timber. So when even one tree falls or is felled, the community loses something worth "more than Rs. 32.00 lakhs".

Nature has always inspired and challenged human life. The trees are an essential component of life and play a critical role in sustaining the natural and human environment. But the human interventions in nature have created unprecedented environmental hazards. Felling of trees has created tremendous eco-imbalance and if it is not taken care of now, humanity and other creatures are condemned to a disastrous future.
The very survival of planet Earth depends on saving trees from destruction.

Mission

1. Restore our natural heritage.
2. Involve the common man, specially the young minds to be a part of making the natural environment healthy.

Methodology

1. Involvement of women led voluntary Agencies for leading such a movement.
2. Identifying spots and organization having sufficient and suitable land for nurseries.
3. Identifying schools, colleges and other interested institutions as partners.
4. Involvement of school and college students and to promote a culture for planting and protecting trees.
5. Develop a linkage with organizations such as "Trees for Life" founded by Balbir Mathur who is leading a global "Awareness and Action Program" for "Tree Planting and Protection"

6. Develop a link with Corporate Bodies and their Associations such as CII, Assochem, PHD, FICCI and other national and international associations for promoting greening of their establishments and helping voluntary agencies in such mission.

Activities

1. Organizing "Tree Plantation" Program mainly in different schools and through the schools and their camps in all areas.
2. Organizing 'on the spot' painting competition, quiz competition and different games which will create more awareness and interest among the school children.
3. Awarding prizes to the best schools who will plant maximum trees and protect them also.
4. Making tree planting a Movement with Women's Group, NGOs including rural & urban area that need such tree planting.
5. Organizing tree plantation in corporate lands.
6. Rejuvenation and regreening of wastelands.
7. Participate in "OWN / GIFT / DEDICATE A TREE" Project as a part of this Movement.

We intend to accomplish the above objectives through various programs and projects in different institutions and hence increase the awareness among all, specially the young hearts and minds towards such pressing needs of the country, the nation and the world at large.

FOREST BIODIVERSITY AND CARBON SEQUESTRATION

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Climatic change is one of the main environmental problems of the 21st century. Due to green house gas (GHG) emission temperature is increasing globally. The first solution is to limit the emission and second is to reduce the amount of carbon from the environment. Currently a great deal of interest is arising in the value of forests as carbon sinks and reforestation schemes aiming for carbon sequestration. The out come of this was clean development mechanism (CDM). Under the clean developing mechanism (CDM) of Kyoto Protocol, carbon in forestry projects must be monitored in order to realize credits. Countries which are the member of UNFCCC must estimate and report carbon stock changes in their forests under the convention rule.

This exploitation of forests targeting mainly for certified emission reduction (CERs) generation may have adverse effect on forest ecosystems. Forests due to their tangible and intangible ecosystem services must be evaluated more than just carbon pools. They are repositories for most of the world's flourishing and threatened biodiversity. Biological diversity and extension of forest resources are main elements of sustainable forest management. But this may effect adversely to the ecosystem services. Because forests are more than just carbon pools: forests cover much of the terrestrial landscape, provide many other important ecosystem services.

Forest management and reforestation projects for carbon sequestration should therefore also take biodiversity considerations into account. A large forest area is covered under pulp and paper wood circle presently. This type of plantations includes only 2-3 types of species, which minimize the biodiversity of an area.

Now there is need to describe the new economic models that assess the costs and benefits of enhancing tree diversity in plantations and of preserving or restoring diversity in managed forests. We should remember that forests are not only carbon sink, they are home of many endangered and rare flora and fauna, which needs urgent attention for conservation.

SOIL CARBON SEQUESTRATION: A STUDY IN *EUCALYPTUS* PLANTATIONS

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The international panel of scientists by evaluation of evidences of climate change found that the anthropogenic interventions have been generating green house gases that trap heat and produced runaway global warming. The Kyoto Agreement established a binding target for the green house gas emission (GHG) reduction of 5% below 1990 level. A time period of 2008-2012 is available to the industrialized world to cut the GHG emission. Developing countries are asked to contribute to climate change mitigation through participation in clean development mechanism (CDM) as partners and host for renewable energy and plantation forestry projects.

Plantation forestry creates the sink for carbon-dioxide along with the restoration of degraded lands. By sequestration of the atmospheric carbon-dioxide the plantations transfer it to long lived pools and securely store it with lowering the degree of fear for reemittence. Soils under these plantations can also sequester carbon in terms of soil organic carbon (SOC) and soil inorganic carbon (SIC) stocks. Storage of carbon in below ground systems is the best long term option for carbon storage in terrestrial ecosystems because most soil organic matter has a long time than plant biomass.

The present study investigates the impact of *Eucalyptus* plantation on soil carbon dynamics. The soil organic matter content under this plantation was assessed along with the climatic variables and microbial activity. It is experienced during the study that capacity of soil as carbon sink is governed to a much extent by climatic variables and conditions supporting microbial activity. There is a great possibility of increase in soil organic carbon sequestration by management of land and selected removal of litter. Thus through applying judicious land use and management practices the soil under such afforestation and reforestation plantations will result into a secure sink for sequestered carbon. Soil carbon sequestration improves soil health and sustains biomass productivity along with secure storage of green house gases indirectly.

BIODIVERSITY CONSERVATION IN UTTARAKHAND HIMALAYA

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Mountain ecosystems are among the world's most vulnerable biogeographical domain. From the Andes to the Himalaya, mountain ecosystems are very distinct from lowlands, being particularly fragile and highly susceptible to erosion, landslides, avalanches, lava flows, earthquakes, torrents, and rock falls; having variable climates with slow recovery of flora, fauna or soil; encompassing heterogenous habitats resulting from altitudinal climatic variations; often remaining the last bastion of wild nature and being generally remote with rapid loss of indigenous culture, traditions, knowledge, and livelihoods. They are highly significant in being biodiversity "hot spots", water reservoirs (for as much as 80 per cent of humanity's freshwater needs), and outstanding natural heritage sites, where biodiversity is linked to cultural patrimony of the mountain people.

Biodiversity of Uttarakhand Himalaya is unique in many respects such as rare and threatened species of plants. The biodiversity rich ecosystems are important components of the ecosystem for carbon sequestration. The alpine pastures locally known as 'bugyals' are famous for their flowering plants and attract a number of tourists and naturalists from all parts of the world. The key issues warranting for conservation of the biodiversity of this part of the Himalaya include abandoning of agricultural areas by hill people either because of migration or by changing employment, deforestation and clearing of forests, mining activities causing destruction of habitats, overgrazing, water exploitation for hydro-electricity causing large-scale human dislocation, clearing of forest for transmission lines, unplanned tourism and mountaineering activities causing heavy pollution by dumping of waste materials, poaching of wild animals, over-exploitation of medicinal plants and invasion by alien plant species has causing change in plant diversity. Solutions demand the practical application of coordinated and integrated environmental management, especially the sustainable development. The conservation of biodiversity should include the rebuilding the vitality of mountain ecosystems, monitoring and reducing the environmental impacts of development in the high latitude area (especially the impacts of commercial forestry, tourism, road construction, mining etc.), determining the characteristics of water regime, especially with regard to the impacts of land use change and the changing biological influences on the hydrological cycle, environmental monitoring in mountain environments, the conservation and management of forest and water resources, the development and co-ordination of community action and community development for environmental improvement in mountains. Sustainable development community participation is the answer.

ARBUSCULAR MYCORRHIZAL FUNGI: A POTENTIAL TOOL IN CARBON SEQUESTRATION

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With a large land area and diverse eco-regions, there is a considerable potential of terrestrial/soil carbon sequestration in India. Of the total land area of 329 million hectares (Mha), 297 Mha is the land area comprising 162 Mha of arable land, 69 Mha of forest and woodland, 11 Mha of permanent pasture, 8 Mha of permanent crops and 58 Mha is other land uses. The soil organic carbon (SOC) pool is estimated at 21 Pg (petagram = Pg = 1 $\times 10^{15}$ g= billion ton) to 30-cm depth and 63 Pg to 150-cm depth. The soil inorganic carbon (SIC) pool is estimated at 196 Pg to 1-m depth. The SOC concentration in most cultivated soils is less than 5 g/kg compared with 15 to 20 g/kg in uncultivated soils. Low SOC concentration is attributed to plowing, removal of crop residue and other bio-solids, and mining of soil fertility. Accelerated soil erosion by water leads to emission of 6 Tg C/y. Important strategies of soil C sequestration include restoration of degraded soils, and adoption of recommended management practices (RMPs) of agricultural and forestry soils. Potential of soil C sequestration in India is estimated at 7 to 10 Tg C/y for restoration of degraded soils and ecosystems, 5 to 7 Tg C/y for erosion control, 6 to 7 Tg C/y for adoption of RMPs on agricultural soils, and 22 to 26 Tg C/y for secondary carbonates. Thus, total potential of soil C sequestration is 39 to 49 (44± 5) Tg C/y.

Large amounts of SOM and carbon are lost from the soil because of present intensive agriculture practices and to rectify the problem, the following measures have been suggested.

- Reduce ploughing through conservation- and zero-tillage
- Use mixed rotations using cover crops and green manures
- Minimize summer fallows and periods with no ground cover
- Apply composts and manures to soil
- Improve pasture and rangelands through grazing and vegetation management
- Use perennial rather than annual grasses, as perennials have 60-80% of biomass below ground compared with 20% for annuals
- Restore and protect wetlands (provided carbon sequestration is greater than methane production)
- Convert agricultural land to woodlands
- Adopt agroforestry in cropping systems
- Cultivate crops for bio-fuels (grasses, coppiced trees)

However, increasing population and industrialization has reduced the land availability and especially in India, most of the population is vegetarian and hence dependent on the cereals and grains and this requires a continuous effort to maximize the productivity. It means that we can compromise only to certain extent with the present agricultural practices. Hence, the above listed measures are practically not possible as to meet the requirement of practices to be followed for effective carbon sequestration. It is, therefore, necessary to look for an alternate strategy, which could fit in the present agriculture scenario considering the measures mentioned and the practical problems of feeding growing population. Use of arbuscular mycorrhizal fungi, an essential component of terrestrial plants, could necessarily be the integral part of agriculture/forestry/horticulture system.

Arbuscular mycorrhizal (AM) fungi form symbiotic relationships within roots of approximately 80% of all plant taxa. The AM fungi colonize fine roots behind the area of active cell elongation. Hyphae radiate out from the roots, effectively performing the functions of uptake of nutrients, particularly phosphorus (P), and of water in exchange for photosynthetically derived carbon (C) from their host. They form a significant pathway for the transfer of photosynthetic C to soils. For example, AM fungi are estimated to utilize 5–25% of photosynthetically fixed C in temperate herbaceous plant species and up to 45% in temperate trees. Studies in tropical forests have indicated that 20–80% of fine root length is colonized by AM fungi, and that spore production can be substantial. Many tree species are highly dependent on AM fungi, being unable to grow beyond the seed reserves if they are not inoculated with AM fungi. The C allocated to arbuscular mycorrhizas and thus their contribution to soil C could be particularly high in the tropics because of the low nutrient levels in highly weathered tropical soils. One of the compounds produced by AM fungi is a recalcitrant glycoprotein, glomalin. Concentrations of glomalin range from 2 to 15 mg g^{-1} of soil in temperate climates, and over 60 mg cm^{-3} was found in a chronosequence of Hawaiian soils. In addition to containing substantial carbon (and up to 5% iron), glomalin enhances soil aggregation, thereby protecting carbonaceous material from rapid degradation in soils. Ecosystem productivity is thus enhanced, due to improved levels of soil aeration, drainage and microbial activity. How glomalin concentrations vary across landscapes, and the influence of soil fertility on glomalin concentrations may provide insights into the importance of AM fungi and their products in soil C sequestration across tropical forest landscapes.

CARBON DYNAMICS IN A RICE-WHEAT AGRICULTURAL SYSTEM

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The aim of this study was to analyze soil carbon sequestration, soil aggregate composition, and soil microbial biomass dynamics as influenced by tillage practices in a rice-wheat agricultural system (located at Uchana, 29º51'N and 76º57'E) in northern India. The rice crop was grown under conventional practices, and wheat crop was grown under conventional tillage, zero-tillage and furrow-irrigated raised bed system. The soil carbon increased by 38% in the surface layer of soil (7.5cm soil depth) after seven years of zero–tillage wheat as compared to conventional tillage. The carbon accumulation in plant biomass production ranged from 4658 to 5147 kg C ha^{-1} in the wheat system and from 5663 to 5924 kg C ha^{-1} in rice system during the respective crop growing seasons. The total input of carbon into the soil in the form of straw and stubbles of rice and wheat (kg C ha^{-1}) was: 123 conventional tillage; 332 zero-tillage; 134 furrow irrigated raised bed system. About 80 to 88% of the ecosystem carbon occurred in the soil pool under different tillage practices. A comparison of carbon pools and turnover showed greater soil carbon storage in zero-tillage than conventional and furrow irrigated raised bed system.

Soil aggregate carbon and microbial biomass carbon showed temporal and spatial variations. In the three tillage systems, microaggregates formed 48 to 61% of total soil aggregate fractions and protected most of organic carbon and nitrogen in soils. The soil microbial biomass carbon and nitrogen were significantly greater in soils under zero-tillage as compared to conventional tillage and furrow irrigated raised bed system. The soil microbial biomass in the three tillage systems varied from 22 to 35 g C m^{-2}, the values being greatest in the case of zero-tillage. Microbial carbon was 2.41 to 3.14% of total soil carbon (rice crop) and accounted for 1.85 to 2.72% of total soil carbon (wheat crop).The soil microbial biomass showed significant increase due to amendments of straw and root residues in soil. Soil microbial biomass was found to be good indicator of the change in soil organic matter as influenced by tillage.

FIBRE YIELDING PLANTS AND CARBON SEQUESTRATION POTENTIAL

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Perhaps the impending environmental crisis has not yet affected much our lives, but the time is shortly to come. The earth desperately needs the attention and action from all of us. It is well known that the plants have been identified as one of the mitigatory measures for global warming and its adverse impact through carbon sequestration besides several direct and indirect uses. The need is to manage the plants on a sustainable basis so that the supply of these productions and regulatory functions can best be ensured. There are several solutions but amazingly, the simple textile fibre yielding plants can make a dramatic positive impact in many environmental areas through enriching soil carbon content, carbon sequestration and other ecosystem services along with livelihood through ecofriendly fibres. The cultivation of fibre yielding plants is thus important in several ways and needs attention at the level of every stakeholder. Meanwhile more awareness is required to bring the policy makers to realize the opportunities in diverse terrestrial ecosystems to increase carbon sequestration which may be stored in soil and vegetation under various land uses. This also needs to be directed at building more awareness at all levels to the benefits at local, regional, national and global levels. The paper analysis the constraints, potential and prospects of cultivating fibre yielding plants for enrichment of soil carbon and ecofriendly measures of livelihood.

CARBON SEQUESTRATION IN GRASSLAND AND TREE-BASED SYTEMS ON SALT-AFFECTED SOILS

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In India, more than seven million hectares of lands are salt affected. About 2.5 million ha of otherwise arable land have been adversely affected by soil sodicity in the Indo-Gangatic plains. This paper analyses the potential salt tolerant grassland vegetation, tree plantations and the agroforestry systems for carbon sequestration in sodic soils of north-western India. The accumulation of carbon in aboveground and belowground plant components were influenced by plant species composition and soil conditions The total carbon input into the soil varied from 164 to 911 gm C m^{-2} yr^{-1} in the grassland systems occurring over a soil pH range of 8.6 to 10. About 20 to 50 % of the decomposed plant residues (including litter and roots) were conserved as new soil organic matter over the annual cycle in different grassland communities, indicating their large potential for carbon sequestration on marginal lands.

Afforestation by salt tolerant tree species has been found to reclaim salt lands. Trees ameliorate highly sodic conditions by altering soil properties and improving the build-up of soil organic matter. The integration of trees with naturally growing salt tolerant grasses was found to be a viable land use option for improving soil organic matter and the fertility of highly sodic soils. After nine to ten years of tree growth, organic carbon content increased by 15 to 57% in soils under the silvopastoral systems on highly sodic soils. Integration of trees with grasses increased the proportion of soil macroaggregates, and soil microbial biomass carbon. The soil microbial biomass and biomass specific respiratory activity were found to be good indicators of improved soil conditions under tree plantations and the agroforestry systems. Thus, the protection of vegetation cover, tree plantations and the integration of trees with grasses/crops were found to be sustainable management strategies for carbon sequestration in salt-affected soils.

FEEDING STRATEGIES TO REDUCE EMISSION OF GREEN HOUSE GASES FROM LIVETOCK SECTOR

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The greenhouse gases bring substantial increase in the global temperature. Methane is an important component of greenhouse gases, and associated with animal agriculture. Methane has a thermogenic effect some four to six times that of carbon dioxide. Methane concentrations in the world's atmosphere are rising rapidly, and although they contribute only 19% of the overall warming, methane is a major component. Methane arises largely from natural anaerobic ecosystems, rice paddies and fermentative digestion in ruminant animals. Animal production plays important roles through production of methane in fermentative digestion of ruminants, a proportion of the faecal materials decomposes anaerobically. Methane output relative to product output of ruminants depends on fermentative digestion in the rumen, and the efficiency of conversion of feed to product (e.g. milk, beef, draught power). Large ruminants produce some 15–20% of the global production of methane. Ruminants on low quality feeds possibly produce over 75% of the methane from the world's population of ruminants because of low energy intake and low digestibility of roughages basal feed. The over all methane production from ruminant population in developing world is only 40% and Indian ruminant livestock contribute 11% methane as against 25% contributed by US and European Countries. Supplementation to improve efficiency of feed utilization and increase product output may reduce methane production per unit of milk or meat by a factor of 4-6. Improving feed quality is one of the proven methods to reduce methane production. Improving feed quality by supplementation with better quality feedstuffs will increase the production cost. Supplementation by cheaper feedstuffs such as by-products of the food industry should be explored for improving productivity and decreasing methane production. Methane production in rumen can be reduced considerably by dietary manipulations, Biodegradation of lignin and manipulation of rumen microbes for increased fiber digestion, reduced methanogenesis and for detoxification of anti nutritional factors. A specific feeding strategy is a key to increase livestock productivity with increased fertilizer value of animal dung in respect to reduced methane production.

VEGETARIANISM AS THE SAFEST MODE FOR KEEPING CO_2 LEVEL AT BAY

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Mode of human consumption is all set to affect the quality of our environment as well as the destiny of our Earth. Animals convert oxygen into carbon dioxide while breathing and plants convert carbon dioxide back into oxygen through photosynthesis. In order to reduce carbon dioxide levels the proportion of animals to plants needs to be reduced. Vegetarianism is good for reduction of greenhouse gasses. Less cows, less methane produced to support the same number of humans. Animals that we eat emit 21% of all the carbon dioxide that can be attributed to human activity. We could therefore slash man-made emissions of carbon dioxide simply by abolishing all livestock. Cattle convert only 6% of their energy intake (mainly grains and soya) into flesh, the remaining 94% is wasted as heat, movement (which is why they keep many animals in very close confinement), hair, bones, faeces, etc. Every molecule of methane is more than 20 times as effective as carbon dioxide is at trapping heat in our atmosphere. Best way to reduce global warming in our lifetimes is to reduce or eliminate our consumption of animal products. Simply by going vegetarian (or, strictly speaking, vegan), we can eliminate one of the major sources of emissions of methane, the greenhouse gas responsible for almost half of the global warming impacting the planet today.

PUBLIC SENSITIZATION IN CARBON CAPTURE AND STORAGE ATTITUDE IN GLOBAL WARMING SCENARIO

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As compared to air and water pollution awareness of people, mitigational efforts awareness for carbon sequestration is very less despite of hue and cry on global warming. Immediate action among developed countries and public willingness is lacking to address global warming. Investment is more in renewable energy technologies than cost – effective climate mitigation technologies.

Certain factors that may come in way in implementing technologies may be citing of wind turbines or pipe lines in local country side where people may object. Mere survey without public involvement would lead to nowhere. Public may not be willing to pay. For this public outreach campaign may be essential.

The increase from 280 ppm in pre-industrial atmospheric concentration of CO_2 to today's atmospheric concentration of 360 ppm has to be blamed on anthropogenic emissions where masses have to be made responsible.

The construction of carbon pools, carbon reservoirs, taxation on carbon dioxide are the basic norms which can be followed. The impact of CO_2 on environment and to save future environmental degradation has to be addressed by a public outreach strategy.

In this paper an attempt has been made by means of media, academics and social activists to sensitise masses to be ready to spend and be a part for sequestering carbon. Respondents have been divided in to education levels and policy makers have been asked to behave as a team to focus on checking vehicular, industrial, power – sector and fossil fuel emissions to sweep away the confusion in specifying sequestering carbon.

GLOBAL WARMING: CONTRIBUTION OF LIVESTOCK AND ITS CONTROL

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Methane, carbon dioxide and nitrous oxide are the major greenhouse gases produced by the agricultural activity of human beings, which are responsible for global warming. Methane has 23 times more global warming potential than carbon dioxide. According to an estimate of Intergovernmental Panel on Climate Change our globe is heading for a warming rate of about 0.2°C per decade in the near future. This has to be checked immediately to protect the environment. Livestock production activities are responsible for more than half of methane generated due to agricultural activity. Several methods like the use of ionophores, methane analogues, propionate inducers, defaunation of rumen etc. have been tested for reduction in enteric methanogenesis with variable degree of success. The use of plant secondary metabolites for inhibition of methanogenesis in the rumen appears to be a superior alternative to synthetic chemical compounds as these metabolites are largely not harmful, have no side effects on the recipient animal and there is no resistance of microbes to anti-microbial compounds. Some of these metabolites may affect digestibility of feed adversely, but that can be avoided by using either a lower and safe level of metabolite or by using a combination of different metabolites in low concentrations which are non toxic. The active principles present in these metabolites are either tannins, saponins or essential oils in nature, which are well known anti-microbial compounds. The experimental results do indicate that it is possible to reduce methane production from the livestock, but *in vivo* long duration feeding trials are needed before the techniques are recommended to the farmers for practical application.

MITIGATION OF CLIMATE CHANGE, THROUGH SOIL CARBON SEQUESTRATION.

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With the advent of the industrial revolution, there has been a drastic increase in the atmospheric concentration of carbon dioxide (CO_2) and other greenhouse gases (GHGs) which is resulted due to change in the land use pattern and increasing combustion of fossil fuels. The atmospheric concentration of CO2 has increased from 280 ppmv in 1750 to 367 ppmv in 1999 and is currently increasing at the rate of 1.5 ppmv/year or 3.3 Pg C/year (1 Pg = petagram = billion ton) (IPCC, 2001). Emissions due to land use change include those by deforestation, biomass burning, conversion of natural to agricultural ecosystems, drainage of wetlands and soil cultivation. These main activities have resulted in decreased soil organic carbon (SOC), which influences soil fertility adversely. Thus it is necessary to restore land use practices with effective management strategies like conversion of marginal lands into restorative land uses, adoption of conservation tillage with cover crops and crop residue mulch, nutrient cycling including the use of compost and manure, and other systems of sustainable management of soil and water resources. These management approaches will lower down the atmospheric CO2, thereby slowing global warming and mitigating climate change, which in turn may result in positive impacts on food security, agro-industries, water quality and the environment.

STUDIES ON BIOMETHANATION OF UREA TREATED PRESSMUD SUPPLEMENTED WITH LIME WATER

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Biomethanation of wastes for energy production is becoming an interesting and viable option in current energy scenario. Microbial production of methane is attractive for waste treatment and resource recovery. Methane is the most reduced carbon compound and formed as the terminal product of the food chain by the fermentative microflora. Biomethanation is microbiological process and successful digestion of organic waste depends on the maintenance of an environment that is favourable for the microorganism involved. The supplementation of alkali plays an important role for maintaining a favourable environment. Pressmud a sugar-factory waste which is produced during cleaning of sugarcane juice by sulphitation process in rich in organic matter and nitrogen was found as prospective raw material for biogas production, anaerobic digestion appears to be promising treatment for pressmud because it would provide energy and reduce organic load of it. Studies were conducted to evaluate the feasibility for biomethanation of alkali treated pressmud at initial solid content of 6 percent. The experiment was carried out at 35+- 1.c in laboratory scale batch fomenters having capacity of 5.0 liter for a period of 40 days. Alkali such as lime water (0.25M) and its combination with urea solution having concentration of 0.05 M, 0.10M and 0.15 M were used for treating equal amount of pressmud. The initial pH of substrate was adjusted to 7.5 except for untreated substrate (pH 7.0). The results indicated an increase in cumulative biogas production of 21, 30 and 13 percent for pressmud treated with 0.05M, 0.1M, 40.15 M urea solution respectively compare to untreated pressmud substrate. However, the highest biodegradation of 43.3 percent observed for substrate treated with 0.15 M urea solution compared to untreated substrate.

ROLE OF FOREST ECOSYSTEM TO MITIGATE CLIMATE CHANGE

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Forests play an important role in the global carbon cycle and consequently in regulating the global climate system. Changes in forest conditions are the result of interactions among many factors such as social, ecological, economic, climatic, and biophysical. Anthropogenic activities have known to affect the biosphere through changes in land-use and forest management activities, thus altering the natural balance of greenhouse gases in the atmosphere. Over the last three centuries, forests have decreased by 1.2 billion hectares in the world. Carbon management in forests will probably be the single most important agenda of the first half of the 21st century in India in the context of the greenhouse effect and mitigation of global climatic changes. The forest ecosystem is a major biological scrubber of atmospheric carbon dioxide that can be significantly increased by careful management. Absorbing carbon dioxide from atmosphere and moving into the physiological system and biomass of the plants, and finally into the soil is the only practical way of removing large volumes of the major greenhouse gas (CO_2) from the atmosphere into the biological system. In forests, carbon can be sequestered over decades or even centuries, until mature ecosystems reach a stage of carbon saturation. The Kyoto Protocol opens new possibilities for using the biosphere as a carbon sink. While forest carbon flows are important in the global carbon cycle and there is considerable potential for modifying these flows to reduce atmospheric carbon-dioxide concentrations.

ROLE OF REMOTE SENSING TECHNOLOGY IN AGRO-ECOLOGICAL ZONING

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Agro-Ecological zoning (AEZ) is one of the most important bases of sustainable agricultural development planning of a region. It can be regarded as a set of core applications, leading to an assessment of land suitability, potential productivity and a further set of advanced or peripheral applications that can be built on the inventories and results of the core agro ecological studies. Attempts have been made to classify the land area into climatic regions for long back. Based on physiography, soils, climate, growing period and available soil moisture, India has been categorized into 20 Agro-ecological Regions on a 1:4000000 scale map. However many of the earlier efforts to delineate agro-ecological zones used manual overlay of isolines representing either potential evapotranspiration or temperature or their combinations and superimposed on soil resource maps. But now days it has been possible to achieve new dimensions to effectively monitor and manage natural resources with the intervention of modern developed techniques such as remote sensing and Geographical Information System (GIS). GIS technology is proved to be capable of containing all data required to solve resource management problems. Topographic maps, land resource map and contour map having physiographic, geographic and bio-climatic information forms primary input for GIS in agro-ecological zoning activities. A zonal database can also be integrated with non-geographic information such as socioeconomic data, which is relevant for making decision on development priority interventions about the sustainable management of zonal resources. Remote sensing provides digital or hard copy data base information on natural resources. This information can be stored and retrieved as and when required and also data can be classified and aggregated for a large number of planning practices. This AEZ concept involves the representation of land in layers of spatial information and combination of layers of spatial information using geographic information system.

IMPACT OF HABILITATION AND TOURISM ON ICTHYOBIODIVERSITY OF NAV KUCHIA TAL, NAINITAL (UTTARAKHAND)

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A field survey was carried out to evaluate the impact of habilitation around historic Nav Kuchia tal on aquatic biodiversity. During survey it was found that habilitation around Nav Kuchia tal is very dense which are for various purposes like resorts, shops and houses etc. For habilitation they are cutting the trees from hills and due to this reason siltation is major problem which destruct the breeding and feeding ground of fishes which adversely affects the icthyodiversity of Nav Kuchia Tal. Discharge from shops, resorts and other waste material like polythene Bags; plastic bottles etc. from tourists are adversely affecting the biodiversity. This study indicates that there is a great need to conserve fishes of Nav Kuchia tal by improving the feeding and breeding ground and also great need to aware the people to keep the neat and clean Nav Kuchia Tal to save the aquatic diversity.

FOREST MANAGEMENT: CARBON MITIGATION AND SOCIAL ISSUES

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Major problem being faced by human society is that the global temperature is believed to be increasing due to human activity that releases Co_2 to the atmosphere. The problem of increasing atmospheric Co_2 can be addressed a number of ways. This paper examines a number of current issues related to mitigating the global warming problem through forest management. Forest has potential to capture and keep large volumes of carbon over long periods as trees absorb carbon through photosynthesis process. A forest, when growing rapidly, can sequester relatively large volumes of additional carbon roughly proportional to the forest growth in biomass. Reducing deforestation, expanding forest cover, expanding forest biomass are activities that could help global community realizing the carbon sequestration potential of forest ecosystem. Community forest management has the potential to resolve this dilemma and capture synergies between local and global environment. Community based forest management has an important role to play in reversing processes of deforestation, sequestering carbon and promoting rural development. It provides a setting that potentially overcomes many of the social obstacles facing conventional concession forest management. Forest management can thus have an influence on carbon sequestration.

CARBON SEQUESTRATION, GLOBAL CLIMATE: LAWS, WHAT HAS BEEN DONE AND WHAT REMAINS?

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Removal of excess carbon from the atmosphere is "Carbon sequestration" which has caused climate change and various factors pertaining to global warming especially with high levels of CO_2 rise (Greenhouse gas (GHG)) due to human activity. Hurricanes impact carbon sequestration by forests and climate change will affect carbon sequestration in oceans. Delay in flowering & presence of leaves which persist are some of the indicators of climate change.

Various policies and legislations are now coming into picture with the various ill effects of carbon sequestration and climate change. Senators of the US have sent a write up to the Government of US to have legislation towards Global warming (GW) which is on its way (Jan 2007). Intergovernmental Panel on Climate Change (IPCC) 4th assessment report released on 2nd Feb 2007 does not raise various issues related to the impact of GW on climate and vulnerability of people. Various Federal Global Warming legislations (2005, 2006 and 2007) are in limelight. The 3rd Assessment Report (TAR) issued in 2001 (The Scientific Basis, Impacts, Adaptation and Vulnerability, Mitigation & Synthesis Report) and 4th Assessment Report does not alter the basic global warming scenario outlined. Kyoto Protocol (1997) to the United Nations Framework Convention on Climate Change is an amendment to the international treaty on climate change, assigning mandatory emission limitations for the reduction of GHG emissions to signatory nations. This is the most important global initiatives to address climate change. The U.N. Framework Convention on Climate Change (UNRCC) was established in 1992. A recent IPCC report has projected a global mean sea level rise of 0.59m by the end of the 21st century with increase in sea surface temperature increasing and speeding of cyclones particularly in the Bay of Bengal, using an RCM (Regional Climate Model) of the Hadley centre with emission scenarios of the IPCC. With storm surge heights which will be much greater with its disaster on the Indian coastline. RCM of British Hadley Center for Climate Prediction and Research (PRECIS) used by Indian Institute of Tropical Management, Pune, India, has outlined GHG emission scenarios with reference to TAR with increase in precipitation and Surface Air Temperature (SAT). India needs to address this issue with proper legislations with policy makers; scientists along with the governmental officials having proper carbon sequestration, GW policies and laws. With temperature rise and IPCC emission scenario, malaria persists in many parts of India and may shift to other parts. Coral reefs are at serious threat with respect to Global temperature rise, bleached corals have been reported. Mitigation and adaptation measures countries must take to minimize adverse effects have to be addressed.

IMPACT OF HEAVY METALS CADMIUM AND LEAD ON HEMATOLOGY OF A FRESH WATER FISH, *Puntius conchonius* Ham.

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A widely distributed fresh water bony fish, *Puntius conchonius* Ham.(Order Cypriniformes, family Cyprinidae) average body weight 4.54±0.27g and total body length 5.0±0.31cm,were caught with a hand net from the Nainital lake (altitude 1938 m a.s.l.)

The fish were brought to laboratory in plastic buckets and acclimatised under laboratory condition. Fishes were exposed with concentration of Cd as $CdCl_2.H_2O$ and Pb as Pb $(NO_3)_2$ for acute (24 hrs. and 48 hrs.) and chronic exposure (60 days);the used concentrations were 12.652mg/l,0.5mg/l and 0.379mg/l, 0.126mg/l respectively.

In acute exposure to Cd resulted in reduced RBC counts, Hb, Hct, and TLC. Blood anomalies during chronic exposure included marked erythropenia, anemia, together with increase in MCV and MCH. Small lymphocyte proportions were increased but the large lymphocytes decreased. There was also monocytopenia, a conspicuous thrombocytosis, besides neutropenia. An enduring and pronounced reduction occurred in the TLCs. The SSI fell in the treated fish.

In lead exposer, depressed RBC counts, Hb and Hct together with leucopenia were noted in acutely intoxicated fish. After eight week exposure, a marked erythropenia, anemia and lowered MCV were observed. In general, percent ratio of large lymphocytes was lowered while that of small lymphocytes raised. A notable monocytopenia, thrombocytopenia and neutrophilia also occurred. An increase was noted in the SSI.

The study reveals that the heavy metal cations are unsafe, and if present in aquatic systems, may seriously impair metabolic and structural profiles of the exposed fish.

EXPLORING MARKETS FOR ECOSYSTEM SERVICES IN INDIA: A CASE FROM ALMORA, UTTARAKHAND

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The concept of market based approach for conserving ecosystem services is gaining momentum throughout the world. However, much works remain to apply these tools into practices. Particular issues include definition and measurement of ecosystem services, development of institutions and mechanism to facilitate trade and integration of these instruments into broader natural resource management agenda (Whitten *et al*, 2003). The basic concept is to create positive economic incentives to enhance the flow, or at least maintain certain environmental functions.

One of the important functions of the forest ecosystem is the recharging of the ground water. The conservation of these forests is especially important in the hilly regions for maintaining the flow of natural springs which are the main sources of water supply (drinking and irrigation both) in many villages of the state. The catchments of the streams providing water to Almora town had a very old natural forest of oak mixed with rhododendron with steeper parts covered by chir pine and cupressus. Chaturvedi (1994) had estimated the capital value of these forests as Rs. 31,630 per hectare for the supply of water alone. However, over a period of time the supply of water has reduced considerably due to the degradation of the forests as well as continuous expansion and increase in the population of the town. The Uttaranchal Peya Jal Nigam is now pumping water from Kosi river which is around 1000m below the altitude of the Almora town. The present paper deals with the economics of water supply of Almora town, quantity of water supplied from forest as well as from other sources, and the efforts made by the concerned departments to maintain these forests. There is urgent need to improve the conditions of these forests and to develop a mechanism to charge some nominal fee (say Rs. 1 per month) from each household of the town and use this money to provide some incentives to the people of the catchment areas to encourage them to protect these forests.

SOCIO-CULTURAL VALUES PROMOTING CONSERVATION OF NATURE'S BIODIVERSITY AND HEALING OF EARTH.

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We are divided by nationalities;
We are divided by languages;
We are divided by ideologies;
We are divided by cultures;
Yet, we have in common -
The common heritage of life
Our mother earth!

Mother earth has delivered all the present lives, right from the single celled to the complex structures contributing to the biodiversity. Biodiversity is defined as the variety of life forms, measured in terms of biomes, ecosystem, species, genetic varieties and the interaction between them (Ntiamoach-Boadn, 1995). She has an unique identity from the rest of the universe, to gift us with the accentuation of quality life, to share & thrive in harmony with nature. Though we have diversified biological heritage, we still stand united with our common ecological heritage- our mother earth.

We have of course benefited from her blessings, but what shall we leave for our forth comers? This remains as a biggest question mark in the universal context. Ecological concerns are repeatedly hitting the front pages of leading dailies, not because we are unaware of the ecological problems, but because we are unconcerned about future in striving for the present. The selfishness of humanity, has handled capitalism as a destructive tool to exploit nature. This has intrusively, harmed our relationship with nature that affects indifferently both the benefited & the innocents. Now the need of the hour is ecological reconstruction to assure a life of dignity & grace for future. The wounded nature calls for the ecological catharsis. Let us rejenuvate ourselves to join her!

The Relationship between Culture and Environment

"Plants, animals & human beings constitute
An integrated whole, it is this specific culture
That makes sense by ordering natural & social
Phenomena into a structured world.
It is an amalgamation of nature & culture!"
-Seeland, 1997.

Man is identified by his society that hallmarks a unique culture. Man is a social animal; he craves individuality & independence but his stature as a human being is shaped & enhanced by the social context. The relationship of culture to environment is one of the oldest matrix in the science of anthropology. The concept of environment determination is developed based on the ways in which cultures are adjusted to the unique features of their local environment. The view that "Culture" can endow life with meaning & value by promoting truth, beauty & goodness is therefore no airy abstract, but on the contrary, it arises directly from everything that men & women are doing to fashion and direct their lives to improve their lot on earth.

"Man did not weave a web of life,
He is merely a strand in it!
What ever he does to the web,
He hoes to himself!
-Chief Seatile.

When humanity draws up its balance sheet of losses & gains, those who have rendered signal services in the cause of culture come into their own because it is seen that without their contribution, the human heritage of meanings & values would be impoverished. The responsibility for promoting cultural values in conservation of nature's biodiversity is widely shared between individuals, families and neighborhood groups as well as society at large scale.

Can Social and Cultural Values Save Our Earth

"Culture is that, which enhances the quality
Of life with meaning and value by making
Possible the formulation, progressive realization,
Appreciation and achievement of truth, beauty &
Moral value for betterment of humanity."
-F.R.Cowell.

Can social & cultural values save our earth? The answer to this question is obviously "yes". In many societies with fine cultural values, there is a deep understanding that right thinking leads to right action. The idea of right thinking is a specific domain, be it farming or forest conservation. The right conservationist strategies emphasis, the benefit to all humankind. The weight of social responsibility is most clearly recognized in the cultural context. If we talk of natural resources management from global perspective, whom do we find in the fore front of the race for protection & preservation of resources. The answer comes very naturally, it is the local communities. They posses' social & cultural values that make them properly exploit their "local knowledge", to obtain forest products. It is a autopoietic system, which has functional efficiency of ecosystem & orienting livelihood towards environmental integrity. The community spirit in biodiversity conservation is obviously visible in the rich socio-cultural values they posses. There are many tribal traditions and practices which are in harmony with the ecological well-being of nature. They have spiritual & emotional relationship with the environment in which they live.

Socio-Cultural Values Promoting Biodiversity Conservation

Biodiversity management is an ancient phenomenon. The origins of biological conservation can be traced to philosophical & religious beliefs about man as a full part of nature. Vedas contain hymns in praise of animals. Santana dharma has linked some animals with specific Gods & Goddess as the best way of conservation of biodiversity. for example: Python has been associated with God Vishnu, Snake with God Shiva, Swan with Goddess Saraswatu, Lion with Goddess Durga, rendering the animal pious & protected. In Mahabharata, Rishis & Munis have been indicated to conserve wildlife fauna such as deer & birds around ashrams. In Arth shastra, Chanakya had imposed severe penalties for killing, entrapping & molesting birds, fishes & deer etc in protected areas.

The Torah, or Old Testament prohibits the destruction of fruit bearing trees. & this commandment has been extended to encompass all manner of wastefulness. Islam recognizes each species as its own "Nation" and an obligation of man to "Khalifa" or "stewardship" of the earth. Specific conservation mechanism such as harma & hima zones and the origins of the idea of carrying capacity was a product of Islamic civilization. As early as 450 BC, Artaxerxes 1, attempted to restrict cutting Lebanese timber (Grove, 1992). Plato, writing in 4th century BC, noted that the removal of trees in Attica, produced social erosion "and what remained is like the skeleton of a body wasted by disease" (Glacken, 1965).

Similarly the traditional life style of local communities, is much intertwined with their environment for them forest is the mother's home. We can understand the profound and unique relationship of local community with the forest can be under stood by the following example. A woman in chomoli district of Uttrakhand gave birth to girl baby while collecting fodder in the forest. So the baby was named as Boni Devi, Goddess of forest. This shows their emotional relationship with forest.

Numerous initiatives taken by the local communities for biodiversity conservation & generating sustainable livelihood emerge as a strong ray of hope. The history of community forest protection & management in the state of Orissa dates back to the pre-independence days. Lapan village in the Sambalpur district which began protection as early as 1936 is an marvelous example. The world famous "Chipko Andulan" of the hill women against the destruction of forest in the Himalayas has proved that they can protect conserve & manage the environment. The Mahila Mangal Dal has received the Indira Priyadarshini Uriksha Mitra Award from the late Prime Minister Shri Rajiv Gandhi in 1984 for their initiatives. The Maiti Movement in Chamoli district of Uttarakhand region has made this region has flourish with trees. During the marriage ceremony of the maiti group of girls, the bride presents sapling to her bridegroom, who plants it under the auspicious chanting of mantras.

The idea of Raksha Sutra Movement, to save the nature wealth of Himalayas is totally anew thought that came of in august 1994.Similar to Raksha banadhan, an Indian festival. The women of different villages tie Raksha sutra to the trees of their forest jointly raised their voice against forest business and failing of trees. All such movements are blended with the ongoing cultural practices of the people, people imbibed with their emotional sentiments and strong determination for the preservation of natural resources. So it clearly demonstrate that, conservation and protection of natural wealth, always incorporate the traditional knowledge practical experiences, religious sentiments, code of social conduct ,cultural practices with community participation.

Another best example to illustrate the traditional conservation strategy is the Indigenous Biodiversity Conservation Areas (IBCAs) of Ghana forest in Africa .It is as old as traditional Ghanaian society itself (backing to 8th century). They follow regulatory strategies often enshrined with religious or cultural beliefs and superstitious and enforced by taboos. Infact Ghana is said to hold ancient keys for a meaningful model of forest conservation.

Conclusion

Biodiversity conservation is discussed in many global forums since few decades back but still we could not land up in an affective technique to heal our earth. There is the lacuna in our approach towards nature. So let us think different. Let us have reverential thinking which make us aware not only of the physical existence but goes beyond it to inherit the worth and beauty of nature. Such type of reverential thinking is practiced in many socio-cultural entities, under different names. I strongly believe that the highly funded natural resources management projects of government can succeed only if the incorporate the rich values of eco-cultural practices, which have not only proved to be possible but have been practices in large scale.

The healing nature of ecological thinking has more power to fetch us a permanent solution to all our struggle towards nature conservation as it emphasizes on the participatory approach united by social and cultural solidarity. Only when we understand and promote the socio-cultural values in the healing the nature, we can actively participate in the ecological catharsis.

So come on, let us continue, chanting the mantra of “conservation”, by adding the right fuel of “socio-cultural values” to strengthen the yajna of “biodiversity”.

CHALLENGES AND CONFLICTS BEING BORNE OUT OF THE CURRENT STATE OF FREE CARBON IN ENVIRONMENT MANIFESTING INTO GLOBAL WARMING, CLIMATE CHANGE AND SOCIO-ECONOMIC UNSUSTAINABILITY

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The term *global warming* is a specific example of the broader term climate change, which can also refer to global cooling. In principle, global warming is neutral as to the period or causes, but in common usage the term generally refers to recent warming and implies a human influence.

Global average air temperature near Earth's surface rose 0.74 ± 0.18 °Celsius (1.3 ± 0.32 °Fahrenheit) in the last century. The prevailing scientific opinion on climate change is that "most of the observed increase in globally averaged temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations."

The atmospheric concentrations of CO_2 and methane have increased by 31% and 149% respectively above pre-industrial levels since 1750. This is considerably higher than at any time during the last 650,000 years, the period for which reliable data has been extracted from ice cores. About three-quarters of the anthropogenic (man-made) emissions of CO_2 to the atmosphere during the past 20 years are due to fossil fuel burning.

India has to tackle climate change from a short-term and long-term perspective. In the short term, energy-efficient and low carbon fuels need to be encouraged through suitable incentives, e.g., tax rebates. A long-term approach to deal with this problem should emphasise the use of renewable sources of energy like solar and wind energy. Greater application of solar energy in rural areas (farming and household energy) would go a long way in reducing dependence on conventional fossil fuels.

STUDY OF SUGAR INDUSTRY EFFLUENT AND ITS EFFECT ON SEED GERMINATION AND SEEDLING GROWTH OF *LINUM USITATISSIMUM* L

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Physico - chemical and biological characteristics of the effluent of Baghpat Co-operative Sugar Mill Ltd., Baghpat of western Uttar Pradesh were investigated. The effluent was found acidic in nature, rich in suspended organic and dissolved matter with higher amounts of nitrate, phosphate, chloride, calcium and high value of BOD and nil dissolved
Oxygen.

Linseed (*Linum usitatissimum* L. Var. Padmini) seeds were kept on adsorbent paper for germination placed in petridishes and treated with equal amount of different concentrations of effluent (25, 50, 75 and 100%) and distilled water for control. The study revealed that seed germination and seedling growth was maximum, even better than control in lower concentration (25%) and declined strikingly with higher concentration reaching minimum at 100% concentration of effluent. Thus sugar mill effluent can be used for irrigation purpose at lower concentration (up to 25%) with out use of additional fertilizers for better crop results.

LOW CARONDIOXIDE LEVEL IN ENVIRONMENT BY MICROORGANISM

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Carbon dioxide is increasing in the environment very rapidly by different sources i.e. Mills, paper and pulp, pollutants and fertilizers. Increasing the CO2 levels causes the so many problems related to global warming, acidrain etc. Microorganisms those have mutant genes found in environment help to lowering the carbondioxide level. This type of microorganism can culture *in vivo* and *in vitro* methods. All methanogens bacteria can absorb carbon dioxide and used it. Microorganism such as plankton and zooplankton found in ocean play a significant role in reduction of CO_2. Zooplankton and bacteria which absorb CO_2 and assimilated to oxygen which are use full to living organism and animals. So microorganism helps to reduction of Co2 level in environment and support to nature to save from Global Warming.

THE POTENTIAL EFFECTS OF SUSTAINABLE SLOPING LAND MANAGEMENT OPTIONS ON CARBON SEQUESTRATION IN UPLAND SOILS IN THE HIMALAYAS

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In recent decades unsustainable land management practices due to increasing population pressure in the Hindu Kush-Himalayas (HKH), especially in the "Middle Mountains", are leading to rapidly degrading catchments. These land use changes and degradations are affecting green house gases emissions influencing climatic change. The rehabilitation and sustainable management of these upland catchments is seen as not only important but also challenging for all mountain societies and governments in the region and associated downstream communities and the present policies provide basis for optimism.

The Kyoto Protocol of the United Nations Framework convention on Climate Change represents a major international effort to decrease greenhouse gas emissions to the atmosphere. In this context the Clean Development Mechanism (CDM) is an arrangement under the Kyoto Protocol allowing industrialized countries with a greenhouse gas reduction commitment to invest in emission reducing projects in developing countries as an alternative. The CDM is currently offered for afforestation and reforestation projects, but in the future it is expected to extend to carbon sequestration in agricultural soils.

In this context sustainable sloping land management, in particular low-cost methods to sequester carbon in soils are emerging as a major international policy goal. However, due to the complex matter of carbon sequestration current applicable numbers of C stock in agricultural soils and other land use are missing. However many observers believe that the CDM in farming systems could offer a great potential to reduce rural poverty by extending payments to low-income farmers who provide carbon storage through sustainable land-use systems.

Sustainable sloping land management options such as low cost soil conservation options can take an important role as carbon sequestration strategies. In order to address this C sequestration potential, promoted sustainable land management options of the ICIMOD coordinated "People and Resource Dynamics Project – PARDYP" (1996-2006) will be analyzed through the C sequestration lens. PARDYP was a research for development project and the main objectives were (1) to find options and approaches to support sustainable and equitable access to water, land, and forests; (2) to improve productivity of farming systems; (3) to increase productivity of agricultural land; and (4) to test and disseminate improved water management options. The project operated in five middle mountain watersheds across the HKH - two in Nepal, and one each in China, India and Pakistan. The basic idea was to test, develop and promote simple options for sustainable land management, while building on local knowledge and practices involving local people.

The goal of our future research is to analyse these promoted options of conservation agriculture and watershed management, in particular the soil conservation practices on the C sequestration capacity. E.g. the effect of erosion control through terracing, increasing soil fertility (soil organic matter, SOM) through better compost application, effects of rehabilitation activities of degraded lands (terracing, planting, hedgerow planting) on soil C sequestration. In addition, the global network WOCAT (World Overview of Conservation, Approaches and Technologies) database offers tools and methods to capture and disseminate good options and to promote them.

The aim of this study will be to contribute to the understanding of C sequestration in sustainable land management system emphasizing the importance of soil conservation practices. These findings of the short and longer term C sequestration will lead to new rules for the CDM.

"MICROBIAL INTERVENTION FOR C-SEQUESTERATION" A CONCEPT PAPER

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Introduction

Carbon dioxide is the most important green house gas, accounting for about half of the green house effect. The natural concentration of green house gases (GHG) has been essential for life as we know that on earth creating the average temperature of 15^0C. Without the naturally occurring green house effect, the average temperature would be -18^0C. However, human activities such as burning fossil fuels (coal and petroleum), the chemical industry and agriculture and land use changes are responsible for increasing the amount of green house gases, especially carbon dioxide in the atmosphere. The result is an increased GHG and raised global temperature by 0.5^0C over past 100 years. As a result of human-induced increases in green house gases, the temperature is projected to increase by 1 to 5^0C during the next 100 years.

Carbon sequestration via bio-geological formation of methane is the process which can be of extreme importance in overcoming the hazardous effects of CO_2 accumulation e.g. global warming, it is estimated that nearly 260 million tonnes CO_2 is in atmosphere (3% of global emission) with 5.5% annual increase. The total stored C in soil & vegetation is 2000 Gt ± 500.

Recent findings have shown that microbial activities in subsurface environment (coal bed, sediments and aquifers etc.) are efficient in CO_2 sequestration. This CO_2 sequestration in these environments is usually coupled with biogenic production of CH_4. The micro flora involved in the process are mainly strict anaerobes which require extremely low oxido-reduction potential (Eh<200 mV) and have a limited trophic spectra ranging from H2, CO2 upto few methylated substrates.

Strategies of Carbon Sequestration

- Enhancing natural carbon sinks
- Capturing CO_2 and storing it in geologic formations or the deep ocean
- Converting CO_2 to benign solid materials
- Converting CO_2 to fuels through biological or chemical processes

Biological means of carbon sequestration

i. Photosynthetic sequestration on crop based systems
ii. Biological Mineralization
iii. Methanogenesis through Carbon Dioxide reduction

Methanogenesis: the process

- Carried out by strict anaerobic archaeal bacteria (methanogens).

Chemolithotrophic Methanogens use carbon dioxide to generate methane using hydrogen and carbon dioxide that is fixed via a reductive acetyl-CoA pathway

- The pathway of interest: (The Wood Pathway)
  - $H_2 + CO_2 = CH_4$ (CO_2 reduction)

Benefits of Biological systems in carbon sequestration

- Potential payoff large
- Low-cost, natural-process based systems - sequestration of large amounts of CO2
- Environmentally acceptable and sustainable
- Can be deployed worldwide in large numbers
- Exploitation of carbonate precipitating microorganisms in metallurgical & fossil fuel refining industries.

Conclusions

This study focuses on the concept of microbial intervention for the carbon sequestration via methanogenesis. It is an eco-friendly approach to remove carbon dioxide from the environment which ultimately helps in reducing the global warming.

Swapnil Soni

Sarvesh Sahay

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CURRENT STATUS OF ENVIRONMENT: Free Carbon Concentration In The Environment And Global Warming And Climate Changes Caused Due To This.

Carbon dioxide content in fresh air varies and is between 0.03% (300 ppm) to 0.06% (600 ppm), depending on location and in exhaled air approximately 4.5%. When inhaled in high concentrations (greater than 5% by volume), it is immediately dangerous to the life and health of humans and other animals. The current threshold limit value (TLV) or maximum level that is considered safe for healthy adults for an 8-hour work day is 0.5% (5000 ppm). The maximum safe level for infants, children, the elderly and individuals with cardio-pulmonary health issues would be significantly less.

As of January 2007, the earth's atmospheric CO_2 concentration is about 0.0383% by volume (383ppmv) or 0.0582% by weight. This represents about 2.996×10^{12} tonnes, and is estimated to be 105 ppm (37.77%) above the pre-industrial average. Since the start of the Industrial Revolution, the atmospheric CO_2 concentration has increased by approximately 110 µL/L or about 40%. Burning fossil fuels such as coal and petroleum is the leading cause of increased man-made CO_2; deforestation is the second major cause. Around 24 billion tonnes of CO_2 are released from fossil fuels per year worldwide, equivalent to about 6 billion tonnes of carbon.

This suggests the great surge in the atmospheric free Carbon concentration in environment primarily because of indiscrimate activities of human beings and this is the cause of the great concern today. Increased amounts of CO_2 in the atmosphere tend to enhance the greenhouse effect and thus contribute to global warming. The effect of combustion-produced carbon dioxide on climate is called the Callendar effect.

Because of the greater land area, and therefore greater plant life, in the northern hemisphere as compared with the southern hemisphere, there is an annual fluctuation of up to 6 ppmv (± 3 ppmv), peaking in May and reaching a minimum in October at the end of the northern hemisphere growing season, when the quantity of biomass on the planet is greatest.

Despite its small concentration, CO_2 is a very important component of Earth's atmosphere, because it absorbs infrared radiation at wavelengths of 4.26 µm (asymmetric stretching vibrational mode) and 14.99 µm (bending vibrational mode) and enhances the greenhouse effect

But even a slight surge in concentration of CO_2 can have catastrophical changes in our environment and this is pity much clear in the way our climate, temperature, precipitation, snowfall, global warming, melting icecaps, unpredictable monsoons, etc. have changed in recent few decades.

Out of 12 hottest years 11 have occurred since 1995. Temperature has risen 0.75degree C over the past century. Also, concentration of GHG's in the atmosphere risen dramatically since the industrial revolution. CH4 has doubled and $CO_{2\ has}$ risen by 30% since 1750. It is predicted that by 2010 temperature will rise between 1.1 to 6.4 degree C and as a result sea level will increase by 18 to 59 cm.

The remedy for this can be preventive as well as curative measures. Infact we have no alternative but to do both mitigation and adaptation complement to each other. But prevention is always better than cure. So, for this various measures should be taken up with utmost urgency like drastic reduction in carbon emissions, improved efficient technologies, development of other renewable and clean sources of energy, etc. To keep GHG's at current level, we need to slash CO_2 emission by 60%.

Various techniques have been proposed for removing excess carbon dioxide from the atmosphere in carbon dioxide sinks. Many scientific techniques are under phase of trial and testing and even practice to control free carbon in nature like carbon sequestration, aforestation, fixation of carbon in biomass, fertilizing phytoplankton in sea for trapping carbon from air, etc.

Methods of CO_2 extraction/separation include: Aqueous solutions (Amine extraction, High pH solutions), Adsorption (molecular sieves, activated carbon, metal organic frameworks), Solid reactants (Serpentine, Olivine, Quicklime), Membrane Gas Separation, Regenerative carbon dioxide removal system, Algae Bioreactor Technology, etc.

So, it is high time today that we all come together, try and develop these technologies and techniques and try to curb this menace that is caused by all of us before it becomes too late and we reach the point of no return.