THEME 4

Forest Biodiversity and Landscapes

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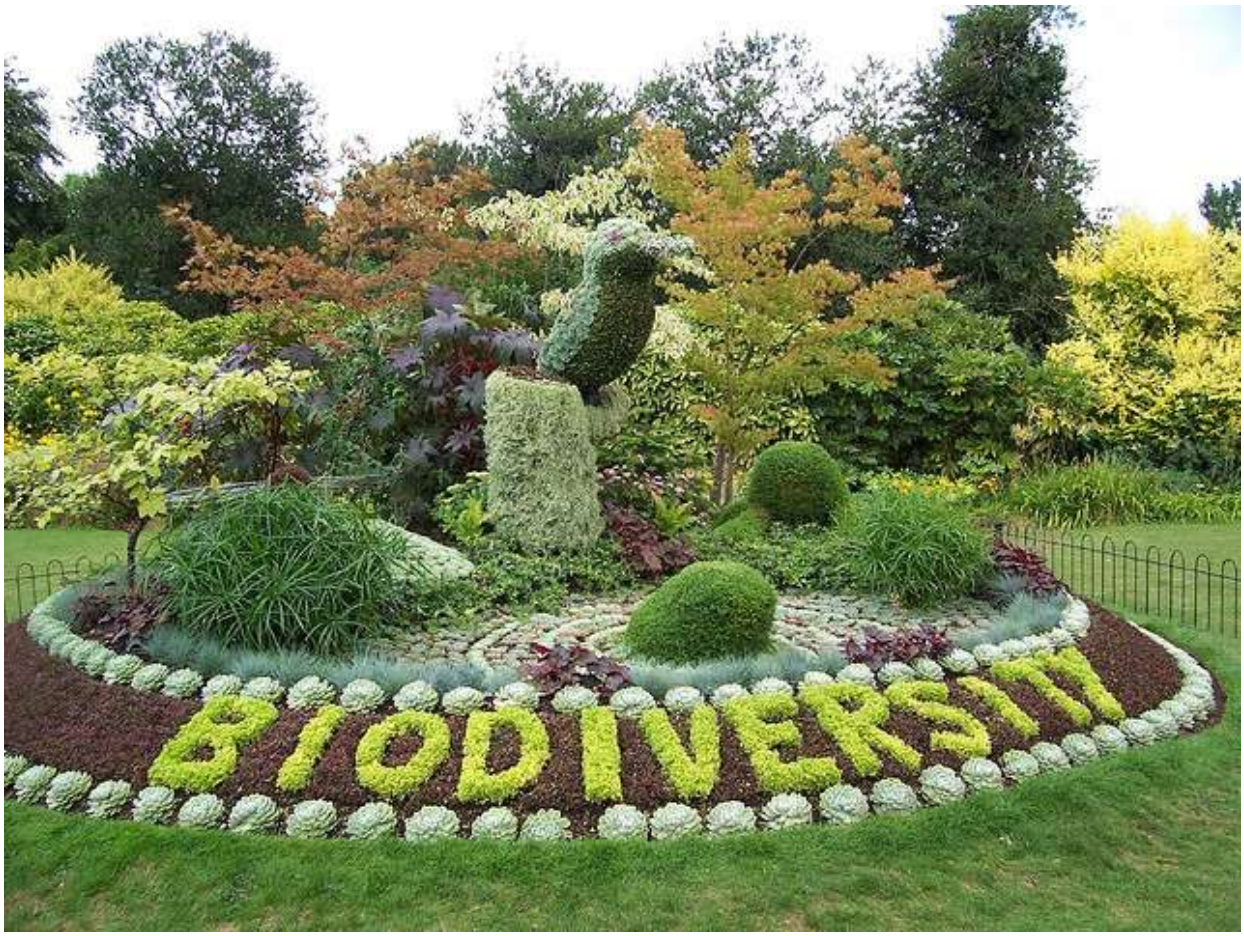

Bio diversity in India

Bio means having to do with life or living beings /organisms. Biology is the science of life. Oxford dictionary defines biodiversity as the variety of animal and plant life in the world/ country or in a particular habitat.

More than 70 % of India's biodiversity is confined within forests. The agricultural biodiversity which accounts for less than 30% of the total, has also 12 centres of origin of cultivated plants having centre of origin of 30000 – 50000 varieties.

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Forest Biodiversity includes all the living organisms found in the wild, be it bacteria or mega species like elephant. Therefore preservation of forests is necessary for survival of biodiversity and ultimately human being.

Micro organisms survive by helping de-composition of all living things after death therefore forests are essential for all. Human dependency on forests in terms of climate, water, medicinal plants (major part of forest biodiversity) is unfathomable.

India has a rich and varied heritage of biodiversity encompassing a wide range of habitats. It is a global biodiversity hotspot which accounts for 7.31% of global species within its 2.4 % area.

The country has been divided into 10 bio geographic regions. India has five world heritage sites of bio-diversity importance (some more are likely to be added in very near future) 666 Protected Areas with overlapping 26 Elephant Reserves and 41 Tiger Reserves.

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The protected areas have been notified to preserve forest biodiversity. The network has been carved out of the erstwhile faunal biodiversity hotspots designated by the landlords who managed forests on behalf of the British Government.

Till late sixties these areas were notified as hunting or shooting blocks and permits were given for hunting limited number of wildlife. The system was abolished by executive orders of Federal and State Governments between1968 and 1970.

During 1972 a new act was promulgated called Wildlife Protection Act. Different species of animals, plants were placed in different schedules. These schedules were notified in consonance with red data book of IUCN. The concept of flora and fauna particularly in the category of endangered and critically endangered, were given total protection under this act.

Project Tiger was launched in 1973 to give full protection to tiger and its eco-system. This gave tigers a new lease of life and this project was considered one of the greatest successful conservation efforts in the world. 1989 saw the peak of tiger numbers which went up to over 4000 from bare estimated 1800 in 1973.

A high density forest is rich in bio-diversity and is able to sustain predators, prey and vegetative bio-mass. All combined makes the ecosystem complete. For human benefit these forests recharge most of our rivers.

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Disappearance of forest will follow disappearance of the other components, thus the ecological balance will be disturbed. A degraded forest is devoid of prey and predator both and not capable of holding water which eventually causes flood and drought.

Forest is home not only to wildlife, the trees at different canopy level allows rain water to percolate and finally drain out to rivers and rivulets, thus recharging them. Rivers and its tributaries are the source of drinking and irrigation water which is mainly to benefit human being. Trees help regulate climate. It is mother nature's gift for carbon sequestrian.

Planting trees and afforestation can never replace natural biodiversity therefore all our afforestation efforts to replace natural forests in the name of more financial gains have accelerated loss of biodiversity. It is now realised world over that there is a definite linkage between economy, the environment and the biodiversity.

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Human and cattle population is threatening flora and fauna, accentuated by globalisation in the industrial front. The country has tried to compensate loss of tree cover by plantations. Though Wildlife Protection Act is reasonably stringent but have failed to protect faunal species due to global demand. Wildlife trade has taken a monstrous leap and considered to be the third highest after arms and narcotics illegal sale.

Global warming is another reality which might trigger extinction of many floral and faunal species. Rising pollution from industrial effluents, garbage and sewage, other pollutants like offshore drilling. Oil spills is taking a heavy toll of river and sea ecosystems.

We must understand the complex relationship between life & nature and bring a balance between them. Looking at short term gains and faulty developmental assurance, will certainly lead us to catastrophe and our future will be threatened due to falls hope of pseudo economic growth inviting more tsunamis, flood, cyclone every year.

Tiger representing one of the most important biodiversity component is talked about not only in India but all over the world. It is dying because of the space it occupies. Globalization and talking of 10 % economic growth is taking a heavy toll of tiger habitat.

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India though trying from every angle to save the specie but saviours are outnumbered by the greedy, politicians, administrators, mine owners, industrialists and even the villagers. Everyone is trying to grab as much land as possible. India is fortunate that tiger is in our heart, mythology and sentiment and so it is surviving.

It is well within our knowledge that more than 70 % of Indian Biodiversity is lying within forests and therefore flora and fauna become very important. Its necessary for the survival of human being particularly in a country like India where more than 80% population is directly or indirectly dependent on forest flora and fauna in different forms be it food from roots , fruits , leaves or any other part of the tree or used as medicine or animal parts are consumed to supplement protein.

The small timber used for construction of huts, thatch grass used for roof, firewood , any form of tree part available within the forest is a must for day to day survival of forest dwellers. Drinking water and water for irrigation also come from forests.

Therefore unfathomable amount of contribution towards survival of human being in India should not be undone by a section of people who are bent upon destroying the basic structure of life associated with forest.

Land is the most important concern as without land nothing can be developed. Every state is asking for revocation of Forest Conservation Act and wildlife protection act. Thank God both these acts are being monitored by Supreme Court of India. Had Supreme Court not been there to control misuse of forest land by now our political masters with the support of bureaucrats would have sold all the forest in the name of development as they have done with thousands of acres of common property land spread all over the country.

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There are documents to prove that most of our common property land has been settled legally or illegally with persons or organisations. However I am not standing here to discuss land use policy of India (I know there is no land use policy documented or enacted), therefore since independence the revenue authorities have only misused initiatives like “Bhoodan movement”. No poor man benefited by Bhoodan land.

Wildlife conservation is a major part of biodiversity conservation. If the forester community have to save their identity, the vertical line drawn between forests and wildlife have to be wiped out.

It is only unfortunate that even 2 % land cannot be ear marked for wildlife and particularly tigers. Remember tigers represent eco-system and being on the apex of the pyramid of food chain it represents all the wildlife species therefore tiger have to be saved to save other wildlife as well as human beings.

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Conservation of Biological Diversity in the Wild At Multiple Scales

V. B. Sawarkar

Indian Forest Congress, New Delhi 22-25 November 2011

National Forest Policy: A Basic Objective

" Conserving the natural heritage of the country by preserving the remaining natural forests with the vast variety of flora and fauna, which represents the remarkable **biological diversity** and genetic resources of the country"

Biological diversity is the variety and variability of life forms, the interacting processes and functions.

It is maintained by the interacting framework of natural habitats

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National Forest Policy 1988

***Conservation of biological diversity is considered essentially to be the role of the Protected Areas (PAs)**

***PAs account for about 22% of the recorded forest area of India**

But…

***By whatever interpretation of its collective Basic Objectives, conservation of biological diversity has become the central mandate for management of forests in India**

In the perspective of the National Forest Policy 1988……

*** It follows that…..**

In whatever terms and manner the forests are defined, described or assessed it is essential to recognize them as made up of a series of habitats in a variety of natural ecosystems. This accords with their evolutionary genesis

Productivity is the pivotal driver of forest management

- **Productivity is assessed/measured in in terms of the site quality, volume of timber or a quantity of produce per unit area, by basal area etc.**
- **Every effort is made to maintain, enhance and restore it**
- **Ecological definition of productivity is the capacity of soil to produce the whole range of native plants and animals i.e. wildlife that is consistent with the biogeographic attributes of a site**
- **In other words productivity is analogous with wildlife and biological diversity**

*Forest lands can be considered under two main categories, the PAs and non PA areas, the latter are mainly managed for production of goods and services under multiple objectives

* The processes of production of goods and utilization of resources in managed forests constitute only a small sub-set of biological diversity

The managed forests constitute some 78% of the recorded forests and if these are to be conserved over the long term then there is no escape but to conserve biological diversity in its entirety to safeguard the interest of the sub-sets that serve the objectives of the managed forests

An even higher calling….

- Provisions under India's Constitution
- Security for water, power, soil, food, health and quality of life
- Economic development of the country
- Maintenance of Earth's temperature and environment within the narrow range that sustains life
- Stewardship of evolutionary processes established billions of years ago

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*Biological diversity is assessed measured, planned and managed at six levels of genes, species, communities, populations, ecosystems and landscapes

**For the field manager it is most convenient to work with species, communities and populations. While the landscapes can be derived, genes and ecosystems enter the picture at some point to be addressed.*

The Ecological Framework

*The future of biological diversity is dependent upon persistence of species, communities and populations over the long term over what remains of their natural range of distribution

*Under the current fragmented state of the forests these would be represented by scattered landscapes

*A landscape is a mosaic of interacting land uses with people and the impacts of their activities integral to it. This fits the situation of the managed forests

A landscape could extend over several thousand km^2 and could have sub units connected by **corridors** along which populations of species could disperse and attain environmental fitness by population size and heterozygosity.

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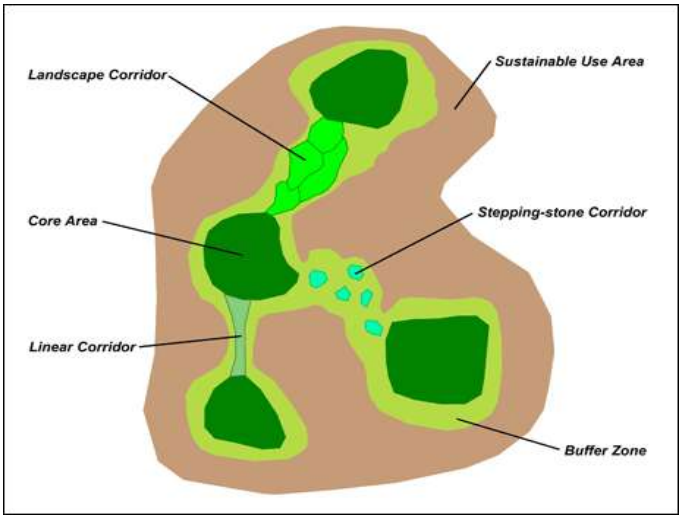

Corridors need to fulfill three principal objectives (i) conserving habitat suitability to allow movement of species (ii) maintaining, promoting and supporting ecosystem services (iii) integrating community welfare

The size of a landscape can be derived by populations of species that…

- Are large bodied
- Wide ranging
- Solitary and or territorial
- Those that need separate seasonal ranges
- Those that have patchy distribution or are rare
- Environmentally fit populations of all other species that need smaller areas including those that are habitat specialists can then be accommodated in such area.

Planning habitat constituents of a landscape: the PAs

*PAs have an important role to play as **source** areas by joining with habitats in managed forests/non forest areas to counter balance the negative pulls of these **sink** areas, thereby enabling conservation of metapopulations

* The eco-sensitive zones outside the PAs and the buffer zones around the tiger reserves create **soft edges** with the abutting forest and non forest lands

Planning habitat constituents of a landscape: the managed forests

- **Use Champion and Seth's classification of forest types as a broad framework**
- **Select species/communities of conservation importance to include all threatened categories of animals, flagship and charismatic species, habitat specialists and likewise such plant communities**
- **Identify management indicator species (MIS) to represent the guilds of other native species. Develop species profiles**
- **Habitat constituents can be based on structures, composition, conditions and space for (i) breeding and rearing the young (ii) food and feeding habits, need for water (iii) cover for shelter and security (iv) successional stages and micro habitat categories needed to fine tune all of the preceding**

Goals for production/utilization of resources can work in harness with goals for conservation of biological diversity

- Silvicultural treatments/forestry operations offer a box of tools that while producing goods and services can create, alter, maintain, restore habitats via vegetation composition, structures, and conditions over the planned space
- These capabilities have seldom been tested, evaluated and established but are not the reasons why new courses should not be and cannot be charted

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Hierarchical Administrative and Operational Framework: Managed Forests

- Divisions clustered under a Circle/Region to constitute landscapes and their management driven by overarching ecosystem values, objectives and strategies to be absorbed in the concerned Working Plans
- Division as the unit of planning with administrative and operational sub-units of compartments, beat, round and range
- Management planned and executed under the Working Plan with its treatment units represented by (i) working circles (ii) felling series/periodic blocks (iii) sections/coupes (iv) ancillary operations

Hierarchical Administrative and Operational Framework For Other Agencies: Forest and Non-forest Lands

- Districts clustered under Commissionarates to accord with the areas of forest landscapes as they fit. The Commissionarate to set overarching goals for maintaining the integrity of natural ecosystems to be absorbed in the District Plans
- Districts as the unit for planning and operations with their sub-units such as tehsils and those smaller. Likewise ZP, its blocks and smaller units and Panchayats. Plans and operations at the district levels to complement/ support the Forest Circle/Region/Division level objectives and strategies

Requisite Reforms

- Revisiting the National Working Plan Code for the necessary revision/adding a guide as an adjunct to it. Appropriate training at all levels and changing gears for research
- All government agencies working at and by the various district levels needing to reorder and synergize their work focus to accord with a common frame of reference that addresses the integrity of natural ecosystems
- The GDP requiring to suitably reflect the priceless contribution of natural ecosystems, of the recorded forest lands in particular, to the citizen's wellbeing, economic progress and national development

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Forests and biodiversity conservation in India

Dr. A.J.T.Johnsingh

Nature Conservation Foundation, Mysore and WWF-India

- India with its location at the confluence of Ethiopian, Oriental and Palaearctic realms, diverse biogeographic zones and monsoonal climate have conditions extremely conducive for supporting high levels of biodiversity

- India's biodiversity as number of species includes: mammals (420, 7.7 % of the number in the world), birds (1232, 13.6%), reptiles (456, 7.8%), amphibians (209, 4.0%), butterflies (c. 1500, 8.3%) and flowering plants (15,000, 6.0%).

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Forest cover in the past……early humans who arrived from Africa would have seen this.

- In the beginning people were largely nomadic hunter-gatherers… they settled into an agrarian life… domestication of various plants and animals…. had free access to forest areas, except perhaps in locations where chieftains had their hunting reserves…least impact on biodiversity….forests were vast…. human population kept low by numerous diseases

- With the arrival of the British the scenario changed…..the human population increased with improvements in medical care…. British saw immense value in the timber species of the country ….. several Forest Acts control of most of the forest areas.

- After independence Indian Government strengthened its hold on wildlife and forests…. Wildlife Protection Act (1972), Forest Conservation Act (1980);
- National Forest Policy (1988) leading to programs like Joint Forest Management and Eco-development?

Forest cover at present (20.64 per cent) as a result of 1.2 billion people, 281,700,000 cattle, more than China (139,721,000), 170,000 villages near forest (147 million people)…….

- various Acts deprived the tribal people of their unlimited access to forest resources. became harder as more and more protected areas were established, 599 protected areas 4.75 % of country's area. .. to undo the historic injustice a legislation, called the *Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006*

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- Rights on forest land for habitation or self-cultivation for livelihood up to a maximum of 4 ha to each individual/ family that have traditionally been living in the forests.
- Critical Wildlife Habitats (CWH) declared within existing Wildlife Sanctuaries and National Parks will be spared . Relocation of people from CWH can take place only after meeting a number of conditions.
- With most protected areas having people living in them (ca. 65%) the process of freeing them from the pressures of human settlements is only becoming more and more difficult.

Threats to the existing forest cover

- Reservoirs and canal construction, establishment of power lines, paved roads and railway lines, all vital for the economic progress of the country, have not only contributed to the loss and fragmentation of the habitat but also to other evils like encroachment.
- Shifting cultivation, regular annual fires set by the people, grazing by a large livestock population, invasive species and fuel wood collection constitute major threats to the quality of the forests.

Shifting cultivation in Vietnam, better situation as islands of forests are left behind

Shifting cultivation in Mizoram, no habitat left behind

Poaching still rampant…. Not much left for poaching

Ipomoea carnea, an exotic noxious weed from Central America, great threat to fresh water habitats

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A tank in the foothills of southern Western Ghats invaded by this noxious weed

Mimosa invisa, a problem weed that has escaped from the tea gardens

Flemingea bracteata

Moyar valley, only place in India where blackbuck, elephant and tiger co-exist

Opuntia dillenii and *Prosopis juliflora*, exotics from tropical America huge problem here

A sambar doe killed on the road, Bijnor Forest Division, Uttaranchal (Photo: Bivash Pandav)

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Speeding vehicles kill more animals than poachers. Need hundreds of speed breakers and tens of overpasses in right places

Porcupine killed on the Chamaraj Nagar-Sathyamangalam road

A four feet long king cobra killed on the Kudremukh road

Trains killing animals- elephants killed on the track

Surmount this problem with under passes in right places

Slowly expanding encroachments, no will power either to curb or remove

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A huge conservation problem that has not caught the attention of the Government

Suggestions to strengthen biodiversity:

- Settle land and property rights regimes across the country
- Develop a knowledge-based participatory land-use policy framework involving all categories of rights holders.
- Categories of land-use: protected areas, multiple use areas and production areas.
- Setting up of flexible institutions and incentive systems to maximise biodiversity conservation.
- The goal should be to minimise loss to humans arising as a result of conflict with wildlife in strictly protected areas and encourage sustainable production practices that would have the least impact on biodiversity in areas identified for biomass production.
- Regular public and peer scrutiny and review for achievement of land-use objectives which should have periodic course corrections, say at 5 – 10 year intervals.

Conclusion……

- We should try and do this in the snow leopard, tiger and elephant landscapes identified in the Country.

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AN ANGIOSPERMIC DIVERSITY OF DISTRICT HARIDWAR UTTARAKHAND, INDIA

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INTRODUCTION

The Himalaya has been a source of attraction, curiosity and challenge to human intellect throughout the ages. Amongst several assets the vegetation provides an everlasting and interesting field of investigation. The diversity, copiousness as well as uniqueness of plant components in various habitats retained sound and aesthetic environment of Himalaya.

In view with multiple stresses and depletion of vegetation and habitats, today's foremost concern of the globe in general and in particular is conservation of biodiversity, for which detailed taxonomic aspects of biological entities (plants and animals) are essential.

STUDY AREA

- Haridwar District is situated in South-West of Uttarakhand, Northern-West parts of India
- It covers a total area of 2360 Km^2 of which the forest area is 25681 hectares
- It includes three tehsils i.e. Laksar, Haridwar and Roorkee and blocks namely Bahdrabad, Roorkee, Bhagwanpur, Narsan, Laksar and Khanpur
- It is bounded by Dehradun District in north, Bijnor & Muzaffernagar in south, Pauri Garhwal in east and Saharanpur in west

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METHODOLOGY

- The extensive survey of District Haridwar were carried out during (2003-2006) in different seasons at various localities
- Most of the plants collected in vegetative, flowering and fruiting stages
- The plants were dried and mounted on standard size of herbarium sheets
- The plant specimens were identified with the help of recent and relevant floras
- The critical herbarium specimens were matched with authentic specimens lodged at Forest Research Institute (Dehradun) & Botanical Survey of India (Northern circle) Dehradun

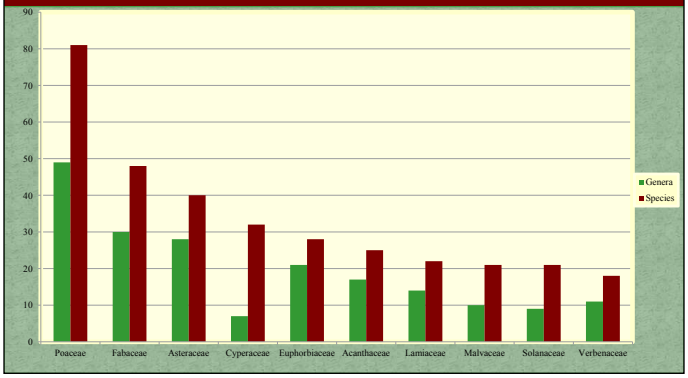
STATISTICAL ANALYSIS

- A total number of 750 species belonging to 484 genera and 132 families
- Out of 750 species, 581 species belongs to Dicotyledons and 169 species to Monocotyledons

Taxonomic Group	Families	Genera	Species
Dicotyledons	107	387	581
Monocotyledons	25	97	169
Total	132	484	750

DOMINANT FAMILIES

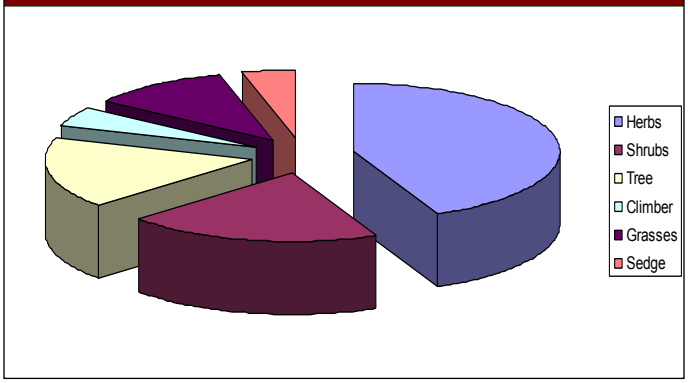
Dominant families of the study area with number of species and genera



RESULT

- A total number of 750 species under 484 genera belong to 132 families have been recorded
- The Dicotyledons were major component represented by 107 families (81.06%), 387 genera (79.95%) and 581 species (77.46%).
- The Monocotyledons represented by 25 families (18.93%), 97 genera (20.04%) and 169 species (22.53%)
- In ten most dominant families of the study area was constitute 44.8% of total floristic composition
- In present flora Poaceae composed of 10.8% of total flora and 47.92% of monocotyledons
- The dominant genera of the study area were *Cyperus* (15 species), *Euphorbia* (13 species) and *Ipomoea* (09 species).

- Classification on the basis of habit shows that herbs were main vegetation form with 43.2% contribution followed by the shrubs (20%), tree (17.06%) climbers (4.6%), grasses (10.8%) and sedges ((4.26%)



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- The 45 families are represented by single species and 12 families with single genus but more than one species
- The ratio of species between Monocotyledons and Dicotyledons was reported to be 1:3.43, of genera 1:5 and of families 1:3.98
- In the flora overall genus and species ratio 1:1.54 as compared to 1:2.2 for Upper Gangetic Plain 1:7 for British India (Gaur, 1999)
- Out of 750 plants species four species (*Feronia limonia* (L.) Swingle, *Rauvolfia serpentina* (L.) Benth ex Kurz, *Sterculia urens* Linn. and *Wrightia arborea* (Denn.) Mabberly) have been recorded to be threatened.

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Diploknema butyracea

a potential source of livelihood improvement

Dr. Nawa Bahar

Scientist

Forest Research Institute

Dehradun

Brief description about the species

- *Diploknema butyracea* is fast growing and an important tree of Kumaon Hills and belongs to the family Sapotaceae.
- It is locally famous as 'Cheura'.
- The population of this species is almost localized in Pithoragarh ,Champawat, Bageshwar district particularly the areas bordering Nepal.
- The tree are found growing in valleys and on the hill slopes at an altitude of 600 - 1850m.

Natural population

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Matured fruits of *Diploknema butyracea*


Outside India, it is found in

- Nepal
- Bhutan
- China
- Cambodia
- Indonesia
- Myanmar
- Philippines
- Thailand
- Malaysia

- The seed contains 42 - 47 per cent oil.
- Cheura ghee has been derived from the seed fat, which is a popular cooking medium in the locality. So, it is also known as 'Butter tree'.
- The oil is also used in lighting lamps.
- Besides yielding a good quality fat, every part of the tree is useful. The tree gives medium quality timber, its green leaves make good fodder to the cattle.
- From the juice of flowers, villagers prepare a jaggery which they call Cheura gur.
- Seed contains Dihydroquercetin an antioxidant used in confectionery industries.
- It provides abundant nectar of honeybees. Nectar secretion per flower per day is recorded at 40.65 ± 8.13mg. Sugar concentration in nectar is recorded at up to 42 per cent. As a rich source of nectar, this species has a major role in honey production.
- The tree bears fruit well upto 50 - 60 years with maximum fruit bearing around 15 years. An average yield of seed per tree is 50 kg per year.

Collection of matured fruits from ground


Fruits of *Diploknema butyracea*



Fruit variation of D. butyracea

Matured Fruit

Fruit length =32.65 ± 4.681mm
Fruit width= 22.05 ± 3.894mm


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Fruits Extraction and Processing


Variation in seed size

Large-sized seeds

Seed Dimension

Length = 31.72 ± 1.396mm
Width = 10.57 ± 0.466mm
Thickness = 8.26 ± 0.484mm
Wt. of seeds(100) = 138g
No. of seed per kg =724
Proportional = 30 %

Medium -sized seeds

Seed Dimension

Length = 24.86 ± 0.750mm
Width = 11.01 ± 0.430mm
Thickness = 8.40 ± 0.390mm
Wt. of seeds(100) = 127g
No. of seed per kg = 787
Proportional = 50 %

Small- sized seeds

Seed Dimension

Length = 20.29 ± 1.047mm
Width = 9.13 ± 0.502mm
Thickness = 6.98 ± 0.373mm
Wt. of seeds(100) = 93g
No. of seed per kg =1075
Proportional = 20 %

Effect of seed size on germination

A

B

C

Parameters	Large (A)	Medium (B)	Small (C)
Germination (%)	97.00	92.00	90.00
MGT (days)	2.66	4.83	5.40
Radicle length (cm)	5.90 ± 0.644	3.80 ± 1.581	2.37 ± 0.602

Seed germination in sand medium


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Seed germination in sand medium


Seed germination studies in lab


Seedling vigour index


Effect of seed size on germination in sand

A

B

C

Parameters	Large (A)	Medium (B)	Small (C)
Shoot length (cm)	14.73 ± 1.89	11.07± 2.47	7.23± 1.13
Root length (cm)	7.58 ± 2.39	7.03 ± 2.69	6.72 ± 1.77
Total length (cm)	22.31	18.10	13.95
Germination (%)	98.00	90.00	86.00
Seedling Vigour Index (SVI)	742.84	632.70	577.92

Seedlings Development Stages




Seedlings growth

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Seedling Vigour Index (SVI)

Seed germination

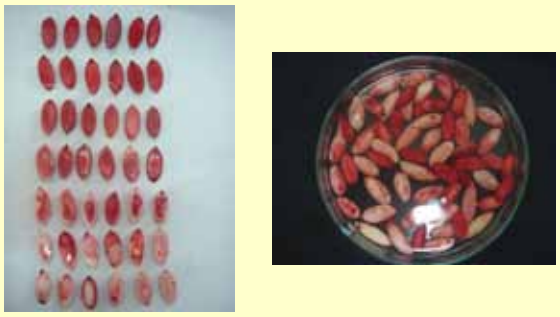
Radicle development

Decoated germinating seeds

Stages of radicle development

Germination (Epigeal type)

Seed viability test by TTZ



Viability assessment by TTZ test

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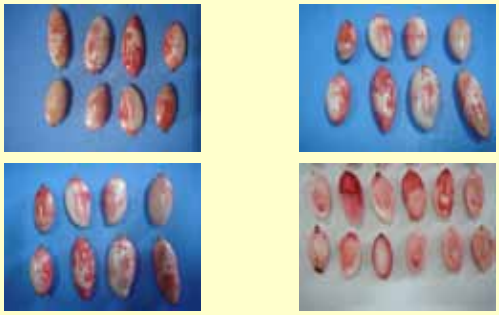
TTZ Test

TTZ Test

Viability test by TTZ



Evaluation of seedling in *Diploknema butyracea* (Butter tree)

- Germination of a seed in a laboratory test is the emergence and development of the seedling to a stage where the aspect of its essential structures indicates whether or not it is able to develop further into a satisfactory plant under favourable conditions in soil.
- In the laboratory the environmental conditions, including moisture, temperature, aeration and light, must not only be specific enough to indicate germination but also favourable for the development of the seedlings to a stage where interpretation of normal and abnormal types may be made. Study was to evaluate the seedlings which an important aspect to maintain the accuracy and the uniformity in germination test.

Abnormal Seedlings

Decayed radicle tip

Abnormal Seedlings

No primary roots

Primary roots short

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Abnormal Seedlings

Primary root short, stunted, thin and weak

Primary root with no root hairs

Abnormal Seedlings

Cotyledons bent over

Shoot is short and weak

Abnormal Seedlings

Twin primary roots

Abnormal Seedlings

No Hypocotyl growth

Tri - cotyledons with decayed root

Abnormal Seedlings

Decayed root tip and hairs

Shoot short, thin and bent

Seedling Evaluation

Normal Seedlings

The healthy seedlings with all the essential structures viz., root, hypocotyle, shoot apex and cotyledons developed in proper proportions.

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Viviparous characteristics of seed

Seeds, which have 30 – 60 per cent moisture at maturation, can germinate while still attached to the mother tree even without an external supply of water. This phenomenon is called vivipary or precocious germination.

Seed germinating within fruit.

Excised embryo test

Desiccation trial of seeds

Storage trial of seed

Growth data recording

Nursery technique (Root Trainers)

- Germination starts in days = 5.25 ± 1.22
- Germination completed in days =17 ± 2.35
- Germination per cent = 87.50 ± 9.32
- Plant per cent = 82.55 ± 6.87
- Seedling collar dia. (mm) = 4.79 ± 0.59
- Seedling height (cm) = 8.08 ± 1.68
- Number of leaves per plant = 4.76 ± 0.69

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Nursery technique (Polybags)

- Germination starts in days = 5.88 ± 1.85
- Germination completed in days =19 ± 2.61
- Germination per cent = 78.40 ± 9.58
- Plant per cent = 72.00 ± 7.65
- Seedling collar dia. (mm) = 4.06 ± 0.69
- Seedling height (cm) = 8.42 ± 1.54
- Number of leaves per plant = 4.45 ± 0.98

Nursery technique (seedbeds)

- Germination starts in days = 6.21 ± 1.77
- Germination completed in days =20 ± 2.82
- Germination per cent = 86.02 ± 5.68
- Plant per cent = 80.93 ± 7.85
- Seedling collar dia. (mm) = 5.39 ± 1.10
- Seedling height (cm) = 11.19 ± 1.87
- Number of leaves per plant = 5.21 ± 0.41

Extracting edible oil from seeds

Seed cake and Edible Oil

Need: seed grading for oil Industry

Need: seed grading for bio – fertilizer (oil cake)

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Need: seed grading for quality stock




Need:seed grading for employment generation




Need: seed grading for poverty alleviation




Project – **Enhancement of seed longevity of *Diploknema butyracea***

Name of Species - ***Diploknema butyracea* (Roxb.) H.J. Lam.**

Common name - **Cheura**

Duration of project - **2008 – 2012 (Four Years)**

Project Leader - **Dr. Nawa Bahar**

Project Code No. - **FRI – 466/SILVI - 42**

Forest Tree Seed laboratory
Silviculture Division
Forest Research Institute, Dehra Dun

Profile of Principal Investigator

Name: Dr. Nawa Bahar
Designation: Scientist-B
Date of Birth: 01-06-1965
Qualification: M.Sc. Ph.D (Botany)
Specialization: Seed Technology
Nationality: Indian
Postal Address: Forest Research Institute, Dehradun
E -mail: baharn@icfre.org

Publications:

Papers: More than 80 research papers published in national and international journals of repute.
Book: (One)
Handbook: (One)
Booklet: (One)
Brochure (One)
Award: Brandis Prize in the field of forestry for the year 2000.

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Dry Season Blooming Tree species, *Boswellia ovalifoliolata* (Burseraceae) and *Terminalia pallida* (Combretaceae) as key food plants for Insects/Sunbirds during Dry Season in Southern Eastern Ghats of Andhra Pradesh

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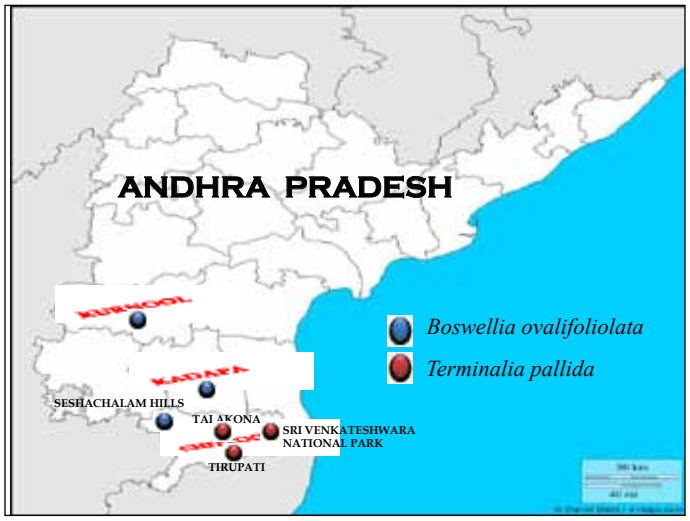
Introduction

- The genus *Boswellia* belongs to the Burseraceae family and is widely distributed in the dry regions of tropical Africa, Arabia and India.
- There are about 18 species of *Boswellia* which are shrubs or trees with outer bark often flaking.
- *B. serrata* and *B. ovalifoliolata* have been reported to be distributed in India.
- The genus *Terminalia* includes about 200 species of trees and shrubs distributed in the tropical and sub-tropical regions of the world.
- 20 species have been reported to be distributed in tropical and sub-tropical states of India.
- The study is contemplated to provide Reproductive Biology information keeping in view their prominent role in the forest ecosystem where they have been reported to be key species.



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Boswellia ovalifoliolata

- ***Boswellia ovalifoliolata*** occurs on the foothills of the Seshachalam hill ranges of Eastern Ghats in Chittoor, Kadapa and Kurnool districts of Andhra Pradesh up to an altitude of about 600-900 m.
- Local tribes and others make deep incisions on the main trunk to extract the gum and resin causing damage to trees which in turn leading to the depletion of the plant population in the natural habitat.
- The gum together with other undisclosed combinations is used extensively to cure a number of diseases: mouth, throat and stomach ulcers, fever, stomach pain, ulcers, scorpion sting, amoebic dysentery, hydrocele, etc.
- The decoction of the bark is used for joint or rheumatic pains.

Terminalia pallida

- *Terminalia pallida* occurs on rocky hilly areas of dry deciduous forests of Chittoor, kadapa and Kurnool districts at 700-800 m elevation in the Eastern Ghats but it is mainly centered at Tirumala Hills of Chittoor, Andhra Pradesh.
- The leaf is used for treating skin blisters and skin diseases while the stem bark as diuretic and swellings.
- The fruit is used as anti-pyretic, purgative, for diarrhea, peptic ulcers, diabetes, venereal diseases, cough, cold, dysentery, fissures, cracks and in tanning.
- It is also used as a substitute for the fruit of *Terminalia chebula*.

Materials and Methods

- Examination of Flower Morphology
- Flower Behaviour
- Determination of Pollen Output
- Examination of Nectar Production (Baker and Baker, 1973)
- Determination of Stigma Receptivity (Dafni et al, 2005)
- Observations of Flower-Visitors
- Examination of Foraging Behaviour of Insects/birds
- Observations of seed dispersal and seedling ecology
- Olympus Binoculars (PX35 DPSR Model)
- Nikon D40X Digital SLR (10.1 megapixel) and Nikon D90 Digital SLR (12mega pixel)

Boswellia ovalifoliolata

Acraea violae, Danaus chrysippus, Nectarinia asiatica, Funambulus palmarum

List of flower foragers on *Boswellia ovalifoliolata*

Family	Scientific Name	Common Name
Order: Hymenoptera		
Apidae	*Apis dorsata*	Rock bee
	A. cerana	Indian honey bee
	A. florea	Dwarf honey bee
	Trigona iridipennis	Stingless bee
	Ceratina sp.	Small carpenter bee
	Xylocopa latipes	Large carpenter bee
	X. pubescens	Large carpenter bee
Scoliidae	*Scolia* sp.	Digger wasp
Vespidae	*Eumenes petiolata*	Potter wasp
	Rhynchium sp.	Potter wasp
Eumenidae	*Eumenes conica*	Potter wasp
	Eumenes sp.	Potter wasp
Diptera		
Bombyliidae	*Hyperalonia* sp.	Pomace fly
Lepidoptera		
Pieridae	*Catopsilia*	Common Emigrant
Nymphalidae	*Junonia lemonias*	Lemon Pansy
	Acraea violae	Tawny Coster
	Danaus chrysippus	Plain Tiger
Class: Aves		
Order: Piciformes		
Capitonidae	*Megalaima haemacephala*	Coppersmith
Order: Passeriformes		
Nectariniidae	*Nectarinia asiatica*	Purple Sunbird
	N. zeylonica	Purple-rumped Sunbird
Pycnonotidae	*Pycnonotus jocosus*	Red Whiskered Bulbul
	P. cafer	Red-vented Bulbul
Campephagidae	*Pericrocotus cinnamomeus*	Small Minivet
Dicruridae	*Dicrurus adsimilis*	Black Drongo
	D. caerulescens	White-bellied Drongo
Paridae	*Parus xanthogenys*	Yellow-cheeked Tit
Muscicapidae	*Turdoides striatus*	Jungle Babbler
Motacillidae	*Motacilla flava*	Yellow Wagtail

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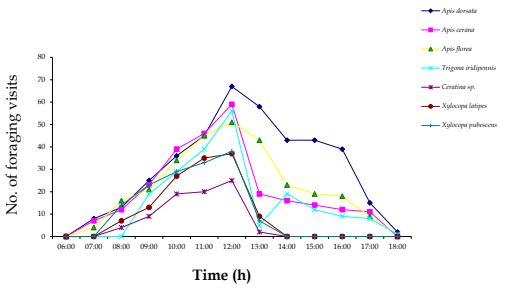
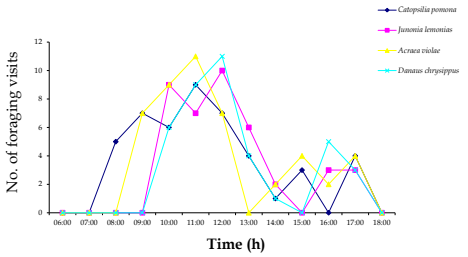
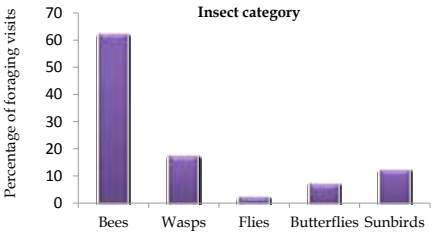


Hourly foraging activity of bees on *Boswellia ovalifoliolata*



Hourly foraging activity of butterflies on *Boswellia ovalifoliolata*



Relative percentage of foraging visits of different categories of insects and sunbirds on *Boswellia ovalifoliolata*

Terminalia pallida

Apis cerana, Scolia sp., Ceratina sp., Eumenes petiolata, Hyperalonia sp.

Graphium nomius, Hypolimnas bolina, Precis iphita, Tirumala limniace

List of flower foragers on *Terminalia pallida*

Family	Scientific Name	Common Name
Hymenoptera		
Apidae	*Apis dorsata*	Rock bee
	A. cerana	Indian honey bee
	A. florea	Dwarf honey bee
	Trigona iridipennis	Stingless bee
	Ceratina sp.	Small carpenter bee
	Xylocopa latipes	Large carpenter bee
Halictidae	*Halictus*	Sweat bee
Scoliidae	*Campsomeris annulata*	Flower wasp
	Scolia sp.	Digger wasp
Vespidae	*Eumenes petiolata*	Potter wasp
	Vespa cincta	Yellow-banded wasp
	V. orientalis	Oriental Hornet
Eumenidae	*Eumenes conica*	Potter wasp
	Eumenes sp.	Potter wasp
Hemiptera		
Lygaeidae	*Lygaeus* sp.	Black and Red bug
Diptera		
Bombyliidae	*Hyperalonia* sp.	Pomace fly
Syrphidae	*Helophilus* sp.	Hoverfly
Lepidoptera		
Papilionidae	*Papilio polytes*	Common Mormon
	Graphium nomius	Spot Swordtail
Nymphalidae	*Junonia lemonias*	Lemon Pansy
	Precis iphita	Chocolate Pansy
	Hypolimnas bolina	Great Eggfly
	Danaus chrysippus	Plain Tiger
	Phalanta phalantha	Common Leopard
	Tirumala limniace	Blue Tiger
	Euploea core	Common Indian Crow
	Neptis hylas	Common Sailer
	Arhopala amantes	Large Oakblue
Hesperiidae	*Pseudocoladenia indrani*	Tricolour Pied Flat

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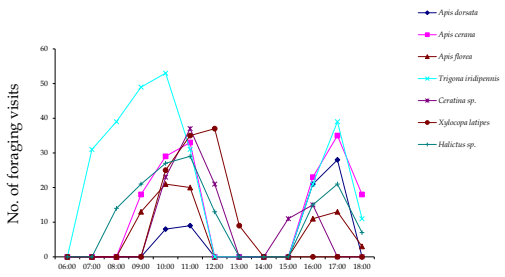
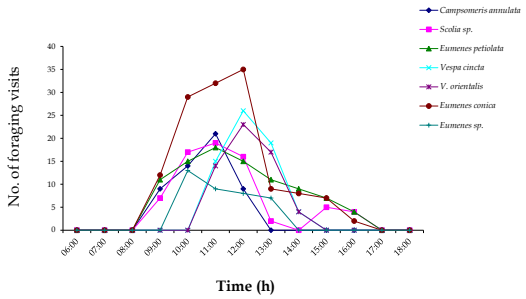
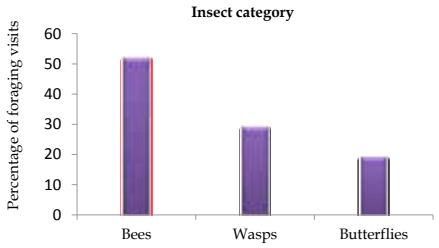


Hourly foraging activity of bees on *Terminalia pallida*



Hourly foraging activity of wasps on *Terminalia pallida*



Insect class-wise percentage of foraging visits on *Terminalia pallida*

Conclusions

- In *Boswellia ovalifoliolata*, the flowers are small, mildly odoriferous and weakly protandrous.
- Insects, especially juvenile *Xylocopa* bees and *Apis dorsata* and wasps are important pollinators in effecting cross-pollination.
- The flowers are not appropriate for birds, however, sunbirds visit them for nectar regularly and pollinate the flowers.
- Fruit set in open-pollination is below 10% while it is up to 34% in manual cross-pollination.
- limitation of cross-pollination, space constraint for seed production from all ovules of the flower and availability of limited resources to the tree with rocky, dry and limited litter in the floor of the forest seem to be the constraints for higher fruit set.
- Mature fruits dehisce and disseminate their light weight, papery and winged seeds with the aid of wind.

- In *T. pallida*, protogyny is a device to promote out-crossing but it is very weak, however it is partly promoted by gradual anther dehiscence over a period of six hours.
- The plant is entomophilous and cross-pollination is effected mainly by large bees, wasps and butterflies.
- The natural fruit set stands around 6% as against the 62% fruit set realized in manual xenogamous pollinations.
- Fruit predation rate is excessively high by a rodent species, *Funambulus palmarum*.
- The fallen fruits are dispersed by rain water and the seeds germinate and establish seedlings depending on the soil status.
- There is a mutualistic relationship between the tree species studied and the dependent pollinators, the former for pollination while the latter for food.

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Phytosociological Study and Resource Analysis of Medicinal Herbs of Padder Valley in J&K

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NWFP Division,
FRI

- The present study was conducted keeping in view the richness of medicinal herbs in the Padder valley of J & K.
- For conducting phytosociological studies, complete survey of the area was carried out.
- The study area falls in the Kishtwar District and the entire tract is extremely mountainous bearing very steep slopes pierced by deep valleys.
- The area is comprised of very rare and threatened species of medicinal herbs.

Introduction

- The Himalaya is known for its loftiest and longest mountain ranges in the world.
- The state of Jammu & Kashmir has a rich repository of medicinal plants. Many of these plants are of high repute in medicinal system and also enlisted as endangered plants.
- Kishtwar popularly known as “Land of Sapphire and Saffron” is also very rich in forest products.
- Due to geographical remoteness of the area very few studies has been done on the status of presence of medicinal herbs in the Padder valley of Kishtwar district.

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Study area

- Padder falls in the jurisdiction of newly created Kishtwar District.
- The entire tract is extremely mountainous bearing very steep slopes pierced by deep valleys.
- Padder range (Study area) is the roughest and most precipitous parts of the Forest Division.
- River Chenab and its tributaries form its main drainage system.

Methodology

- Stratified random sampling was adopted to assess the resource availability in the selected areas.
- During field trips, the digital photographs and herbarium specimens were collected.Quadrats of 1×1m were laid out randomly for enumerating herb species in the region. The vegetation data was analyzed for density, frequency and abundance according to formulae given by Curtis and McIntosh (1950).
- The relative values of density, frequency and dominance were determined following Misra (1989) and were summed to get Importance Value Index (IVI) of individual herb species. The abundance to frequency ratio (A/F) of different species was determined for eliciting the distribution pattern.
- The data collected from the quadrates were analyzed for the α-diversity and estimation of other diversity indices and evenness.

Results

- Data on frequency, density, abundance and IVI were recorded for different medicinal herbs from four different sites of Padder valley namely Pilali, Karzaidar, Ishtiyari and Batwas.
- *Bunium periscum* was the dominant herb having maximum density (m^2) in all the sites 0.65 in Site I, 0.66 in Site II, 0.65 in Site III and 0.76 in Site IV.
- *Atropa acuminata* (0.08) has lowest density in Site I, *Heracleum lanatum* (0.07) in Site II, *Viola biflora* (0.15) in Site III and *Fritillaria cirrhosa* (0.07) in Site IV.
- *Bunium periscum* also showed maximum IVI value in all the sites which indicates its dominance and ecological success, its good power of regeneration and greater ecological amplitude.
- The highest value of IVI for *Bunium periscum* in all the sites reflect the gregarious nature of this species and its wide range adaptability to the locality factors.

Table 1: Total Number of herb species found at all the sites

Botanical Name	Family	Pilali (2678-3010m)	Karzaidar (3170-3310)	Ishtiyari (2650-2895)	Batwas (2904-3238)
Aconitum heterophyllum Wallich ex Royle	Ranunculaceae	+	+	+	+
Allium victoralis L.	Liliaceae	-	+	-	-
Angelica glauca Edgew	Apiaceae	+	+	+	+
Arnebia benthamii (Wallich ex G. Don)	Boraginaceae	+	+	-	+
Artemisia brevifolia Wallich	Asteraceae	+	+	+	+
Artemsia gmelinii Weber ex. Stechm	Asteraceae	-	+	+	+
Asparagus filicinus Buch-Ham	Liliaceae	-	-	+	+
Atropa acuminata Royle	Solanaceae	+	-	-	+
Bunium periscum (Boiss.) Fedtsch.	Apiaceae	+	+	+	+
Dactylorhiza hatagirea (D. Don) Soo	Orchidaceae	+	+	+	+
Dioscorea deltoidea Wall.	Dioscoreaceae	+	+	+	+
Dracocephalum heterophyllum Benth.	Lamiaceae	-	-	-	+
Epimedium elatum Morr. & Decne	Berberidaceae	-	+	-	+
Fritillaria cirrhosa D. Don	Liliaceae	-	-	-	+
Heracleum lanatum Michx	Apiaceae	+	+	-	-
Hyoscyamus Linn.	Solanaceae	+	+	+	+
Inula grandiflora Willd.	Asteraceae	+	-	-	-
Inula racemosa Hook.f.	Asteraceae	-	-	-	+
Jurinea macrocephala (Royle) C. B. Clarke	Asteraceae	+	+	+	+
Malva sylvestris (L.) Boiss.	Malvaceae	+	-	-	+
Meconopsis latfolia Prain	Papaveraceae	-	+	-	+
Persicaria hydropiper	Polygonaceae	+	-	-	-
Picrorhiza kurrooa Royle ex. Benth	Scrophulariaceae	+	+	+	+
Plantago lanceolata Linn.	Plantaginaceae	+	+	-	-
Podophyllum hexandrum Royle.	Podophyllaceae	+	+	+	+
Polygonum aviculare	Polygonaceae	+	-	-	-
Rheum emodi Wall	Polygonaceae	+	+	+	+
Saussurea costus (Falc) Lipsch	Asteraceae	+	+	+	+
Solanum nigrum L.	Solanaceae	-	+	-	-
Taraxacum officinale Webr.	Asteraceae	+	+	+	+
Thalictrum cultratum Wallich.	Ranunculaceae	+	+	-	+
Trillium govaniana Wallich ex. D. Don.	Liliaceae	+	+	-	-
Valeriana jatamansi Jones	Valerianaceae	-	+	-	+
Viola biflora L.	Violaceae	+	+	+	+

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- Table 1 shows the biodiversity of herb species in different sites of the study area.
- Table depicts a total of 34 different herb species were present at all the sites. Common herb species found at all the sites were *Bunium periscum, Dioscorea deltoidea, Dactylorhiza hatagirea, Angelica glauca, Podophyllum hexandrum, Picrorhiza kurrooa, Artemisia brevifolia, Angelica glauca, Viola biflora, Malva sylvestris, Hyoscyamus niger, Plantago lanceolata,* and *Taraxacum officinale*.
- A total of 18 different families were represented in the study area.

Table 2: Distribution of herb species at Pilali (Site I)

Botanical name	Frequency (%)	Density (m^2)	Abundance	A/F	IVI
Bunium periscum	33.33	0.65	1.96	0.06	48.51
Dactylorhiza hatagirea	31.33	0.51	1.64	0.05	26.11
Saussurea lappa	14.00	0.21	1.52	0.11	17.18
Dioscorea deltoidea	14.67	0.32	2.18	0.15	15.42
Rheum webbianum	12.67	0.21	1.63	0.13	15.24
Picrorhiza kurrooa	19.33	0.23	1.21	0.06	14.76
Jurinea macrocephala	11.33	0.19	1.71	0.15	13.88
Artemisia brevifolia	18.67	0.25	1.32	0.07	13.30
Podophyllum hexandrum	12.00	0.19	1.56	0.13	11.92
Trillium govaniana	14.00	0.24	1.71	0.12	11.87
Persicaria hydropiper	13.33	0.21	1.60	0.12	10.84
Polygonum aviculare	12.00	0.18	1.50	0.13	9.67
Aconitum heterophyllum	9.33	0.14	1.50	0.16	9.57
Angelica glauca	8.00	0.17	2.17	0.27	8.94
Viola biflora	10.00	0.22	2.20	0.22	8.79
Malva sylvestris	12.00	0.14	1.17	0.10	8.75
Arnebia benthamii	12.00	0.15	1.28	0.11	8.72
Thalictrum cultratum	10.00	0.17	1.67	0.17	8.60
Heracleum lanatum	10.67	0.16	1.50	0.14	8.51
Hyoscyamus niger	9.33	0.15	1.57	0.17	8.30
Planatago lanceolata	7.33	0.13	1.73	0.24	6.39
Inula grandiflora	6.67	0.12	1.80	0.27	5.63
Taraxacum officinale	6.67	0.10	1.50	0.23	5.05
Atropa acuminata	5.33	0.08	1.50	0.28	4.04

•Table 2.showed *Bunium periscum* (48.51) with maximum IVI and *Atropa acuminata* (4.04) has minimum IVI.
• *Viola biflora* has maximum abundance of 2.20 and *Picrorhiza kurrooa* has minimum abundance of 1.21.
• The table also showed *Bunium periscum* has maximum frequency of 33.33 and the minimum frequency was recorded for *Atropa acuminata* (5.33).

Table 3: Distribution of herb species at Karzaidar (Site II)

Botanical name	Frequency (%)	Density (m^2)	Abundance	A/F	IVI
Bunium periscum	32.00	0.66	2.06	0.06	29.53
Podophyllum hexandrum	22.00	0.28	1.27	0.06	21.90
Artemisia brevifolia	20.67	0.29	1.42	0.07	21.51
Jurinea macrocephala	24.67	0.33	1.32	0.05	20.36
Dioscorea deltoidea	26.00	0.35	1.33	0.05	19.32
Saussurea lappa	15.33	0.24	1.57	0.10	16.52
Aconitum heterophyllum	17.33	0.21	1.23	0.07	16.16
Artemsia gmelinii	14.00	0.21	1.52	0.11	13.18
Allium victoralis	14.67	0.24	1.64	0.11	12.47
Picrorhiza kurrooa	15.33	0.21	1.39	0.09	11.82
Dactylorhiza hatagirea	16.00	0.21	1.33	0.08	11.43
Viola biflora	16.67	0.21	1.28	0.08	9.78
Taraxacum officinale	12.67	0.17	1.32	0.10	9.43
Valeriana jatamansi	12.00	0.19	1.61	0.13	9.37
Arnebia benthamii	12.00	0.17	1.39	0.12	8.53
Hyoscyamus	10.00	0.14	1.40	0.14	7.74
Solanum nigrum	12.00	0.15	1.22	0.10	7.66
Malva sylvestris	10.67	0.14	1.31	0.12	7.25
Trillium govaniana	8.00	0.16	2.00	0.25	5.85
Meconopsis latfolia	8.00	0.11	1.42	0.18	5.39
Planatago lanceolata	6.67	0.11	1.70	0.26	5.21
Epimedium elatum	7.33	0.11	1.45	0.20	5.19
Thalictrum cultratum	7.33	0.11	1.55	0.21	5.02
Rheum webbianum	6.00	0.09	1.56	0.26	4.98
Heracleum lanatum	5.33	0.07	1.38	0.26	3.77

•.The table depicts *Bunium periscum* (29.53) with maximum IVI and *Heracleum lanatum* (3.77) with minimum IVI.
•*Bunium periscum* also has maximum abundance value of 2.06 and the minimum abundance value (1.22) was recorded for *Solanum nigrum*.
•Maximum frequency was also shown by *Bunium periscum* (32.00) and minimum was recorded for *Heracleum lanatum* (5.33

Table 4: Distribution of herb species at Ishtiyari (Site III)

Botanical name	Frequency (%)	Density (m^2)	Abundance	A/F	IVI
Bunium periscum	30.00	0.65	2.16	0.07	31.60
Aconitum heterophyllum	28.67	0.36	1.26	0.04	27.12
Dioscorea deltoidea	26.00	0.45	1.72	0.07	*26.80*
Picrorhiza kurrooa	30.00	0.43	1.44	0.05	24.96
Artemsia gmelinii	25.33	0.29	1.16	0.05	24.11
Artemisia brevifolia	21.33	0.29	1.38	0.06	22.75
Dactylorhiza hatagirea	26.00	0.35	1.33	0.05	20.55
Saussurea lappa	25.33	0.32	1.26	0.05	20.03
Taraxacum officinale	21.33	0.29	1.38	0.06	17.20
Asparagus filicinus	22.00	0.25	1.15	0.05	16.07
Podophyllum hexandrum	16.00	0.21	1.33	0.08	15.94
Rheum webbianum	18.67	0.23	1.25	0.07	13.03
Jurinea macrocephala	18.67	0.21	1.14	0.06	12.38
Angelica glauca	12.67	0.19	1.47	0.12	10.81
Hyoscyamus	12.00	0.16	1.33	0.11	9.49
Viola biflora	10.00	0.15	1.47	0.15	7.17

• The table 4 depicts *Bunium periscum* (31.60) with maximum IVI and *Viola biflora* (7.17) with minimum IVI.
•*Bunium periscum* also has maximum abundance value of 2.16 and the minimum abundance was recorded for *Jurinea macrocephala* with a value of 1.14.
• *Bunium periscum* and *Picrorhiza kurrooa* both showed maximum frequency value of 30.00 and minimum was recorded for *Viola biflora* (10.00).

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Table 5: Distribution of herb species at Batwas (Site IV)

Botanical name	Frequency (%)	Density (m^2)	Abundance	A/F	IVI
Bunium periscum	36.67	0.76	2.07	0.06	29.67
Artemisia brevifolia	28.00	0.43	1.52	0.05	25.06
Podophyllum hexandrum	27.33	0.44	1.61	0.06	24.33
Arnebia benthamii	22.67	0.43	1.91	0.08	24.16
Dioscorea deltoidea	28.00	0.51	1.83	0.07	23.74
Aconitum heterophyllum	15.33	0.32	2.09	0.14	16.34
Saussurea lappa	15.33	0.26	1.70	0.11	14.16
Jurinea macrocephala	16.67	0.33	1.96	0.12	13.32
Artemsia gmelinii	14.00	0.21	1.52	0.11	12.86
Inula racemosa	12.00	0.35	2.89	0.24	11.77
Valeriana jatamansi	17.33	0.21	1.23	0.07	10.83
Angelica glauca	14.00	0.24	1.71	0.12	10.49
Viola biflora	16.67	0.16	0.96	0.06	7.88
Hyoscyamus	10.00	0.19	1.87	0.19	7.83
Picrorhiza kurrooa	7.33	0.21	2.91	0.40	7.77
Taraxacum officinale	12.67	0.14	1.11	0.09	7.23
Dactylorhiza hatagirea	16.00	0.11	0.67	0.04	7.18
Thalictrum cultratum	12.00	0.15	1.22	0.10	7.02
Malva sylvestris	10.67	0.14	1.31	0.12	6.21
Atropa acuminata	8.00	0.18	2.25	0.28	6.03
Meconopsis latfolia	8.00	0.11	1.42	0.18	5.09
Rheum webbianum	6.00	0.09	1.56	0.26	4.70
Dracocephalum heterophyllum	7.33	0.11	1.55	0.21	4.69
Asparagus filicinus	6.00	0.10	1.67	0.28	4.36
Fritillaria cirrhosa	6.67	0.07	1.10	0.17	3.76
Epimedium elatum	5.33	0.09	1.63	0.30	3.51

•The table depicts *Bunium periscum* (29.67) with maximum IVI and *Epimedium elatum* (3.51) with minimum IVI.
•*Hyoscyamus niger* has maximum abundance value (2.91) and *Dactylorhiza hatagirea* has the minimum abundance value (0.67).
• Maximum frequency was recorded for *Bunium periscum* (36.67) and minimum was recorded for *Epimedium elatum* (5.33).

Table 6- Diversity Indices of herb species at different elevations of all the sites

Place	α-diversity	Diversity index (H)	Concentration of dominance (Cd)	Evenness (J)
Karzaidar	26	3.113	0.05	0.87
Batwas	26	3.062	0.06	0.82
Pilali	24	3.00	0.06	0.84
Ishtiyari	16	2.702	0.07	0.93

- Table 6 depicts the richness, diversity, concentration of dominance and evenness profile of different study sites.
- A perusal of data reveals that the highest richness (α-diversity) of herb layer was observed at Karzaidar and Batwas (26) followed by Pilali (24) and Ishtiyari (16).
- The highest diversity of index (3.11) was exhibited at Karzaidar, followed by Batwas (3.06), Pillali (3) and Ishtiyari (2.70). The highest Cd (0.07) was exhibited at Ishtiyari and the lowest was at Karzaidar (0.05).
- The highest evenness (0.93) was observed at Ishtiyari followed by Karzaidar (0.87), Pillali (0.84) and Batwas (0.82).

Conclusion

- Resource analysis of Padder Valley demonstrates that the area is rich in herb species of medicinal value.
- It has been reported that the study area is facing severe problems of natural regeneration at most of the places owing to trampling, grazing and browsing.
- It is therefore recommended that such studies should be carried out regularly to keep a watch on the existing population of medicinal flora as well to plan for their conservation.

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Seed characteristics and germination behaviour of undehisced fruits in *Aphanamixis polystachya*: Implications for reducing seed harvest cycles

Gogate P. P.*, Patil Y. B., Prajakta Y. Sonavane, Rahila I. Boat, Patil M. D., Pooja Y. Pawar, Rane A. D., Gunaga Rajesh P. and Bhave S. G.

INTRODUCTION

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- *Aphanamixis polystachya* (Wall.) R.N. Parker also known as *Amoora rohituka* is a valuable medicinal plant belonging to family Meliaceae.
- It is mainly distributed in the tropical areas of Asia such as Southern China, India, Malaysia, and Indonesia (Chen *et al*., 1997)
- In India it is distributed in Bihar, Sikkim, West Bengal, Andaman and Nicobar, Arunachal Pradesh, Assam, Meghalaya, Gujarat, Maharashtra, Karnataka, Goa, Kerala and Tamil Nadu (Ganeshaiah 2003).

- A number of limionoids, triterpenes, sesquiterpenes alkaloids and flavonoid glycosides have been isolated from A. *polystachya*.
- This plant is extensively used in traditional system of medicine for various ailments in different Asian countries (Naskar, 1993).
- This species has favourable biodiesel properties like saponification value (203.8), iodine value (109.1) and Cetane Number (48.52) Azam *et al.,* (2005)

- This species is reported to have have low natural regeneration (ICFRE, 2008-09). Moreover it is one of the species of conservation concerned in south India (Ravikumar and Ved 2000).

Needs for investigation

- It is one of the species of conservation concerned in South India (Ravikumar and Ved 2000)
- *A. polystachya* is enumerated by National Commission on Agriculture for further research (Nithiyanandam, 2002)
- It has low natural regeneration (ICFRE, 2008-09)
- Dehiscence pattern of fruit is usually not synchronised.
- Seeds are dispersed through hornbill after dehiscence of fruit (Datta and Rawat, 2008).

Asynchronized dehiscence

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OBJECTIVES

- **Reduction of harvesting cycles for economic harvesting**
- **Comparison of germination and oil content in seeds obtained from dehisced and undehisced fruits**

METHODOLOGY

- **Seeds from dehisced and undehisced fruits were evaluated from shape and size.**
- **Experiment was laid down in Randomized Block Design (RBD) with three replications, each containing 100 seeds.**

SEEDS FROM DEHISCED FRUITS

- **These seeds were subjected to fourteen pre-sowing treatments (seven for each coated and de-coated seeds) for attaining maximum germination.**
- **Observations on seed germination was recorded for initial 36 days after sowing.**
- **Germination percentage, mean daily germination(MDG), peak value(PV), Germination value(GV),Germination rate(GR), collar diameter, Root length and Shoot height was estimated.**
- **Seed oil content was estimated by using soxhlet apparatus using petroleum ether.**

SEEDS FROM UNDEHISCED FRUITS

- **Ripeness property was estimated for extracted seeds from the undehisced fruits, if any by conducting dip and float test in water.**
- **Both, dipped and floated seeds were observed for germination by adopting best treatment for naturally dehisced fruit.**
- **Oil content for Dipped and floated seeds by Soxhlet method.**

RESULTS

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SEED PARAMETERS

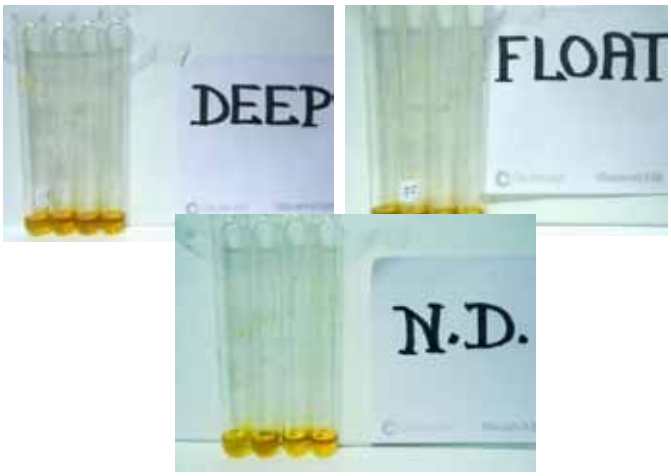
- The seeds present in the dehisced fruits were heavier (1.33 g) and larger (13.43 mm) then the seeds from undehisced fruits (Seed weight: 1.09-1.19 g; seed diameter: 11.96-12.49 mm).
- While, the seed diameter and length of the seeds of undehisced fruits which swam in water and those of the dipped once was same.

Table 1. Seed parameters of dehisced and undehisced fruits.

fruit	Traits	Minimum	Maximum	Average	SD	SE±	CD (p=0.05)
Dehisced	Seed diameter	11.28	15.04	13.43	0.79	1.06	2.08
	Seed Length	14.99	23.61	19.59	1.65	1.11	2.18
	Weight (de-coated)	0.91	1.73	1.33	0.18	0.16	0.32
Undehisced	'dip' seed diameter	11.26	13.77	12.49	0.63	1.06	2.08
	'float' seed diameter	11.9	14.81	11.96	2.22	1.06	2.08
	'dip' seed length	15.56	18.86	17.34	0.86	1.11	2.18
	'float' seed length	15.07	18.51	16.71	0.99	1.11	2.18
	'dip' seed weight	0.94	1.58	1.19	0.14	0.16	0.32
	'float' seed weight	0.54	1.98	1.09	0.27	0.16	0.32

SEED OIL CONTENT

- The oil content of the seeds (42 percent) present in the dehisced fruits was significantly higher than those present in the seeds in the undehisced fruits (floating seeds: 40.97 percent and dipped seeds : 39.33 percent).



SEED GERMINATION

- Decoated seeds without pre-sowing treatment (control-decoated) produced more germinants.
- So also, the seedling growth parameters of the seedlings produced from the coated seeds like collar diameter, shoot height and root length were lower than the seedlings produced from the decoated seeds.

- The seed types *viz.* dipped and float seeds collected from undehisced produced nearly same number of germinants when decoated (control decoated), which was the best treatment for the mature seeds.
- So also, other germination parameters expect leaf area were same for the seeds which swam in water and those settled deep in the water.

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CONCLUSION

- **No much variation in the seeds of dehisced and undehisced fruits with respect of seed oil content, seed germination and germination parameters.**
- **Removal of seed coat from the seeds eventually improve germination.**
- **Complete harvesting of those bunches containing one or more dehisced fruits for attaining additional yield benefits.**

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MANGROVE DIVERSITY IN ANDAMAN AND NICOBAR ISLANDS (INDIA) WITH SPECIAL REFERENCES TO NATURAL HYBRIDS OF GENUS *RHIZOPHORA*

Ragavan.P*, Mani saxena, Tarun Coomar and Alok Saxena

****Andaman and Nicobar Island Forest Plantation and Development Corporation Ltd***

Port Blair

MANGROVES COVER IN ANI

- Area wise third in the country after west Bengal (2152 sq.km) and Gujarat (1046 sq.km)
- Total mangrove area in ANI **615 sq.km**
  - Andaman 612 sq.km
  - Nicobar 3 sq.km

Change from 2003 to 2007 is 43sq.km

- 34 true mangrove species with 13 families (Dagar et al 1991)

UNIQUENESS

- **Controversial floral composition**
- **Morphological variation**
- **Natural hybrids of Rhizophora**
- Luxuriant growth of mangroves
- Density
- Impact of tsunami
- Precocious flowering in tsunami affected area

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DEGRADATION OF MANGROVE AT NORTH ANDAMAN

South Andaman

Degradation of Mangroves in carnicobar (Kimous bay)

Precocious flowering in tsunami affected area

OBJECTIVES

1. To review the floral composition of Mangroves in ANI
2. To clarify the taxonomical distinctiveness of *R.mucronata* and *R.stylosa*
3. To clarify the taxonomical distinctiveness of *R.lamarckii* and *R.annamalayana.*

Controversial Floral composition in ANI

- According to Dagar et al (1991) 34 true mangrove species
- Debnath (2004) 58 mangrove species Including associates
- Naskar and Mandal (2008) 61 species including associates
- Dagar not included the *Pempis acidula (Debnath included the species)*
- Debnath not reported the *sonneratia apetala (but present in Dagar 1991)*
- *Naskar and Mandal (2008) listed Avicinnia alba (but not reported by Dagar and Denbnath)*
- After tsunami no studies have been done on floral composition of Mangroves of ANI.

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Island wise selected sites in ANI

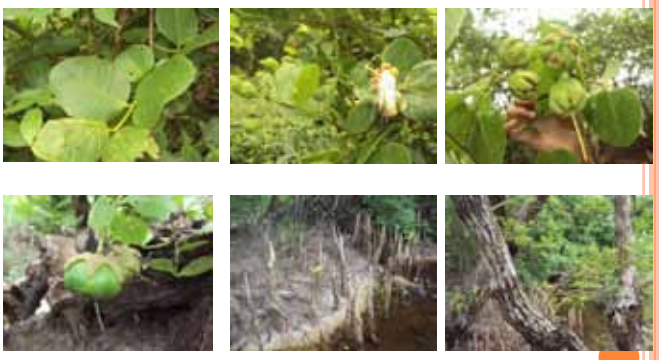
Islands	Site Names
South Andaman	Carbyn's cove (ii) Sippighat (iii) Wright Myo (iv) Shoalbay (v) Burmanallah (vi) Chidiyatapu (vii) Guptapara,
Havelock	Radhanagar Beach, Buffalo beach , Havelock Jetty area
North Andaman	Austin Creek (Mayabunder) (ii) Kalighat (Diglipur) (iii) Karmatang (iv) Pokkadera (v) Danapur
Middle Andaman	(i) Yerrata (ii) Kadamatala (iii) Baratang
Little Andaman	Dugong creek and Harminder Bay.
Car Nicobar	Kimous

Findings

29 true mangrove species (comparison with Dagar 1991)
including one new record *Sonneratia ovata Back.*

Base on Tomlinson classification 42 species .
(17 major mangrove species,
10 minor mangrove species and
15 mangrove associates)

Sonerratia ovata



List mangrove flora in ANI (Based on Tomlinson 1986)

Major elements	***Minor elements***	***Associates***
Avicennia marina	*Xylocarpus granatum*	*Acanthus ebracteatus*
Avicennia officinalis	*Xylocarpus mekongensis*	*Acanthus ilicifolius*
Bruguiera cylindrica	*Xylocarpus moluccensis*	*Acanthus volubilis*
Bruguiera gymnorhiza	*Acrostichum aureum Linn*	*Dolichandrone spathacea*
Bruguiera parviflora	*Acrostichum speciosum Wild*	*Cassine vibrunifolia*
Ceriops tagal	*Aegiceras corniculatum*	*Phoenix paludosa*
Lumnitzera littorea	*Excoecaria agallocha*	*Barringtonia racemosa*
L racemosa	*Heritiera littoralis*	*B. asiatica*
Nypha fruticans	*Pemphis acidula*	*Cerbera odallum*
Rhizophora apiculata	*Scyphiphora hydrophyllacea*	*Cynometra irripa*
R mucronata		*Scaevola seicea*
R stylosa		*Fimbristylis ferruginea*
R.lamarckii		*Hibiscus tiliaceus*
Sonneratia alba		*Pandanus odoratissimus*
S caeseolaris		*Thespesia populnea*
*S ovata**		
S.griffithii		

Misidentified /Rare Mangrove species in ANI

Ceriops decandra (Griff.) Ding Hou.
Aegialitis roduntifolia Roxb.
Kandelia candel (Linn.) Druce
Bruguiera sexangula (Lour.) Poir.
Cyanometra ramiflora Linn
Sonneratia apetala.
Acanthus volublis

Misidentification mainly due to the morphological variation between the individual of same species.

B. gymnorhiza might be misidentified as B.sexangula!

Contd…

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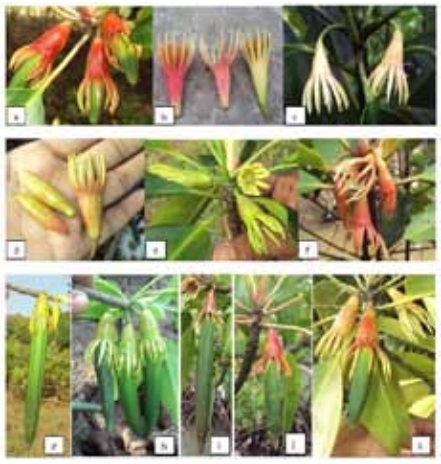

Contd…

Normal

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Natural hybrids of Genus *Rhizophora* in Andaman and Nicobar Islands

Rhizophora hybrids

- *Rhizophora annamalayana* Kathir,(*R.apiculata X R.mucronata*)
- *Rhizophora lamarckii* Montr and (R.apiculata X R.stylosa)
- *Rhizophora selala* (Salvoza) Toml (*R. samoensis* X R.stylosa)

- *R.selala* is restricted to Atlantic East Pacific
- *R.annamalayana and R.lamarckii* is present in IWP region

Rhizophora Hybrids in India

Singh et al (1987) first recorded *Rhizophora* hybrids in ANI (Havelock Island)

He described as *R.lamarckii* (but he could not record *R.stylosa* from Havelock)

Key characters

- •Occurrence of Stamen in Two distinct whorls
- •Style length (2-3mm)

Kathiresan (1995) identified *R.annamalayana* as new hybrids between R.apiculata and R.mucronata .

Key Character

- •Occurrence of Stamen in Two distinct whorls (outer long one and inner small one)
- •Stlye length 2.2mm

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How *R.annamalayana* is different from *R.lamarckii*?

1. Broad dark green leaves (yellow green leaves)
2. Occurrence of stamens in two whorls (single whorl)
3. Plenty of dark spots in underside of the leaf (lacking)
4. Absence of *R.stylosa* in Pichavaram

But the systematic distinction between *R.lamarckii* and *R.annamalayana* is still unclear

Why systematic distinction between *R.lamarckii* and *R.annamalayana* is still unclear?

1. Lack of clear taxonomical description

e.g. Kathiresan (1995,1999)

R.apiculata(1.8mm?) **R.mucronata (1.4mm)**

R.annamalayana

2.2mm?

But According to Duke and Bunt (1979)

- ***R. apiculata* (0.9mm, 0.5-1.1mm)**

By no means style length of *R.apiculata* is 1.8mm

Singh et al (1987)

R.apiculata **R.mucronata**

R.lamarckii

2-3mm

Style lengths (mm) of *Rhizophora hybrids by various authors*

Name of authors	*R.lamarckii*	*R.annamalayana*
Duke and Bunt (1979)	1.9mm (1.5 to 2.7mm)	
Kathiresan (1995)	-	2.2mm Pichavaram
Parani et al (1997a,1997b)	-	1.5-2.5mm Pichavaram
Singh et al (1987)	2-3mm (ANI)	-
Duke 2010	3.0-4.5 (New Caledonia)	-
Duke et al 2002	2.7(1.7-3.7)NW pacific islands 2.0(1.3-2.9) Australian site	-
Duke 2006b	2-3mm	-
Chan 1996	2-3mm Malaysia	-

2. Parentage

- *R.stylosa* and *R.mucronata* are same species or variants of one species?
- Presence of intermediate forms between R.stylosa and R.mucronata
- Absence of hybrids with the presence of potent parents in some place.
- According to Duke 2006a and Salvoza (1936) style length is the key character to distinguish *R.sylosa* and *R.mucronata*.

Land of Hybridization (ANI)

- Occurrence of **two forms of *R.apiculata***
- *Occurrence of **series of intermediate** between R.stylosa and R.mucronata (based on style length)*
- *Occurrence of **8 hybrid individual (can grouped into three based on style length)***

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TWO FORMS OF *R.*

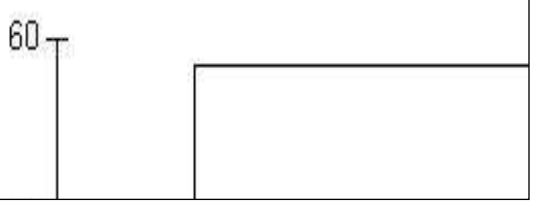
INTERMEDIATES BE
R.MUCRONATA

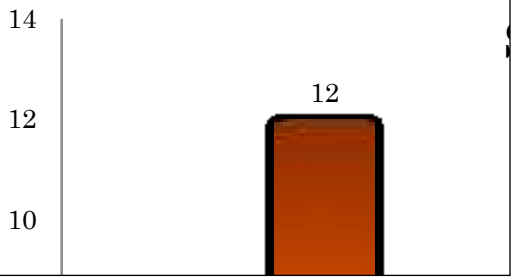
Comparative styl

Methodology

In order to delimit the *R.m*

selected and each tree





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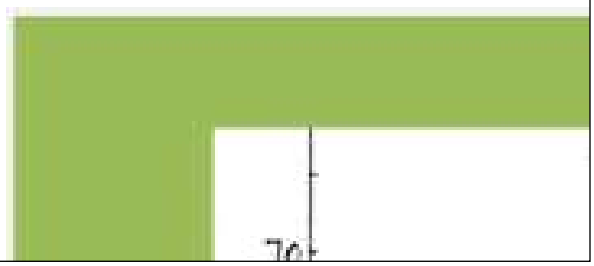
HYBRIDS

From the same study are

Morphological attribu *in Havelock*

Characters	Ind 1	Ind 2	Ir
Leaf Length	12.91±0.044	13.92±0.043	1 0
Leaf width	6.36± 0.030	8.03±0.016	7
style	2.2±0.006	2.26±0.007	2

Group average based



Group 1 hybri

Group 2

Group 3

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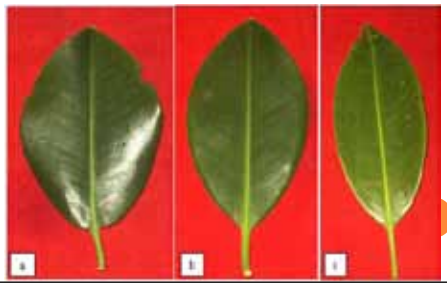
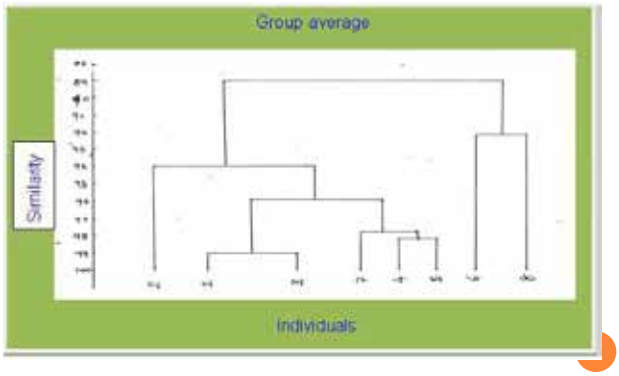


Group average based on style length, leaf length and width



Comparative morphology of leaf

Drift in the style length of R.mucronata in Pichavaram

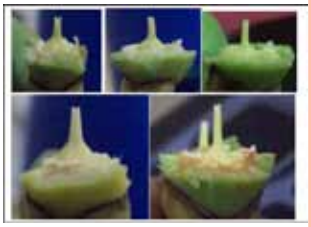
Two groups

- 0.7mm to 1mm
- 1.1-2.2mm

Two groups of Hybrids in Pichavaram

Style length 1.1 to 1.4mm

Style length 1.7 to 2.4



FINDINGS

- Based on the style length

1. Individual 1, 2 and 3 are *R.lamarckii (R.apiculata and R.stylosa)* (Duke and Bunt 1979)

2. Individual 4 , and 5 are *R.annamalayana (R.apiculata and R.mucronata)* Kathiresan (1995)

3. Individual 7, 6 and 8 is hybrid variant or introgression product.

4. Presence of stamens in Two distinct whorls is Characteristic of Indian *Rhizophora* hybrids

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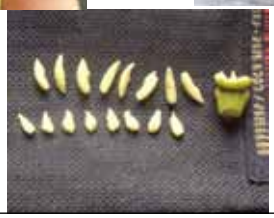
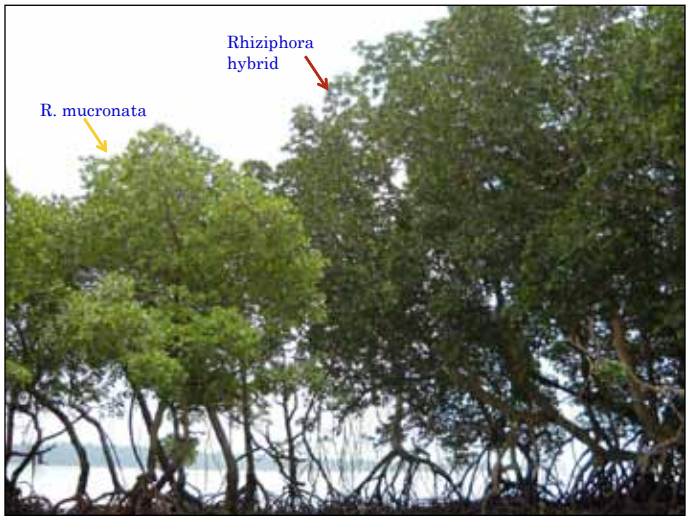
Presence of stamens in Two distinct whorls



Well developed stilt root of Rhizophora hybrids



Please provide your valuable suggestion

- Can I treat intermediate from as separate species?
- I believe that one more type of hybrid is also present in Pichavaram as well as in ANI.
- Back crossing is also occur in *Rhizophora*.

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BIODIVERSITY CONSERVATION: *IN CONTEXT TO SUSTAINABLE LAND AND ECOSYSTEM MANAGEMENT (SLEM) MAINSTREAMING AND UP-SCALING*

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2001 The National Action Plan to Combat Desertification (UNCCD-NAP), identified six major causes of land degradation:

1. unsustainable water management
2. poor agricultural practices
3. human and livestock pressure on land
4. deforestation
5. climate change and
6. Industrialization and other developmental pressures

2001-05 National Consultations in India evolved the concept of SLEM Synergy needed between food and ecological security.

2006 SLEM – CPP LAUNCHED a joint initiative under the Country Partnership Programme of the Govt. of India and the Global Environment Facility supported by the World Bank, FAO and the UNDP

2009 TFO set up at ICFRE

2010 SLEM Project initiated.

1.Genesis

Policy and Institutional Reform for mainstreaming and Scale –up of the Sustainable land and Ecosystem Management Project

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BIODIVERSITY	LAND	CLIMATE CHANGE
POLICY ENVIRONMENT	**SLEM**	BEST MANAGEMENT PRACTICES
BASELINE FOR PRESENT STATUS OF LAND DEGRADATION	POLICY REFORMS	COMMUNICATION STRATEGY

GEF Implementing Agency	Project Name	Project Area/ Implementing Agency
World Bank	Policy and Institutional Reform for Mainstreaming and Up-scaling Sustainable Land and Ecosystem Management in India	ICFRE (TFO) MoEF
	Sustainable Land Water and Biodiversity Conservation and Management for Improved Livelihoods in Uttarakhand Decentralized Watershed Management	Uttarakhand/ Watershed Development Dept., Govt of Uttarakhand
	Sustainable Rural Livelihood Security through Innovations in Land and Ecosystem Management (NAIP)	Indian Council of Agricultural Research, Min. of Agriculture
UNDP	Integrated Land and Ecosystem Management to Combat Land Degradation and Deforestation in Madhya Pradesh	Madhya Pradesh/State Forest Dept. & State Govt.
	Sustainable Land Management in Shifting Cultivation Areas of Nagaland for Ecological and Livelihood Security	Nagaland/ State Dept. of Soil and Water Conservation, Government of Nagaland and Village Council and Village Dev. Boards
	Sustainable Participatory Management of Natural Resources to Control Land Degradation in the Thar Desert Ecosystem	Thar Desert/ Min. of Rural Development (Govt. of Rajasthan) & Jal Bhagirathi Foundation
FAO	Reversing Environmental Degradation and Rural Poverty through Adaptation to Climate Change in Drought Stricken Areas In Southern India	Andhra Pradesh/Bharati Integrated Rural Development Society (BIRDS)

- Nearly 2 billion ha of land worldwide are severely degraded irreversibly
- Degradation of land results :
  - Loss of biodiversity
  - loss of Productivity
  - Distortion in ecosystem functions, and
  - Increased vulnerability to climate change

Comparative position of species biodiversity in India

Group	Estimated Number	Rank amongst Mega diverse countries
Higher plants	18664	IX
Mammals	390	VII
Birds	458	IX
Reptiles	521	V
Amphibian	231	IX
Fishes	5749	I

Source: Based on Arora and Ahuja 2006 (original source: http://earthtrends.wri.org)

Threatened species listed in WPA and appendices of CITES and CMS

Group	Schedules of IWPA					Appendices of CITES			Appendices of CMS		
	I	II	III	IV	V	I	II	III	I	I/II	II
Mammals	16	6	1	-	-	56	31	5	4	4	10
Birds	10	-	-	23	-	87	55	5	4	18	-
Reptiles	10	11	-	1	-	10	8	-	1	4	-
Amphibia	18	2	-	28	-	-	-	-	-	-	-
Pisces	-	-	-	-	-	-	3	-	-	-	-
Crustacea	-	-	-	-	-	-	-	-	-	-	-
Mollusca	3	-	-	-	-	-	-	-	-	-	-
Hymenoptera	-	-	-	-	-	-	-	-	-	-	-
Lepidoptera	-	-	-	-	-	-	-	-	-	-	-
Odonata	1	-	-	-	-	-	-	-	-	-	-
Anoplura	-	-	-	-	-	-	-	-	-	-	-
Total	**58**	**19**	**1**	**52**	**-**	**153**	**97**	**10**	**9**	**26**	**10**

Source: www.wii.gov.in/indianfauna/globally%20threatened%20indian%20fauna.pdf

Biodiversity hotspots of India (eastern Himalaya and western Ghats) overlap with that of:

- Nepal
- China
- Myanmar
- Sri Lanka

- Plant species endangerment increases with climate change-driven habitat loss
- Rare, endangered and threatened flora to become extinct due to anthropogenic climate change in the absence of shift in range and genetic adaptations

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Factors combine to accelerate the land degradation process include:

Inadequate policies and distorted incentives

- **Inappropriate agricultural land use practices**
- **Inefficient irrigation management practices**
- **Inappropriate/ expensive technologies**
- **Expansion on fragile lands/ecosystems**
- **Vulnerability to extreme weather events**

Objective of the on-going SLEM project

I. To contribute to poverty alleviation in India by promoting SLEM practices which would improve land and ecosystem productivity
II. To reduce vulnerability to extreme weather events (droughts, floods), including the effects of climate change

- **World Bank, UNDP and FAO programs under SLEM-CPP programme provide a viable opportunity for effective partnership approach:**
  - **provide support to the land/natural resources dependent poor and vulnerable population of rural areas for sustenance;**
  - **increase the awareness of soil degradation and depletion of water resources**
  - **soil and water conservation**
  - **Integrated crop and livestock husbandry, agro-forestry**
  - **Introduction of alternative livelihood options**

Sustainable Land and Ecosystem Management (SLM) is aimed to :

- **minimizing land degradation**
- **rehabilitating degraded areas and**
- **ensuring the optimal use of land resources for the benefit of present and future generations**

Potential Environmental Markets Drive Investment in Biodiversity and Ecosystem Services

- Systems to value and trade in environmental goods and services being developed world over
- India needs to position itself to be a part of the green economy
- Developing a Bio-banking program for offsetting impacts on threatened species as part of the review of biodiversity legislation

Bio-Banking is a mechanism for assessing, minimizing and offsetting the impacts of development on biodiversity. It balances the needs of landowners and developers with the need to maintain biodiversity. For developers, BioBanking is a voluntary alternative to the current 'threatened species assessment of significance' process that applies to some development applications.
Developers can choose to use Bio-Banking, or they may choose to follow the threatened species assessment process that has been in place.

www.environment.nsw.gov.au/ 2008

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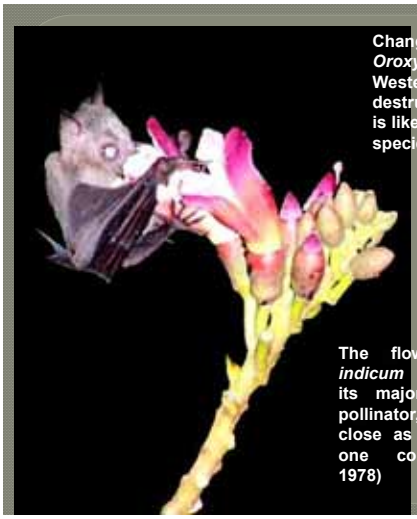
- Need to develop business model for investment in biodiversity conservation and ecosystem
- Rules and regulation that act as a barrier to investment in biodiversity conservation needs to revisited



Change in phenology in *Oroxylum indicum* of Western Himalaya or habitat destruction of the pollinator is likely to endanger the species survival.

The flowers of *Oroxylon indicum* (Bignoniaceae) and its major Southeast Asian pollinator, *E. spelaea*, is so close as to suggest one to one co-evolution (Gould, 1978)

Role of biodiversity in ecosystem functioning:

- **Soils conservation, Ecosystem resistance to and recovery (resilience) from disturbances,**
- **Provides ecosystem goods and services in the form of sustained source of water resources adaptability to long term changes in environmental conditions**
- **Eco-tourism**

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Introduction of Agroforestry in Rice Cultivation for Conservation of Rice Varieties of the Apatani Tribe

Swati Chaliha and Promode Kant

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RICH RICE DIVERSITY IN APATANI VILLAGE

- Estimated diversity of rice found in the North Eastern region of India is 9650 (Mao et. al, 2009)
- Arunachal Pradesh yielded 616 germplasm collections of rice from 1987 to 2002 (Hore, 2005)
- Around 16 landraces reported in the Apatani village (Dollo et al, 2009)

REASONS FOR THE DEVELOPMENT OF WIDE RANGE OF RICE VARIETIES

- Diverse physiographic and agro- climatic landscapes
- Natural selection
- Preference of farmers belonging to distinct ethnic groups
- Cross migration of people both eastwards and westwards over a very long period.
- *Indica* varieties have spread eastward to Southeast Asia and north to China from the Indian plains
- The tribes in the highlands of Northeastern India introduced *japonica* variety as they settled in these highlands from their earlier homes in South East Asia over the past millennium.

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APATANI WAY OF RICE CULTIVATION

- Wetland rice cultivation practiced in broad and well leveled terraces
- Hill streams trapped in the bunds, channelised and diverted into primary, secondary and tertiary networks to provide water in the terraces.
- Water from one terrace reaches another through bamboo or wooden pipes.
- Fish pits in the plots for pisciculture
- Rice varieties maintained and preserved by the tribal cultivators who grow their own special varieties inherited from their forefathers and the rich genetic diversity of rice is thus passed on from one generation to the next.

PADDY VARIETIES OF THE APATANIS

- Dollo et al, 2009 explored 16 landraces. These are –

  Ampu Ahare, Ampu Hatte, Radhe Eamo, Eylang Eamo, Ampu Puloo Hatte, Kogii Pyate, Zeehe Pyate, Pyate Pyapu, Tepe Pyaping, Pyapu Pyaping, Kogii Pyaping, Zeehe Pyaping, Pyare Mipye, Mishang Mipye, Mithu Mipye, Eylang Mipye

- Most rice varieties belong to the *Japonica* variety of rice (Hore, 2005)
- Low yielding varieties get less share of the tribal land
- Low yielding varieties gradually abandoned by the farmers

PROJECTIONS FOR THE NORTH EAST INDIA

TEMPERATURE

- The projected rise in mean temperatures in the region by 2030s with respect to 1970s ranges from 1.8 to 2.1°C
- Minimum temperatures likely to rise from 1 to 2.5°C
- Maximum temperatures to rise by 1 to 3.5°C

RAINFALL

- The increase of mean annual precipitations in the 2030s, with respect to the 1970s, is of the order of 0.3% to 3%
- the number of rainy days is likely to decrease by 1–10 days resulting in increase in the intensity of rainfall in the region by 1–6mm/day

By 2030 the temperature is projected to increase significantly but the increase in rainfall and number of overcast days would be only marginal

CLIMATE CHANGE IMPACTS ON RICE

- The most crucial time - grain or seed setting period
- Higher maximum temperature during grain setting stage may cause spikelet sterility
- This sterility is related to the number of viable pollens reaching the stigma following the dehiscence of anther, a process which is highly sensitive to temperature

  (Pollen grains of rice remain viable for just about 10 minutes)
- After pollination, pollen tube is formed and elongates to reach the embryo sac.
- Temperature of 33.7 °C and more at anthesis for an hour enough to induce sterility in rice and even shorter periods could cause harm.
- Spikelets undergoing anthesis before the high temperature is reached also affected if the high temperature point is reached when the florets are still open even though pollination may have already occurred.

Contd..

- Criticality of anthesis- only a very short period of exposure to high temperature is enough to induce sterility which makes it difficult for any sort of acclimation to occur.
- A rise of 2-3°C in night temperature particularly during the sensitive reproductive and early grain-filling stages of rice leads to reduced biomass, low grain yield and change in quality (Nagarajan et al, 2010)
- Grain yield can decline by 10% for each 1°C increase in minimum temperature
- *Japonica* varieties mostly found in the Apatani fields are suggested to be less tolerant to high temperature than *indica* spp.

FLOWER OPENING TIME

- Flower opening time varies among rice cultivars signifying that it is largely under genetic control though environmental factors may also play a role
- Kobayasi et al, 2009 examined about 100 widely diverse cultivars and found that the flowering opening time varied from 0901 hours to 1235 hours during the day

Table - Distribution of flowering opening time of japonica varieties

	Time range	Number of cultivars undergoing anthesis	Number of japonica varieties undergoing anthesis	Percentage of japonica varieties undergoing anthesis
1st quartet	0901 hrs -0954 hrs 30 sec	8	0	0%
2nd quartet	0954hrs 30 sec -1048 hrs	34	1	2.9%
3rd quartet	1048 hrs -1141 hrs 30 sec	40	20	50%
4th quartet	1141 hrs 30 sec-1235 hrs	18	14	78%

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POSSIBLE ADAPTATION ROUTES

- Shifts to higher altitudes not viable. Making new terraces require high levels of investments
- Very small window of time frame for alteration of sowing period
- Genetic introgression of early morning flowering trait in late flowering traditional varieties.
- Manipulating physical environment to reduce temperature during mid day

CONSERVATION STRATEGIES

- To keep the temperature down by controlling the microenvironment of the terraced fields
- Manipulation of shade and water availability
- Protection of the forest above the terraces will enhance the capacity to absorb moisture in the soils leading to increase in the lean flows in the streams below
- Larger catchment for continuous percolation to the terraces

KEY TO CONSERVATION: FOREST PROTECTION

- Rice terraces in the Ifugao Province of Cordillera Mountains, Northern Philippines capped with a ring of private forests
- Private forest or *muyongs* managed intensively to ensure adequate water supply to flood the terraces
- Complex irrigation system akin to the water management system of Apatani

MOVING FURTHER

- Construction of water storage dams on the higher side of the rice fields for water availability in the dry season

INTRODUCTION OF AGROFORESTRY IN RICE FIELDS

- Tree cultivation along the boundaries
- Some degree of tree cover may be beneficial even though paddy requires more direct solar radiation
- Example of Bali rice terraces interspersed with patches of coconut
- Agroforestry system tailored for the Apatani Village with rice as the main crop and moderate sized limited foliage fruit trees (orange) or other high value tree crops, firewood, bamboo species etc
- More than one farm product, distribution of economic risks
- An element of entrepreneurship by creating opportunities for community projects

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Ecological studies of Shrub species in Chaupal Forest Division of Himachal Pradesh

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Indian Forestry Congress 2011
New Delhi India
Indian Council of Forestry Research and Education (ICFRE) Dehradun Uttarakhand, Ministry of Environment and Forests

Presented by

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Introduction

•India has rich diversity of flora and fauna due to immense variety of climate and altitudinal zone coupled with varied ecological habitats.

• The floristic elements also show high degrees of endemism with almost 95% of the species being native of Western Himalayan flora, while about 5% (150 species) are exotic, introduced over the last 150 years.

•Himachal Pradesh has 12 critically endangered, 21 endangered and 27 vulnerable plant species (Anon., 2011).

Study Area

•The study area lies between 30°46′30″ to 31°4′30″ N latitude and 77°24′30″ to 77°49′0″ E longitude and between the elevation of 1200 to 2540 m above mean sea level.

•In winter, the temperature is −1° C to 18° C and in summer 20° C to 32° C .

•The average annual rainfall is about 1412 mm per annum with the highest precipitation during rainy season (July -September).

Site No.	Site Name	Altitude (m)
Site – I	Thekra (UPF)	1500 – 1680
Site – II	Malat (DPF)	1710 – 2400
Site – III	Jawalnu (DPF)	1780 – 2400
Site – IV	Roeshty (DPF)	1972 – 2450
Site – V	Mashmund (UPF)	1772 - 1950

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Material and Methods

•Five study sites were selected namely Thekra (UPF) , Malat (DPF), Jawalnu (DPF), Roeshty (DPF) and Mashmund (UPF) as site I, II, III, IV and V respectively .

•The studies were conducted by grid pattern method and the vegetation data was collected using randomly distributed 10 numbers quadrates of 5 m x 5 m for all the five sites. Care was taken to sample the most representative area.

•Vegetation data were quantitatively analyzed for frequency, density and basal area and relative frequency, relative density and relative basal area following method of Mishra (1968). These three relative values were added to get importance value index (IVI).

Results

Phytosociological attributes of Shrubs at site - I

Species	Density (plants/ha)	Frequency (%)	Total Basal Area(m^2/ha)	Relative Density	Relative Frequency	Relative (BA)	IVI
Cassia tora	60.00	30.00	0.013	8.22	8.58	3.731	20.522
Cornus capitata	100.00	50.00	0.082	13.69	14.29	23.533	51.518
Dodonaea visicosa	70.00	40.00	0.027	9.59	11.43	7.534	28.552
Indigofera pulchella	130.00	50.00	0.041	17.80	14.29	11.743	43.838
Murraya koenigii	90.00	50.00	0.013	12.29	14.29	3.884	30.499
Myrsine Africana	110.00	40.00	0.054	15.07	11.43	15.665	42.162
Prinsepia utilis	50.00	30.00	0.031	6.85	8.58	8.796	24.217
Sorberia tomentosa	70.00	30.00	0.071	9.59	8.58	20.557	38.717
Woodfordia fruticosa	50.00	30.00	0.016	6.58	8.58	4.558	19.979

Results

Phytosociological attributes of Shrubs at site - II

Species	Density (plants/ha)	Frequency (%)	Total Basal Area(m^2/ha)	Relative Density	Relative Frequency	Relative Basal Area	IVI
Berberis aristata	100.00	40.00	0.035	16.39	21.05	20.793	58.239
Berberis lyceum	50.00	20.00	0.011	8.19	10.52	6.818	25.541
Daphne cannabina	150.00	20.00	0.026	24.59	10.52	15.458	50.574
Jasmine officinale	150.00	40.00	0.046	24.59	21.05	27.122	72.765
Prinsepia utilis	90.00	40.00	0.043	14.76	21.05	25.658	61.464
Wikstroemia canescens	70.00	30.00	0.007	11.48	15.79	4.150	31.415

Results

Phytosociological attributes of Shrubs at site - III

Species	Density (plants/ha)	Frequency (%)	Total Basal Area(m^2/ha)	Relative Density	Relative Frequency	Relative Basal Area	IVI
Berberis aristata	80.00	40.00	0.048	11.94	12.50	12.585	37.025
Rosa moschata	60.00	30.00	0.054	8.96	9.38	14.312	32.642
Rubus elipticus	120.00	50.00	0.055	17.91	15.62	14.628	48.163
Sarcococca saligna	70.00	50.00	0.024	10.45	15.62	6.427	32.499
Sorbaria tomentosa	80.00	40.00	0.092	11.94	12.50	24.473	48.914
Wikstroemia canescens	110.00	30.00	0.026	16.42	12.50	6.758	35.675
Woodfordia fruticosa	80.00	40.00	0.019	11.94	9.38	4.949	26.263
Zanthoxylum alatum	70.00	40.00	0.059	10.45	12.50	15.869	38.818

Results

Phytosociological attributes of Shrubs at site - IV

Species	Density (plants/ha)	Frequency (%)	Total basal area (m^2/ha)	Relative Density	Relative Frequency	Relative Basal Area	IVI
Berbiris arista	100.00	50.00	0.065	9.43	12.19	13.409	35.038
Cassia tora	70.00	20.00	0.022	6.60	4.88	4.527	16.008
Daphne cannabina	200.00	50.00	0.052	18.87	12.19	10.686	41.749
Debregeasia hypoleuca	70.00	40.00	0.031	6.60	9.76	6.465	22.825
Dendrocalamus strictus	100.00	70.00	0.065	9.43	17.08	13.345	39.852
Prinsepia utilis	110.00	40.00	0.038	10.38	9.76	7.677	27.809
Sarcococca saligna	210.00	70.00	0.104	19.81	17.08	21.558	58.442
Sorberia tomentosa	90.00	30.00	0.064	8.49	7.32	13.296	29.103
Wikstroemia canescens	110.00	40.00	0.044	10.38	9.76	9.039	29.173

Results

Phytosociological attributes of Shrubs at site - V

Species	Density (plants/ha)	Frequency (%)	Total Basal Area (m^2/ha)	Relative Density	Relative Frequency	Relative Basal Area	IVI
Berberis aristata	120.00	60.00	0.024	19.36	23.08	5.191	47.622
Daphne cannabina	170.00	50.00	0.047	27.42	19.23	10.029	56.679
Rhus parviflora	70.00	30.00	0.037	11.29	11.54	7.993	30.821
Rosa moschata	60.00	40.00	0.045	9.68	15.39	9.610	34.672
Sorbaria tomentosa	80.00	40.00	0.173	12.90	15.39	37.346	65.633
Zanthoxylum alatum	120.00	40.00	0.139	19.36	15.39	29.831	64.570

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Results

Species Diversity

A total of 21 species belonging to 15 families represented the floral diversity of study sites and maximum species (9) were recorded at site-I and IV

List of occurrence of Shrubs found in study area.

Botanical Name	Vernicular Name	Family	Site				
			I	II	III	IV	V
Berberis aristata	Kashmal	Berberidaceae	-	+	+	+	+
Berberis lyceum	Kashmal	Berberidaceae	-	+	-	-	-
Cassia tora	Elu	Caesalpiniaceae	+	-	-	+	-
Cornus capitata	Haldu	Cornaceae	+	-	-	-	-
Daphne cannabina	Niggi	Thymelaeaceae	-	+	-	+	+
Debregeasia hypoleuca	Shariu	Urticaceae	-	-	-	+	-
Dendrocalamus strictus	Bans	Poaceae	-	-	-	+	-
Dodonaea viscose	Mehndu	Spindaceae	+	-	-	-	-
Indigofera pulchella	Kathi	Papilionaceae	+	-	-	-	-
Jasminum officinale	Malti	Oleaceae	-	+	-	-	-
Murraya koenigii	Kari patta	Rutaceae	+	-	-	-	-
Myrsine Africana	Chapra	Myrsinaceae	+	-	-	-	-
Prinsepia utilis	Bhekal	Rosaceae	+	+	-	+	-
Rhus parviflora	Tungla	Anacardiaceae	-	-	-	-	+
Rosa moschata	Bun gulab	Rosaceae	-	-	+	-	+
Rubus ellipticus	Akhre	Rosaceae	-	-	+	-	-
Sarcococca saligna	Dlun	Buxaceae	-	-	+	+	-
Sorboria tomentosa	Bungrae	Rosaceae	+	-	+	+	+
Wikstroemia canescens	Choopay	Thymelaeaceae	-	+	+	+	-
Woodfordia fruticosa	Dhawa	Lythraceae	+	-	+	-	-
Zanthoxylum alatum	Tirmir	Rutaceae	-	-	+	-	-

Results

Concentration of Dominance (Cd)

It is a measure of dominance of one or a few species in a community. The values of concentration of dominance ranged from 0.103 to 0.185 for shrubs. Similar findings were also described by Whittaker (1965) and Risser & Rice (1971) for certain temperate forests where value of Cd ranged from 0.01 to 0.99.

Species Richness (S) Species Diversity (H') and Concentration of Dominance (Cd) of Shrubs at study sites.

Site	Shrubs		
	S	H'	Cd
I	9	2.146	0.122
II	6	1.732	0.185
III	8	2.059	0.103
IV	9	2.137	0.125
V	6	1.752	0.179

Results

Spatial distribution

•Most of the species among all the sites studied were contagiously distributed and rest of the species were randomly and regularly distributed.

•The contagious distribution is the characteristic of natural vegetation and has been reported by several workers (Greig-Smith, 1957; Odum, 1971; Kershaw, 1973; Singh and Yadav, 1974).

Results

Sorenson's Index of Similarity (S)

The values for similarity index lies between 0.133 to 1.00 for different strata in all the sites studied.

Maximum similarity 0.571, 1.00 and 0.571 was observed between site-III and V respectively whereas, minimum similarity (0.133) was recorded between site-IV and V, III and IV and site-I and II respectively

The maximum similarity between different sites (III, V) may be due to same altitudinal zone and similar type of habitat conditions. Less difference in the value of similarity index indicated that growth forms in the stands responded in a similar fashion (Adhikari et al., 1991). The results are in line with the findings of Rawat et al., (1989) and Silas et al., (1987).

Frequency** = Number of quadrate in which species occurred.....x 100
Total number of quadrate studied

Relative dominance (RD) = Total basal area of species...x 100
Total basal area of all the species

Relative density = Number of individuals of the species ....x 100
Total number of individuals of all the species

Relative FrequencyRF = Number of occurrence of species (frequency**).....x 100
Number of occurrence of all species (sum of frequency**)

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Studies on the seed germination, seed viability and propagation of endangered Jaal (*Salvadora oleoides*) Decne. : Haryana Experience

Jagdish Chander IFS

Presentation Outline…

- Jaal (*Salvadora oleoides*)- An Introduction
- Jaal in history and culture
- Jaal: Lifeline of Haryana
- Food Value
- Unexplored Ecological value
- Genetic variability
- Jaal in problem
- Lucky 2010
- Seed weight, germination, viability, raising of tall plants, effect of root hormone, and growth enhancement studies
- Conclusions

Jaal in history and culture:

In The Mahabharata Book VIII: Karna Parva, Chapter 30, verse 24 mentions the tree species as Sami, Pilu and Karir tree species as "Shami pilu kariranam, vanesu sukhavartmasu) and (apupan saktu pindis ca khadanto mathitanvita. Meaning - "When shall I be amongst those ladies eating cakes of flour and meat and balls of pounded barley mixed with skimmed milk, in the forests, having many pleasant paths of Sami and Pilu and Karira!" (VIII.30.24).

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Salvadora oleoides: An introduction:

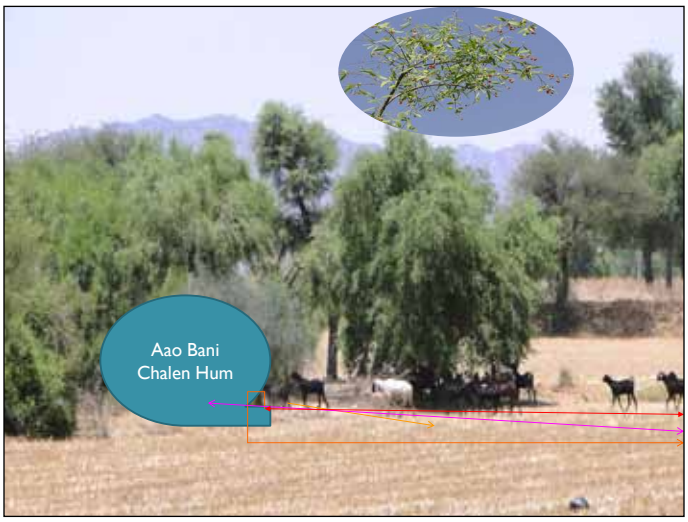
A small evergreen tree, attaining 6-9 m height under favourable conditions.

Trunk short, often twisted. Branches drooping, numerous, stiff, often swollen at forks

In Haryana, it is distributed in western, southern and central parts, and is not found beyond Karnal.

Jaal: Lifeline of Haryana

Essential feature of Johad/ village pond



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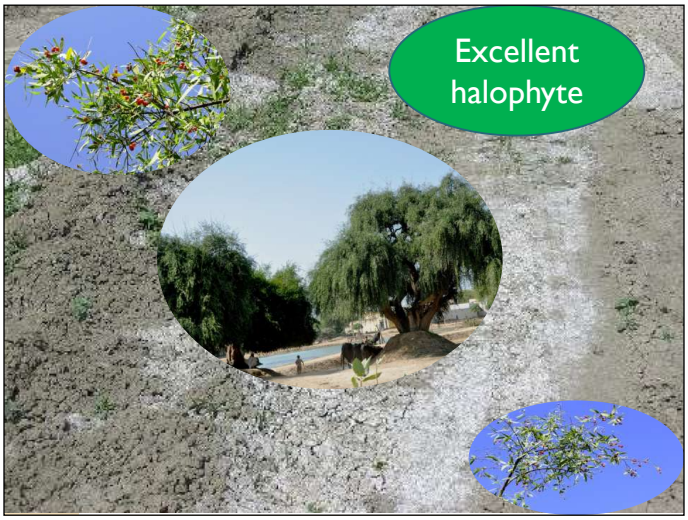

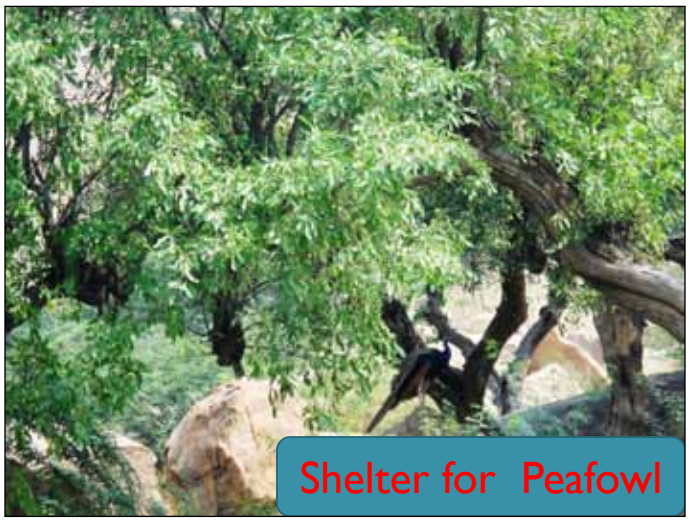

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Food For
Camel
Rabbit
Goat
Sheep

Food Value

Sweety & Juicy Peel

Consumption of Jaal fruits is considered as the best remedy for beating the desiccating effect of *loo* (hot winds)

- The fruits contain **15 times more calcium than wheat.**
- Rich in Lauric and Myristic acid.
- Industrial value and are used for soap making.

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Genetic variability

The pink and yellow fruits

Jaal in problem

Jaal: The flagship species of Haryana

No natural regener-ation

Just little over 5000 trees left in Haryana

The only good patch left in Haryna

Bani (village forest) vanished

Nimbi Dhuloth (Mahendergarh)

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Absence of seed setting is leading to shrinkage in its habitat.
Vanishing from banies, village ponds, common lands, saline and alkaline land and hard rocky terrain.

- **Lucky 2010**
- ***The year 2010 proved to be a good seed year***
- ***Jaal in Haryana set seeds after a gap of about 30 years.***

Good seed bearing

STUDIES CONDUCTED:
- Seed germination
- Seed weight
- Seed viability
- Growth enhancement studies like effect of manures and fertilizers.
- Raising tall plants through root shoot cuttings.
- Effect of root hormones on rooting and growth.

Material and Method:
- Seeds were collected from three different locations viz. Bir Hisar, Mahendergarh and Rajgarh.
- Were depulped and thereafter dried in shade for a week.

Seed Weight: Sun dried seeds were weighed.
- Germination study:
- Two hundred shade dried seeds were sown in two germination trays each. Also two hundred fresh seeds with pulp intact were sown in two germination trays separately at room temperature (27 ° C).

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Seed storage and viability studies:

•The seeds were stored at room temperature

• Seed viability study was conducted in germination chambers of Forest Seed Testing Laboratory Pinjore.

• One hundred seeds were sown separately in two germination trays at an interval of seven days and the number of seeds germinated was counted.

•This process continued till the germination dropped to 20 percent.

Study on raising tall seedlings of Jaal:

•The study was conducted at Bithmarha in Hisar district.

•The seeds were sown directly in the nursery beds of size 10mx1m in the month of June, 2010.

•The plants were uprooted in the first week of February.

Root shoot cuttings containing 5cm shoot and 10 cm root portion were prepared:

• 400 stumps treated with 500 PPM of IBA were planted in the polybags of size 20cmx30cm.

• 400 stumps treated with 500 PPM of IBA were planted in bigger containers of size 30cmx45cm.

Control: 400 stumps without IBA treatment were planted in polybags of size 20cmx30cm.

Effect of manures and fertilizers on the growth of Jaal plants:

•Seeds were sown in polybags of size 15cmx22cm in the month of June.

•In the second week of February, 50 plants were planted in bigger Pbags in each treatment:

A: DAP treatment:

•Gunny bag of size 30cm x 45cm were filled with 50 gm of DAP thoroughly mixed with local soil. In 50 gunny bags one Jaal plant was planted in each bag.

• **B: Farm Yard Manure (FYM)**

Treatment: 50 gunny bags of size 30cm x 45cm were filled with one kg of FYM thoroughly mixed with local soil and plants were planted.

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C: Urea treatment:

- **50 plants were planted in gunny bags** of size 30cm x 45cm containing standard soil mixture and 50 gram of urea in it.
- **D: Vermicompost treatment:** 50 Gunny bags of size 30cm x 45cm were filled with 500 gm of vermicompost thoroughly mixed with local soil and the plants were planted.

E: *Azotobacter* treatment:

- **50 plants were planted in gunny bags** of size 30cm x 45cm containing local soil and *Azotobacter* in it.

Control:

- 50 gunny bags were filled with local soil.

Jaal in containers of size 30cmx45cm

Results:

- Germination started after 48 hours of sowing of seeds and was completed within 120 hours.
- The germination in both pulped and the depulped seeds was around 90 percent.

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Viability Results:

- 90 percent viability up to 160 days. Seeds became non viable after 170 days.
- Jaal seeds have to be sown in beds or in polybags up to the month of August in the same year.
- Seeds become non-viable by Feb. next.
- The sowing cannot be delayed beyond August

•Cold Frost

Results of root shoot cuttings:

- The sprouting of cuttings started after one month.
- Irrespective of the size of the container only ten percent cuttings sprouted.
- Only 5 percent cuttings rooted & IBA did not succeed in successfully rooting the cuttings
- Plants became bushy and did not put good growth.
- Should not be attempted.

Height of Jaal (*Salvadora oleoides*) plants recorded in response to manures and fertilizer treatment

S. No.	Treatment	Maximum Height (Cm)	Average Height (Cm)
1	FYM	99	54.54
2	Urea	72	50.94
3	Vermicompost	70	50.32
4	DAP	88	50.04
5	*Azotobacter*	76	46.94
6	Control	64	46.64

Conclusions

- *S. oleoides* is becoming endangered due to non setting of seeds.
- Once there is good seed setting germination is not a problem.
- Root shoot cuttings do not root. Hence, should not be attempted.
- Organic manures are the best growth enhancers.

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Protected Area Management: *New Paradigm for Conservation*

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Paper presented in the First Indian Forestry Congress, 21-23 November, 2011, New Delhi

Presentation Outline…

- Protected Area Coverage
- Classic, Modern and Emerging Models of Protected Area Management
- Protected Area Programme of Work
- Protected Area Management Effectiveness
- New Paradigm for Protected Areas
- Potential Scenarios for Protected Areas
- The Way Ahead

Protected Areas

- The concept of Protected Areas has existed from time immemorial in various incarnations ~ *'Sacred Groves'* in India and Africa; *'Royal Decrees'* in South Asia; and *'Taboo Areas'* in Pacific Islands

- Modern protected areas in the form of national parks, sanctuaries etc only began in the mid-1800s

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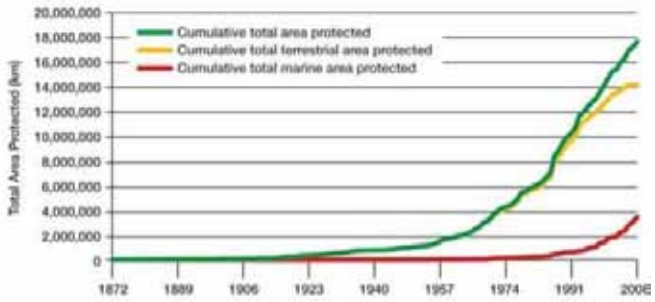
Protected Area Global Coverage



Growth in nationally designated protected areas from 1872 to 2008

Source: http://www.bipindicators.net/pacoverage

Protected Areas in India

Category	Number	Total Area (km^2)	%Coverage of Geographical Area
National Parks (NPs)	102	39888.11	1.21
Wildlife Sanctuaries (WLSs)	515	119930.50	3.65
Community Reserves (Com. Res.)	4	20.69	0.00
Conservation Reserves (Con. Res.)	47	1382.27	0.04
Total Protected Areas (PAs)	668	161221.57	4.90

Classic, Modern and Emerging Models of Protected Areas

	Classic Model (mid-1800s – 1970s)	Modern Model (1970s – mid-2000s)	Emerging Model (mid-2000s and beyond)
Rationale for establishing protected areas	"Set aside" from productive use	Concurrent social, ecological and economic objectives	Strategy to maintain critical life support systems
Purpose of protected areas	Established primarily for scenic values rather than functional Values	Established for scientific, economic and cultural reasons	Established to support ecosystem services, and promote climate change adaptation, resilience and mitigation

Source: Ervin, J. et. al, UNDP, 2010

Classic, Modern and Emerging Models of Protected Areas

	Classic Model (mid-1800s – 1970s)	Modern Model (1970s – mid-2000s)	Emerging Model (mid-2000s and beyond)
Management purpose	Managed mostly for park visitors	Managed with local people in mind	Managed for social, economic and ecological values, with an emphasis on maintaining ecosystem services
Role of wilderness in protected areas management	Emphasis on intrinsic value of wilderness	Emphasis on ecological and cultural importance of wilderness and large, intact areas	Emphasis on protection of intact areas and restoration of degraded areas to maintain ecosystem functioning

Source: Ervin, J. et. al, UNDP, 2010

Classic, Modern and Emerging Models of Protected Areas

	Classic Model (mid-1800s – 1970s)	Modern Model (1970s – mid-2000s)	Emerging Model (mid-2000s and beyond)
Management actors	Managed by central government	Managed by central government and by local communities	Managed by many partners with many governance models
Financing of protected areas	Protected areas are financed by a central government (e.g., through annual budget allocations)	Protected areas are financed by many partners (e.g., bilateral donors, foundations, NGOs)	Protected areas are financed by mainstreaming protected areas into national and local economies and through innovative finance mechanisms

Source: Ervin, J. et. al, UNDP, 2010

Classic, Modern and Emerging Models of Protected Areas

	Classic Model (mid-1800s – 1970s)	Modern Model (1970s – mid-2000s)	Emerging Model (mid-2000s and beyond)
Planning	Excluded local people	Conducted with, for and sometimes by local people	Conducted with, for and by many different stakeholders from many different sectors

Source: Ervin, J. et. al, UNDP, 2010

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Classic, Modern and Emerging Models of Protected Areas

	Classic Model (mid-1800s – 1970s)	Modern Model (1970s – mid-2000s)	Emerging Model (mid-2000s and beyond)
Connection of protected areas with surrounding landscape and human uses	Viewed as islands, isolated from the surrounding landscape, seascape and human uses	Viewed as part of a comprehensive ecological network	Viewed as integral part of national economies and sectoral plans, including land-use, climate adaptation, energy, social development, disaster mitigation, transportation and infrastructure plans

Source: Ervin, J. et. al, UNDP, 2010

Classic, Modern and Emerging Models of Protected Areas

	Classic Model (mid-1800s – 1970s)	Modern Model (1970s – mid-2000s)	Emerging Model (mid-2000s and beyond)
Asset value of protected areas	Viewed as national assets	Viewed as a valuable community assets and global concern	Viewed as ecologically, socially and economically valuable at all levels
Management planning horizon	Managed by natural scientists over short-term planning horizons	Managed by natural and social scientists over medium-term planning horizons	Managed by multi-disciplinary professionals over long-term planning horizons

Source: Ervin, J. et. al, UNDP, 2010

Protected Areas

- Protected areas are the '*cornerstone*' of global biodiversity conservation
- Protected areas are to be managed as a '*critical component of a life support system*' and they are expected to do more ~ ecologically, socially and economically ~ than they have ever before

CBD Programme of Work on Protected Areas (PoWPA)

- The CBD Programme of Work on Protected Areas (PoWPA) is a globally accepted framework for creating comprehensive, effectively managed and sustainably funded national and regional protected area systems around the globe.

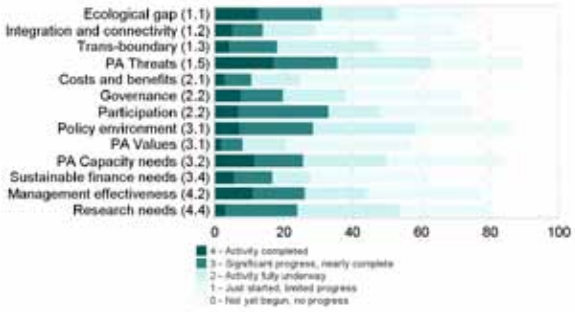
CBD Programme of Work on Protected Areas (PoWPA)

Programme Elements

- Element 1: Strengthening protected areas systems and sites
- Element 2: Governance, equity, participation and benefits sharing
- Element 3: Protected area enabling environment
- Element 4: Standards, assessment and monitoring

CBD Programme of Work on Protected Areas (PoWPA)

- Global Summary of PoWPA Implementation



Source: http://www.cbd.int/protected/implementation/

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Protected Area Management Effectiveness
How secure are PAs?

Element Name	No. of Criteria	Criteria
Context	*03*	Site values, Threats, Biotic pressures
Planning	*09*	Zonation, Management Plan, Stakeholders, Habitat Management, Protection, Human-Wildlife Conflict, Landscape Management
Inputs	*05*	Human Resources, Infrastructure, Funds, NGO inputs
Process	*05*	Trained Manpower, HRD, Livelihoods
Outputs	*04*	Dissemination, Visitor Services, Maintenance schedule
Outcomes	*06*	Population Trends, Threats abatement, Community relationship

MEE Score (% age) of Landscape Clusters (2010-11)

Cluster Number	Cluster Name	States	No. of Tiger Reserves	Mean MEE Score%	MEE Score Range %
I	Shivalik- Gangetic Plain Landscape Complex and Central Indian Landscape Complex and Eastern Ghats Landscape Complex	Uttar Pradesh, Uttarakhand, Rajasthan, Maharashtra	8	64	56-73
II	Central Indian Landscape Complex and Eastern Ghats Landscape Complex	Madhya Pradesh	6	79	56-88
III	Shivalik-Gangetic Plain Landscape Complex and Central Indian Landscape Complex and Eastern Ghats Landscape Complex	Bihar, Chattishgarh, Orissa, Andhra Pradesh, Jharkhand	8	42	33-63
IV	Western Ghats Landscape Complex	Karnataka, Kerala, Tamil Nadu	9	75	63-80
V	North East Hills & Brahmaputra Flood Plains and Sundarbans	Arunachal Pradesh, Assam, Mizoram, West Bengal	8	66	56-77
Total			39	65	33-88

Category-wise outcome of MEE Process (2010-11)

S. No.	Name of Tiger Reserve	Rating
1	Annamalai	Very Good
2	Bandhavgarh	
3	Bandipur	
4	Bhadra	
5	Dandeli-Anshi	
6	Kalakad-Mundathurai	
7	Kanha	
8	Kaziranga	
9	Mudumalai	
10	Parambikulam	
11	Pench, Madhya Pradesh	
12	Periyar	
13	Satpura	
14	Sundarbans	

Category-wise outcome of MEE Process (2010-11)

S. No.	Name of Tiger Reserve	Rating
1	Buxa	Good
2	Corbett	
3	Dampa	
4	Dudhwa	
5	Manas	
6	Melghat	
7	Nagarhole	
8	Pakke	
9	Pench, Maharashtra	
10	Ranthambhore	
11	Tadoba-Andhari	

Category-wise outcome of MEE Process (2010-11)

S. No.	Name of Tiger Reserve	Rating
1	Achanakmar	Satisfactory
2	Namdapha	
3	Nameri	
4	Sanjay	
5	Sayadari	
6	Valmiki	

S. No.	Name of Tiger Reserve	Rating
1	Satkosia	Poor

Category-wise outcome of MEE Process (2010-11) of Tiger Reserves falling in the '*Red Corridor*'

S. No.	Category	Name of Tiger Reserve
1	Very Good	---
2	Good	Nagarjunsagar-Srisailam
3	Satisfactory	Simlipal
4	Poor	Indravati, Palamau, Udanti-Sitanadi

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Category-wise outcome of MEE Process (2010-11) of Tiger Reserves, which had recently lost all tigers

S. No.	Category	Name of Tiger Reserve
1	Very Good	Panna
2	Good	---
3	Satisfactory	Sariska
4	Poor	---

Summary of the outcome of MEE Process (2010-11)

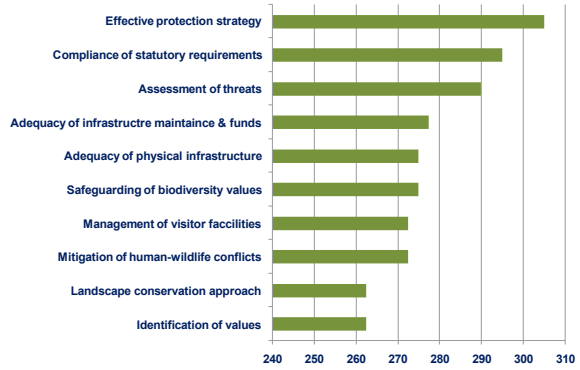
Rating	Number of Tiger Reserves	Percentage
Very Good	15	38
Good	12	31
Satisfactory	8	21
Poor	4	10
Total	39	

Comparison of MEE Rating of Tiger Reserves in 2005-06 and 2010-11

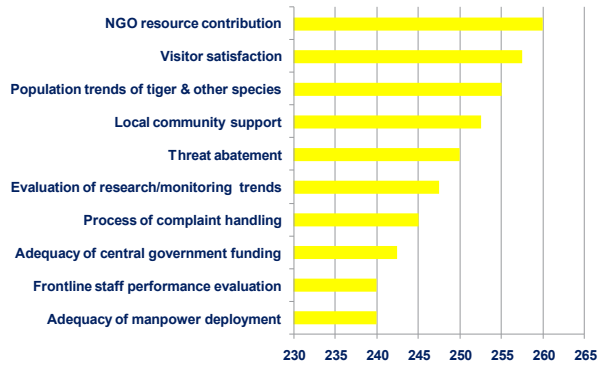
Category	2005-06	%	2010-11	%
Very Good	09	32	10	36
Good	10	36	11	39
Satisfactory	07	25	05	18
Poor	02	07	02	07
Total	28		28	

Performance of Headline Indicators…

Performance of Headline Indicators (Top Ten)…



Performance of Headline Indicators (Middle Ten)…



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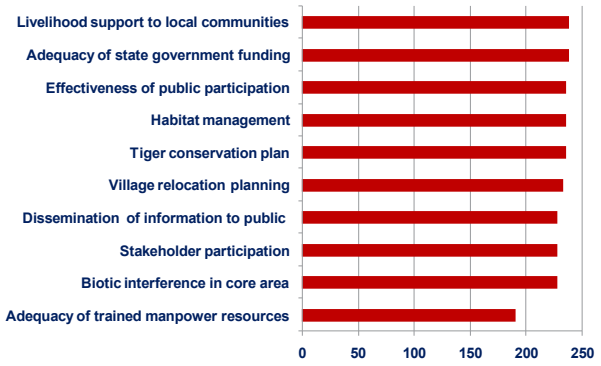
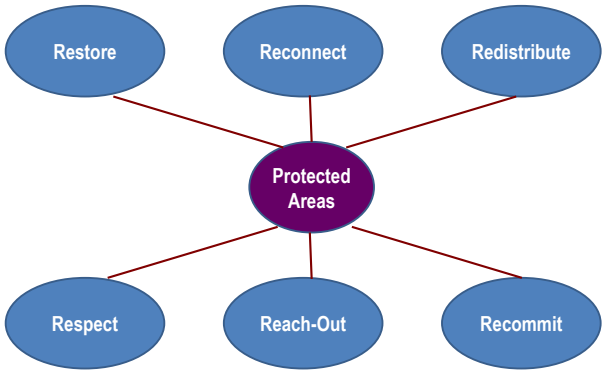
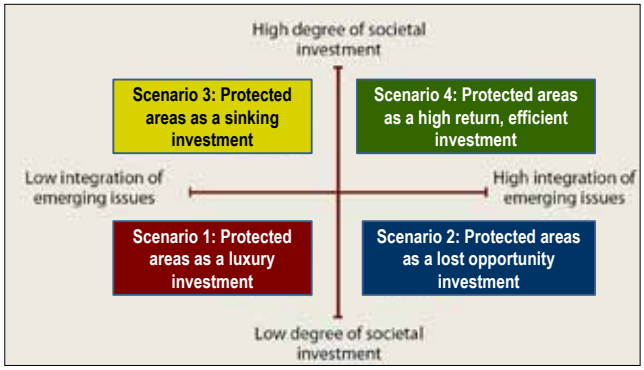
Performance of Headline Indicators (Bottom Ten)…



New Paradigm of Protected Area Management



Potential Scenarios for Protected Areas



Source: Ervin, J. et. al, UNDP, 2010

The Way Ahead

- The linkages between comprehensive, re-silent, effectively managed and financially secure protected areas on the one hand and the economic and social well-being of countries, communities and individuals on the other hand though not fully appreciated are a reality.
- As countries move towards creating a carbon-neutral and climate-resilient future, the role of protected areas in securing biodiversity conservation and human well-being will become more significant than ever before.

The Way Ahead

- Finally, protected areas have to be managed not as *'islands of biodiversity'* but as the '*building blocks of regional networks*' that will sustain ecological processes over time and space.

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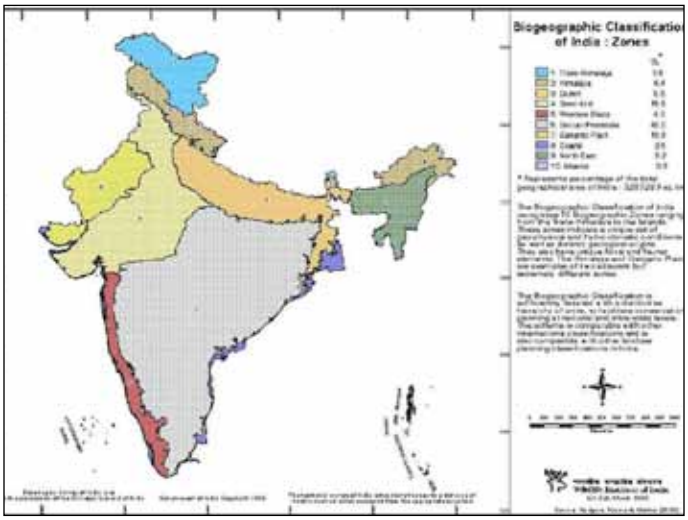
Landscape management : A hope for Wildlife

Landscape

Landscape comprises the visible features of an area of land, including the physical elements of landforms such as (ice-capped) mountains, hills, water bodies such as rivers, lakes, ponds and the sea, living elements of land cover including indigenous vegetation, human elements including different forms of land use, buildings and structures, and transitory elements such as lighting and weather conditions.

Combining both their physical origins and the cultural overlay of human presence, often created over millennia, landscapes reflect the living synthesis of people and place vital to local and national identity. Landscapes, their character and quality, help define the self image of a region, its sense of place that differentiates it from other regions. It is the dynamic backdrop to people's lives.

The Earth has a vast range of landscapes including the icy landscapes of polar regions, mountainous landscapes, vast arid desert landscapes, islands and coastal landscapes, densely forested or wooded landscapes including past boreal forests and tropical rainforests, and agricultural landscapes of temperate and tropical regions.



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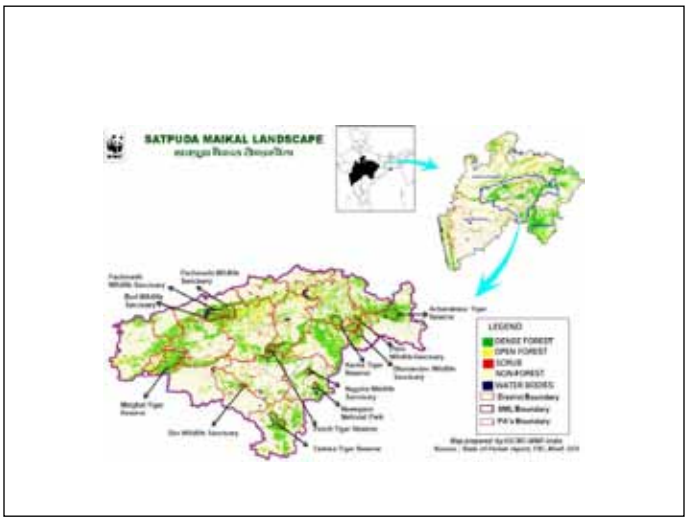

Approaches taken for conservation

- Island approach – National Parks and Sanctuaries
- Flagship species – Tiger, Elephant and one Horned Rhino
- Landscape level – Source and sink concept

Habitat degradation

- Over use by long ranging animals
- Monoculture
- Exotic species plantations
- Conversion of grasslands to plantations
- Drying of Water bodies
- Weed infestation
- Changes in grass composition from palatable to coarse

Habitat Fragmentation

- Developmental projects
- Urbanization
- Roads and Highways
- Land transfers for non forest activities
- Disasters and natural calamities

Post independence

- Prime wildlife habitat in territorial divisions faced brunt of development
- Migration corridors lost there connectivity
- Shikar companies broke all norms of hunting
- Rare breeding habitat and Hot spots sacrificed to myopic planning
- Rehabilitation of people from Pakistan and Bangaladesh

Concept of landscape management

- It is estimated that more than 300 individuals of a species in single population can prevent genetic depression
- It is advisable to have more genetically diverse population in different landscapes (Keep your eggs in different baskets)
- Stable population will be able to bear the brunt of any natural calamity and diseases like Canine distemper and Render pest
- Such concept will be successful when we have more habitat for migration in different seasons and corridors intact and effective
- Exclusion of human being is next to impossible from such a vast area hence we should consider human being as part of the ecosystem.

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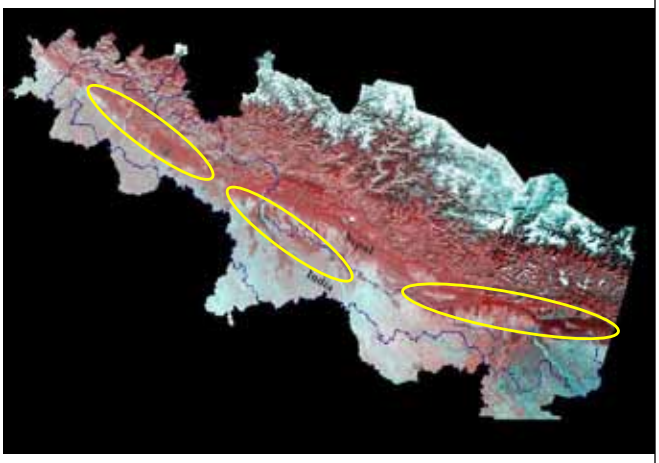
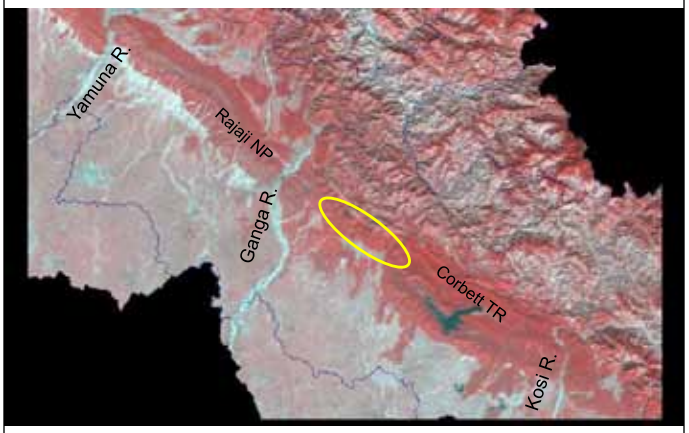
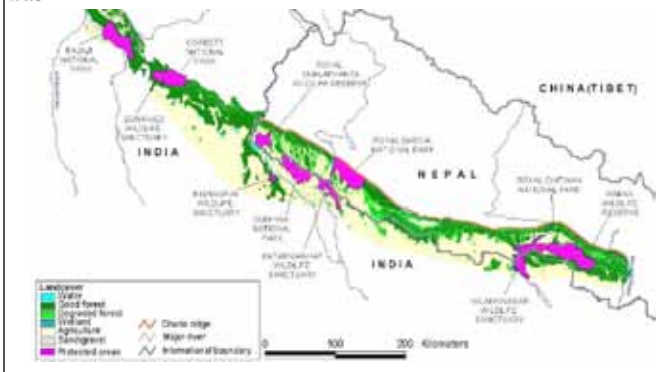
Terai Arc of India and Nepal





Rajaji-Corbett Corridor and Kolluchaur Reserve Forest

Terai Arc Landscape



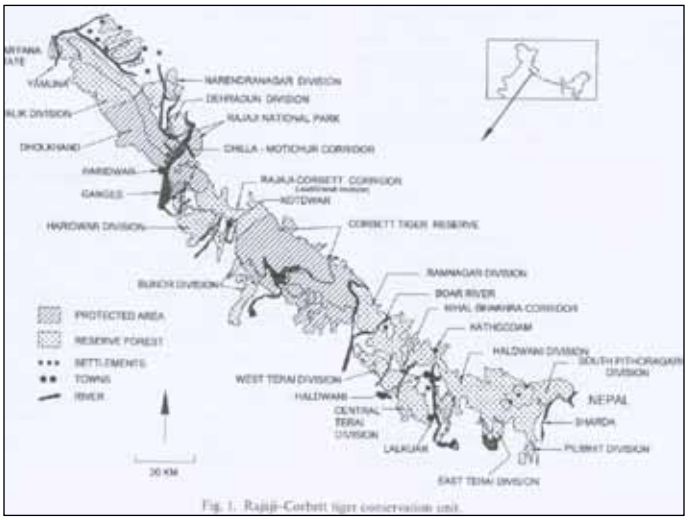


Fig. 1. Rajaji-Corbett tiger conservation unit

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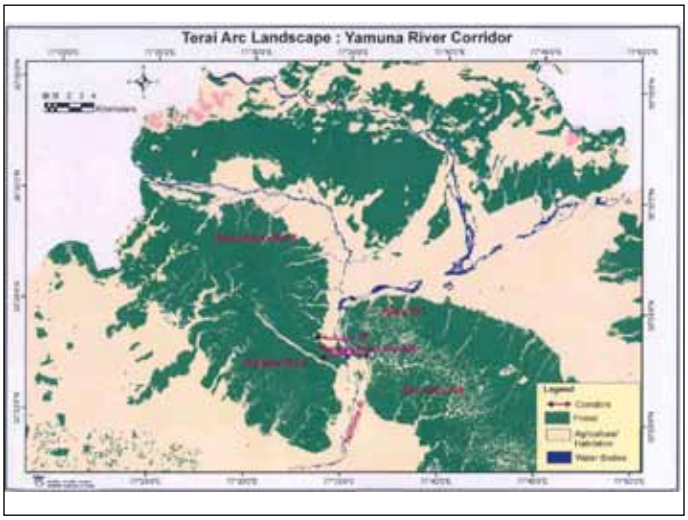

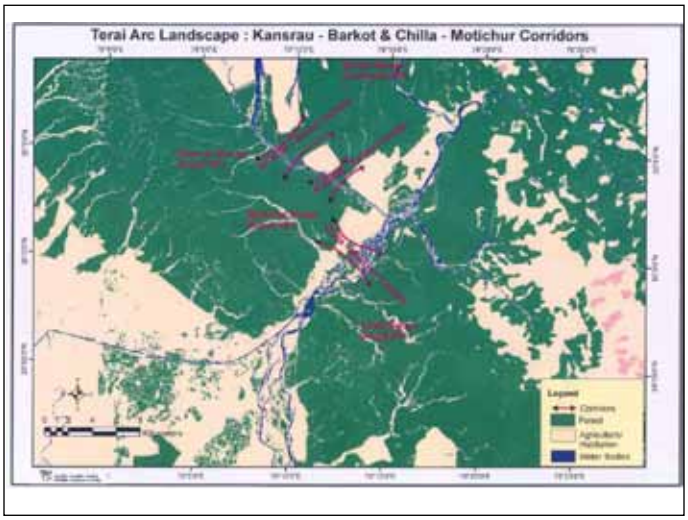

Chilla-Motichur Corridor

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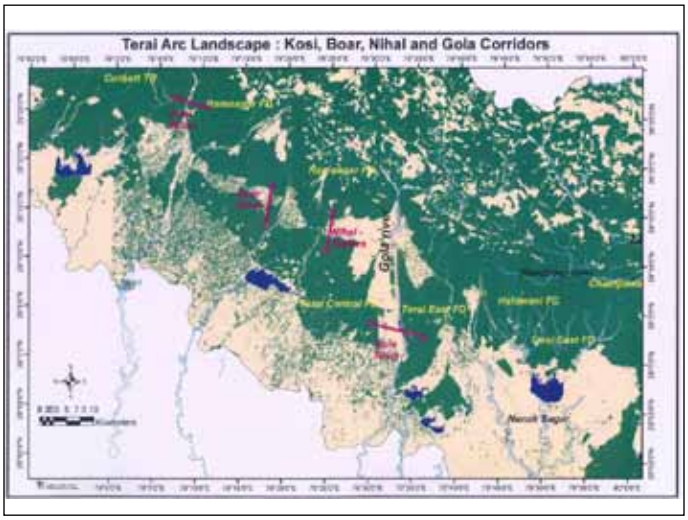

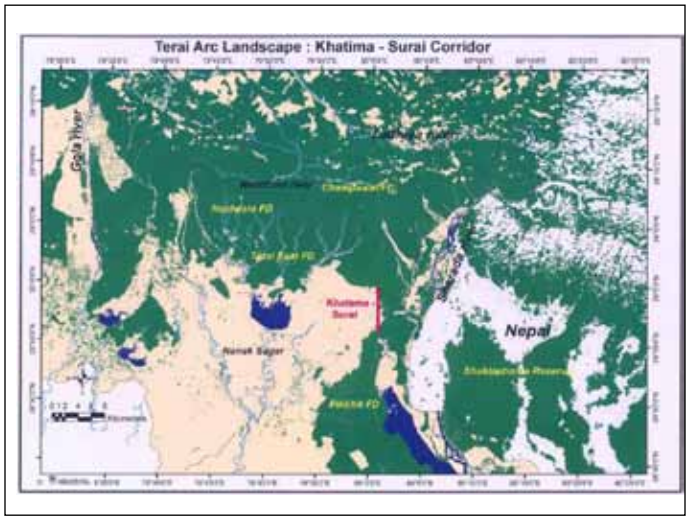

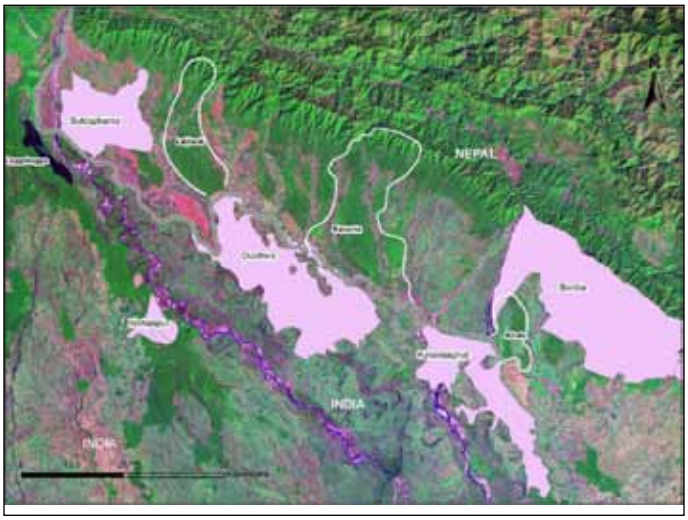

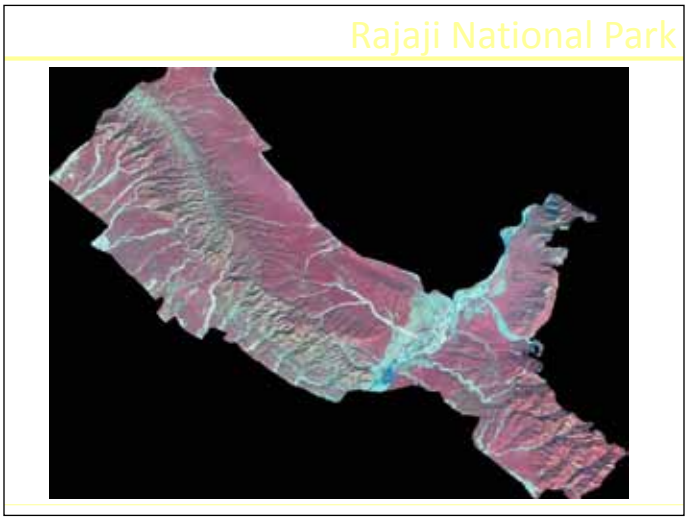

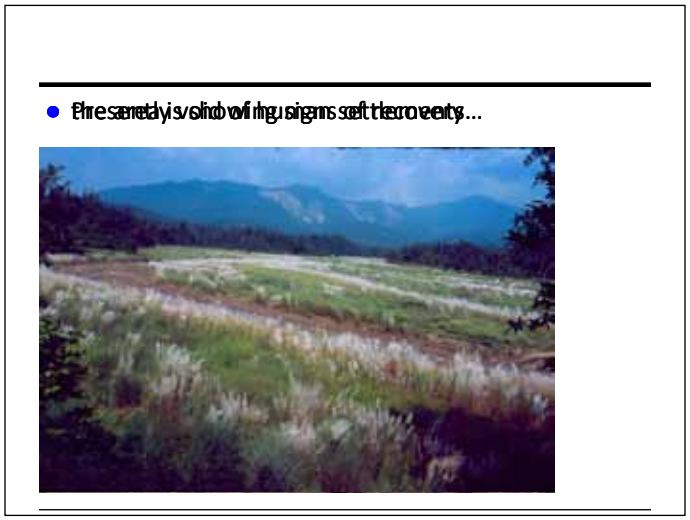

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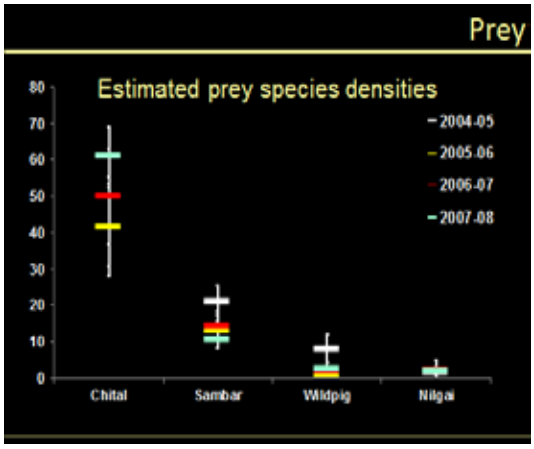

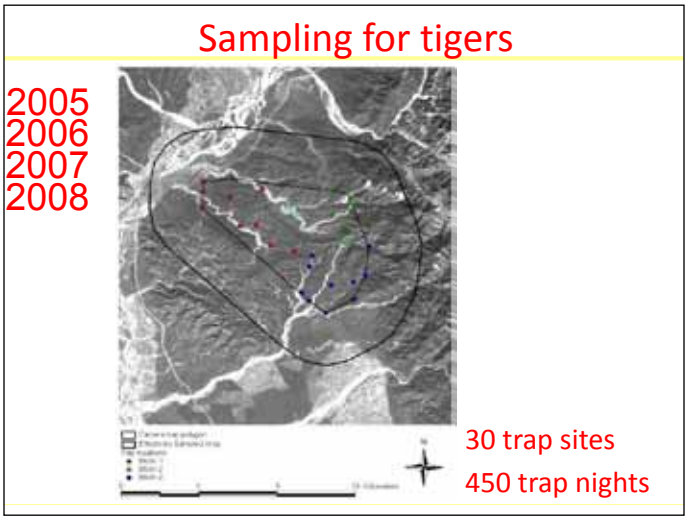

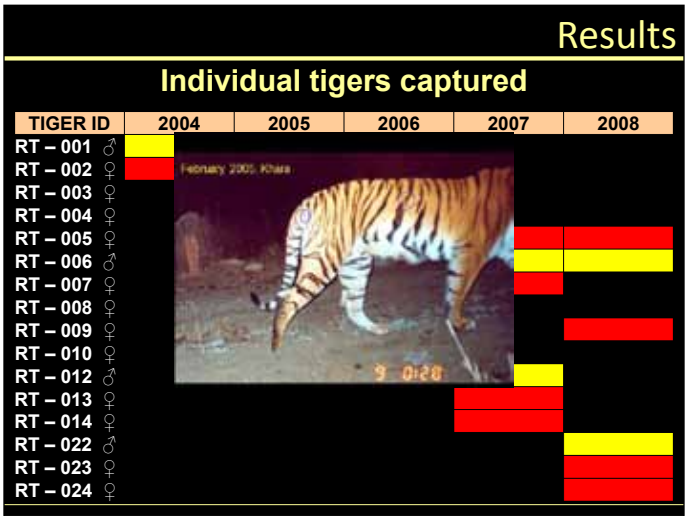

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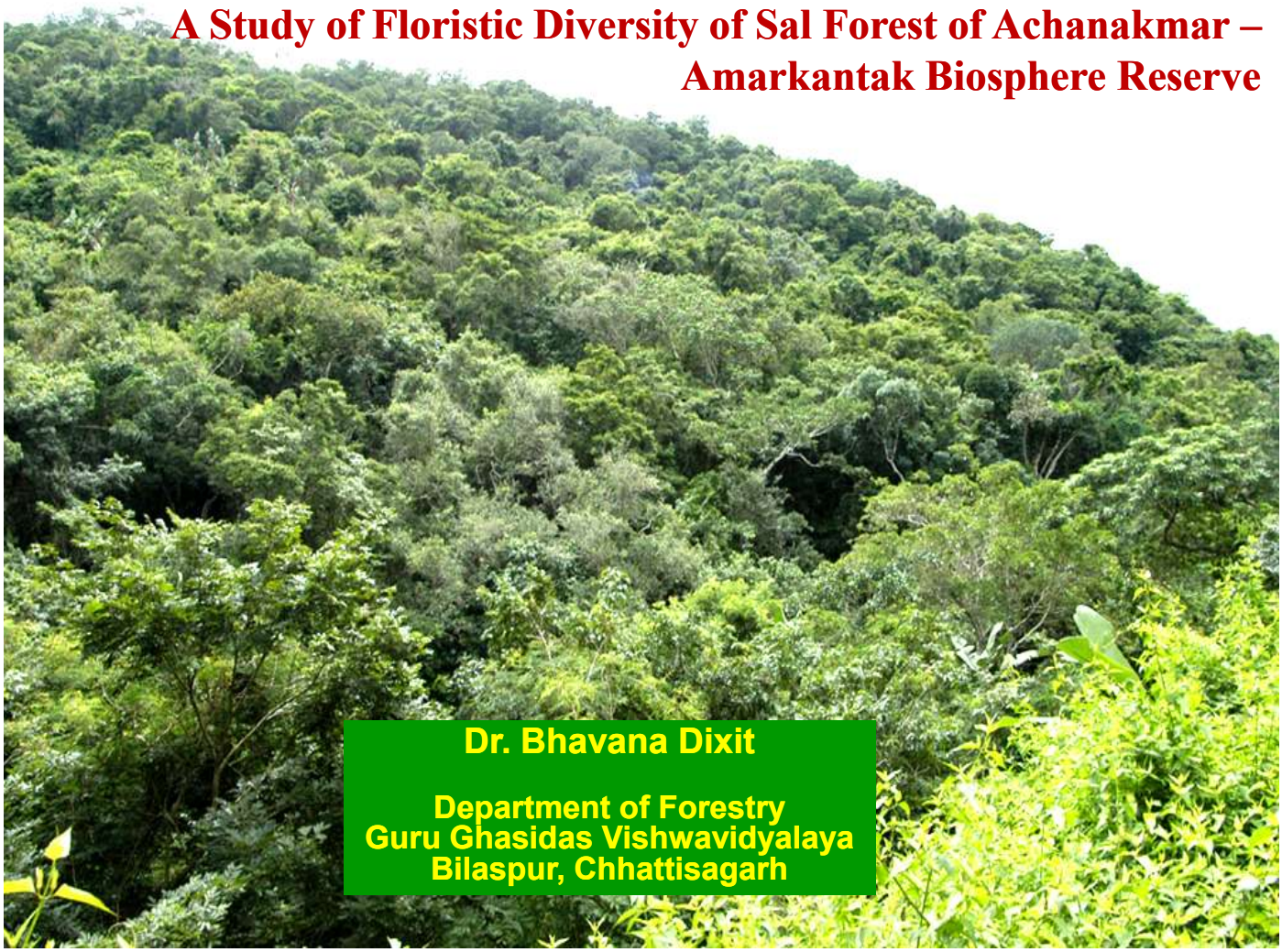
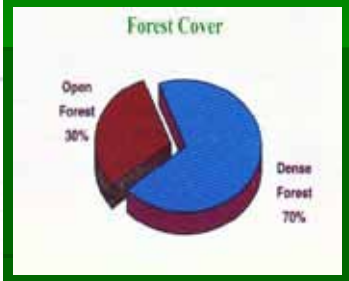
A Study of Floristic Diversity of Sal Forest of Achanakmar – Amarkantak Biosphere Reserve



Dr. Bhavana Dixit

Department of Forestry
Guru Ghasidas Vishwavidyalaya
Bilaspur, Chhattisagarh

Chhattisgarh.....



➢The state of Chhattisgarh being placed in Deccan bio-geographical area , houses an important part of that rich and unique biological diversity . What is amore conspicuous is that the state is significantly rich in endemism with respect to many plants having medicinal importance. The forests of the state fall under two major forest types, i.e., Tropical Moist Deciduous forest and the Tropical Dry Deciduous forest. The state of Chhattisgarh is endowed with about 22 varied forest sub-types existing in the state.

➢The forest cover of state is placed at 55,870 Sq.Km. according to forest survey of India assessment (2007) the extent of very dense forest is 4,162 Sq.Km., dense forest : 35,036 Sq.Km. and open forest is 16,670 Sq.Km. The legal forest area (as per the legal definition) of the state is 59,772 Sq. Km. This accounts for 44.2 % of geographical area of the state.

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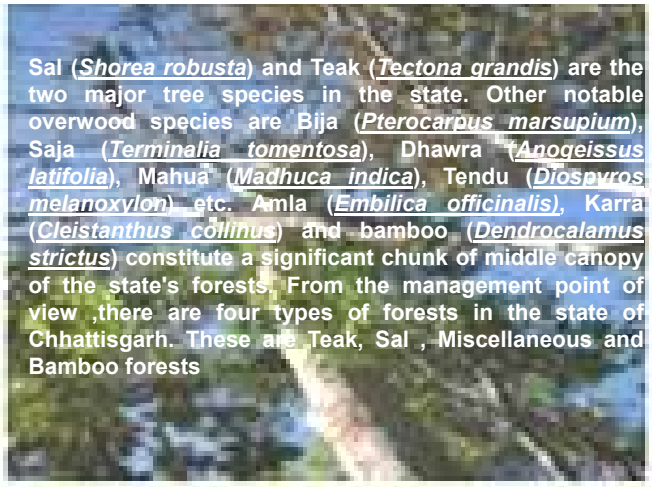


Sal (*Shorea robusta*) and Teak (*Tectona grandis*) are the two major tree species in the state. Other notable overwood species are Bija (*Pterocarpus marsupium*), Saja (*Terminalia tomentosa*), Dhawra (*Anogeissus latifolia*), Mahua (*Madhuca indica*), Tendu (*Diospyros melanoxylon*) etc. Amla (*Embilica officinalis*), Karra (*Cleistanthus collinus*) and bamboo (*Dendrocalamus strictus*) constitute a significant chunk of middle canopy of the state's forests. From the management point of view ,there are four types of forests in the state of Chhattisgarh. These are Teak, Sal , Miscellaneous and Bamboo forests

Achanakmar- Amarkantak Biosphere Reserve

•Latitude : 22°15' to 23° 58' N

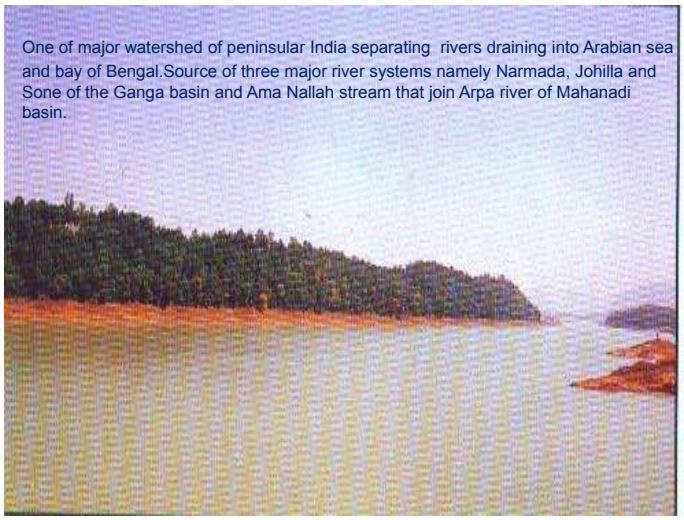
•Longitude : 81 ° 25'N to 82° 3' E.

•Area : 3835.51 km2

Overview
Achanakmar- Amarkantak Biosphere Reserve

- Varied topography
- Typical monsoon climate
- Lateritic, alluvial and black cotton soil
- Mean monthly minimum temperature within the annual cycle ranges from 10.9° to 25.6° C and mean monthly maximum temperature from 24.1 to 42° C.
- The annual rainfall average 1322mm. (mean monthly range is 6.63 mm to 359.88 mm) of which about 85% occurs during the period mid June to September.

One of major watershed of peninsular India separating rivers draining into Arabian sea and bay of Bengal.Source of three major river systems namely Narmada, Johilla and Sone of the Ganga basin and Ama Nallah stream that join Arpa river of Mahanadi basin.



Represents Tropical Deciduous Vegetation

- Northern Tropical Moist Deciduous
- Southern Dry Mixed Deciduous forests

(Champion & Seth, 1968).

METHODOLOGY

• **Forest sites-**
a. Pure Sal forest
b.Degraded forest

Experimental plots-
Size-100*100m
No.-03
No.of Quadrates-10
Size of quadrates-
Upperstory vegetation-10*10m
Understory vegetation-2*2m

•**ALPHA:DIVERSITY WITHIN A SITE•**
*Shanon –Wiener Index
*Concentration of dominance
*Equatibility
*Species Richness

• **BETA DIVERSITY-OVER A LARGE AREA**

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Results

Total 66 **species belonging** 26 **families recorded**

- **Top Canopy pure sal forests dominated by *Shorea robusta, Pterocarpus marsupium,Terminalia tomentosa, Woodfordia fruiticosa and Diospyros melanoxylon***
- **The second layer was dominated by the *Miliusa tomentosa* and in the third layer the saplings of *Diospyros melanoxylon* and *Shorea robusta* were predominant .**

Total basal cover

- **Trees** 36.36 m^2ha^{-1}
- **Understory** 1.85 m^2ha^{-}

Total Density

- **Trees** 1203 m^2ha^{-1}
- **Understory**1572 $m^2ha^{-1}y$

Results

- Woody species density- GBH distribution followed non linear inverse relationships. The forest thus, exhibited a small structure with 44-47% individuals having < 10 cm GBH and 16-27% individuals having <50 cm GBH
- species diversity
- Shannon-Wiener index, 2.82, 2.92
- Equitability 0.99, 1.01
- Species richness, 4.76, 2.32
- Concentration of Dominance 0.21, 0.22
- Beta diversity and 5.78,8.82

Community structure of the tropical moist deciduous forest (tree layer)

Species	Density (stems ha^{-1})	Basal cover (m^2 ha^{-1})	IVI
Adina cordifolica Benth & Hok. F. Rubiaceae	3.0	0.03	0.91
Anogeissus latifolia Wall.ex Bedd, Combretaceae	27.0	1.10	10.45
Bauhinia vahlii Wight & Arn. Caesalpiniaceae	3.0	0.02	0.88
Bauhinia malabarica Roxb. Caesalpiniaceae	7.0	0.07	2.12
Burseraceae	-	-	-
Buchanania lanan Spreng, Anacardiaceae	80.0	1.32	17.97
Bridelia squamosa Gehrm, Euphorbiaceae	7.0	0.12	2.26
Careya arborea Roxb. Lecythidaceae	7.0	0.62	2.86
Cassia fistula Linn. Caesalpiniaceae	3.00	0.02	0.88
Cordial dichotoma Forst. F. Boraginaceae	3.00	0.06	0.99
Dalbergia paniculata Roxb. Fabaceae	-	-	-
Diospyros melanoxylon Roxb. Ebenaceae	117	2.0	24.84
Dendrocalamus strictus Nees Poaceae	17.0	0.32	4.79
Embellia robusta C.B. Clarke non Roxb. Myrsinaceae	143.0	1.59	21.43
Eugenia cumini Druce, Myrtaceae	17.0	0.80	6.10
Emblica officinalis Gaertn, Euphorbiaceae	27.0	0.19	5.26
Ficus religiosa Linn. Moraceae	3.00	0.06	0.99
Grewia tiliacfolia Vahl., Tiliaceae	20.0	0.36	4.57
Kydia calycina Roxb.	3.00	0.01	0.87
Madhuca indica J.F.Gmel. Sapotaceae	-	-	-
Miliusa tomentosa (Roxb.) J. Sinclair, Annonaceae	107.0	0.73	20.52
Mitragyna parvifolia (Roxb.) Korth, Rubiaceae	3.00	0.14	1.21
Ougeinia oojeinensis (Roxb.) HHHochr. Fabaceae	23.0	0.44	5.61
Pterocarpus marsupium Roxb. Fabaceae	40.0	3.31	18.78
Radermachera xylocarpa Roxb. K. Schum Bignoniaceae	10.0	0.50	4.12
Semecarpus anacardium Linn. F. Anacardiaceae	3.0	0.04	0.94
Shorea robusta Gaertn f. Dipterocarpacear	350	14.24	84.97
Terminalia tomentosa Wt & Agn. Combretaceae	140	4.98	37.43
Tectona grandis Linn. F. Verbenaceae	-	-	-
Terminalia chebula Retz. Combretaceae	3	0.31	1.69
Woodfordia fruticosa Lythraceae	10.0	1.73	6.17
Zizyphus xylopyra Willd, Rhamnaceae	7.0	0.26	2.64
Total	1203	36.36	

Species structure of the tropical moist deciduous forest (understorey layer)

Species	Density (stems ha^{-1})	Basal cover (m^2 ha^{-1})	IVI
Aegle marmelos Correa ex. Roxb. Rutaceae	-	-	-
Anogeissus latifolia	7.0	0.001	1.15
Adina cordifolia	17.0	0.007	2.99
Bauhinia vahlaii	33.0	0.004	6.67
Buchananania lanzan	20.0	0.02	3.88
Boswellia serrata Roxb. Burseracae	-	-	-
Cassia fistula	17.0	0.004	3.48
Dillenia aurea Sm. Dilleniaceae	3.0	0.0002	0.86
Diospyros melanoxylon	187.0	0.39	45.39
Embella robusta	397.0	0.24	46.93
Emblica officinalis	23.0	0.05	8.52
Eugenia cumini	157.0	0.08	20.85
Gardenia turgida Roxb. Rubiaceae	3.0	0.0003	0.86
Garuga pinnata	-	-	-
Grewia tilifolia	40.0	0.05	8.07
Grewia hirsute vah. Tiliaceae	17.0	0.0004	2.63
Helicteres isora Linn. Sterculiaceae	13.0	0.0003	1.50
Heretic laevis Roxb. Boraginaceae	23.0	0.01	4.83
Indigofera pulchella Roxb. Fabaceae	10.0	0.003	1.45
Lagerstoemia parviflora	10.0	0.01	3.36
Madhuca indica	1.0	0.0004	2.19
Maliusa tomentosa	230.0	0.33	47.72
Picrocarpus marsupium	7.0	0.02	3.06
Radermachera xylocarpa	7.0	0.02	3.06
Randia uliginosa Dc. Ribiaceae	7.0	0.00007	1.10
Schleichera oleosa (Lour.) Oken. Sapindaceae	27.0	0.008	5.90
Semecarpus anacardium	30.0	0.007	1.22
Shorea robusta	247.0	0.16	38.09
Smilex macrophylla Roxb. Liliaceae	7.0	0.0007	2.02
Terminalia tomentosa	10.0	0.03	3.79
Terminalia chebula	7.0		1.48
Tectona grandis	-	-	-
Ventillago calyculata Tul. Rhamnaceae	30.0	0.39	25.82
Wendlandia exserta Dc. Rubiaceae	-	-	-
Ziziphus xylopyra	30.0	0.007	1.22
Ziziphus ocnoplia Mill. Rhamnaceae	-	-	-
Total	1572	1.85	

Note : All data are average of three plots

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. Diversity parameters of sal dominated and degraded moist deciduous forest

Parameters		Sal Forest
Species richness (d)	a) b)	4.76 2.32
Shannon – Wiener index	a) b)	2.82 2.92
Concentration of dominance (Cd)	a) b)	0.21 0.22
Equitability (e)	a) b)	0.99 1.01
Number of species per 0.1 ha	a) b)	30 30
Beta diversity (Bd)	a) b)	5.78 8.82

CONCLUSION

Sal dominated forests are highly diverse than miscellaneous degraded moist deciduous forests in all aspect.

Indications - climatic conditions of Chhattisgarh region favors highly diverse forests of Sal and would continue to be favorable for Sal and its associates in the climax formation over a long successional process in future.

Therefore, the management plan for this forest should focus on Sal and its associates in order to safeguard the overall diversity in the region.

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Protected Areas Management in Odisha-An Institutional Approach

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Introduction

- IUCN defines Protected Areas (PAs) as, "an area of land and/or sea especially dedicated to the protection and maintenance of biological diversity… managed through legal or other effective means…" .
- 17.1 million square km of the earth's surface (11.5 percent of the land surface) and 1.7 million sq km of marine ecosystem.
- Six category of PAs: Strict Nature Reserve/Wilderness Area, National Parks, Natural Monument, Habitat/Species Management Area, Protected Landscape/ Seascape, and Managed Resource Protected Areas.
- The first four categories are strict PAs and only the last two categories show the linkage with human society.

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- In the earlier period, Command and Control (C&C) measures were adopted governments to maintain ecological viability of the PAs.
- Displacement of people, prohibiting communities over the access to resources, and denied indigenous communities to enjoy their traditional rights and responsibilities.
- This management regime does not recognize any types of societal linkage towards ecosystem conservation.
- The opportunity cost of protection were increased which exacerbate and perpetuate poverty:
  - Villages living near Bhadra TR are losing 12 percent of livestock per year.
  - Sariska TR experienced 27 percent of harvest loss due to wild population.
  - Kibber Wildlife Sanctuary suffered 18 percent of livestock loss costing $128 USD to each family.
  - Within two years, Kyona WLS experienced Rs. 2.13 lakh worth of livestock loss.

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- within five years, 242 causalities were done by elephants in Bihar.
- Each year Sunderbans experiences 36-100 causalities by tigers.
- Within five years, 67 percent causalities done by sloth bear in MP.
- 193 attacks by Gir lion during 1973-91 in Gujarat.

- It is not the keeping away of the communities but to accept their interdependency which can make the management objectives successful.
- Various country specific approaches are developed to achieve ecological sustainability by incorporating poverty into the decision making process.
- This change in perspective is leveled as paradigm shift.

- Objectives of this study:
- To understand emergence of the poverty centered approaches to management.
- To discuss the initiatives taken by government of India towards this approaches.
- To explore livelihoods and ecological impact of these approaches.
- Growing misery and poverty forced those people to act against the protection of ecosystem.
- As a result many PAs were experienced several threats which gone against the sustainable ecosystem management principles.

Protected Areas Management: Paradigm Shift

- Establishment of PAs does not necessarily guarantee protection of biodiversity.
- Effectiveness requires adopting appropriate management objectives and governance systems.
- There is a symbiotic relationship between the PAs & poverty and understanding the linkage is a practical and ethical necessity.
- Biodiversity conservation and sustainable use of resources need to be reconciled with livelihood opportunities and the empowerment of poor.
- Two important issues emerge by a paradigm shift: equity and property rights.

- Property Rights issue started with the UN Declaration of Human Rights in 1948.
- Ethical principles and values set rights to achieve a minimum standard of life as human rights.
- Governments strive for in providing for their citizens-basic life requirements that all humans are entitled to.
- The ILO Convention (1989): indigenous people should participate in the management and conservation of renewable and non-renewable natural resource.
- Third World Parks Congress (The Bali Action Plan,1982) : people can contribute towards successful PAs Management if rights are given to share resources.

- Fourth World Park Congress (Caracas Declaration): PAs must be carried out in a manner sensitive to the local needs and encouraged communities to participate actively in the management process.
- CBD (UNCED, 1992): conservation and sustainable use of biological diversity, fair and equitable sharing of the benefits.
- The Fifth World Park Congress (2003), South Africa has given various recommendations on poverty and PAs.
- The Millennium Development Goals also widely accepted the interdependence of human welfare and conservation of natural resources.
- Ramsar Convention: recognises long standing rights, ancestral values, and traditional knowledge of indigenous people and institutions associated with their use of wetlands.

- IUCN recommendation: communities should develop local strategies with environment priorities and get enough scope to convert these strategies into action.
- WCC Resolution (1.53): recognise indigenous rights to establish co-management agreements and secure equitable benefit sharing.
- CBD: respecting, preserving and maintaining knowledge, innovations and practices of indigenous local communities with respect to the conservation and sustainable use of biological diversity
- Not only rights, communities should have to endow with responsibilities:
- IUCN Resolution 1.44 (Montreal, 1996): the needs of conservation may well require some limits on public access to land.

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- IUCN and WWF Policy Statement: Some resources should keep untouched for the purpose of maintenance of viability of the ecosystem.
- Sometime on the feasibility and ethical ground it is very difficult to fulfill every demand or claim of every person in the society.
- For effective conservation there is a need for a balance in trade-off between the rights and duties.
- Change in perspective towards recognition of the fundamental linkage between natural resources, people and culture has leveled a "paradigm shift"
- History of protected areas management policy in India also experienced this paradigm shift.

Table 1: Paradigm Shift in Protected Areas Management

The conventional Approach	New Approach
Established as separate units	Planned as part of regional, national, and international systems
Managed as "islands"	PAs connected by corridors, stepping stones, and biodiversity-friendly and land uses
Managed reactively, within a short timescale, with little to lessons from experience	Managed adaptively, on a long time perspective, taking advantage of on-going learning
About protection of existing natural and landscape assets-not about the restoration of lost values	About protected but also restoration and rehabilitation, so that lost or eroded values can be recovered
Set up and run for conservation (not for productive use) and scenic protection (not ecosystem functioning)	Setup and run for conservation but also scientific, socio-economic (including the maintenance of ecosystem services) and cultural objectives
Established in a technocratic way	Established as a political act, requiring sensitivity consultations and astute judgement
Managed by natural scientist and natural resource experts	Managed by multi-skilled individuals, including some with social skills
Established and managed as a means to control the activities of local people, without regard to their needs and without their involvement	Managed by multi-skilled individuals, including some with social skills
Established and managed as a means to control the activities of local people, without regard to their needs and without their involvement	Established and run with, for, and in some cases by local people; sensitive to the concerns of local communities
Run by central government	Run by many partners, including different tiers of government, local communities, indigenous groups, the private sector, NGOs and others
Paid for by taxpayers	Paid for from many sources and, as possible, self sustaining
Benefits of conservation assumed as self-evident	Benefits of conservation evaluated and quantified
Benefiting primarily visitors and tourists	Benefiting primarily the local communities who assume the opportunity costs of conservation
Viewed as an asset for which national considerations prevail over the local ones	Viewed as a community heritage as well as a national asset

Sources: Borrini-Feyerabend et al. (2004)

Protected Areas Management Regimes in Odisha

- PAN comprises of one NP, eighteen WLSs, and one proposed NP which covers about 4.2 percent of the GA and 11.2 percent of the TFA of the state.
- More than three lakh people are residing inside the PAs of Odisha and earn a subsistence level of livelihoods etc.
- Government of Odisha adopted the Wildlife (Protection) Act (WLPA), 1972 on August 1974.
- There is no such provision undertaken for inclusion of indigenous people in the management process.
- There is strict prohibition for collection and processing of forest produces that will create any harm to existing wildlife.
- Provisions are made regarding compensation of live or livestock loss or crop loss by wildlife.

- Persons have certain responsibilities for conservation of the forest ecosystem and protection of wildlife.
- Eco-Development Programme as a strategy for sustainable conservation of biodiversity in the PAs adopted in Odisha during 2006.
- It was started as a pilot project in Satkosia Tiger Reserve and then extended to Bhitarkanika, Kotagarh, Kuldiha and Lakhri Valley WLS.
- Opportunities are provided to local communities and NGOs to contribute in the conservation process by participating various stages of the programme.
- According to the micro planning, eco-development in the buffer areas to maintain integrity of the core area.

- The principal tools used under this system include social mapping, visioning, forest dependency, wellness ranking, and household interview.
- A range of eco-development activities specific to a particular area are then identified and funds are allocated for over all development.
- Rewards to these activities, local communities have to assure to provide certain responsibilities towards conservation forest ecosystem.
- Forest Rights Act, 2006 recognises and vests rights over the forest land of the schedule tribe and other forest dwellers.
- Various provisions are made to secure both individual and community tenure rights over the forest land.

- Clear provisions are undertaken active participation of people with adequate gender equality in the decision making process.
- Critical wildlife habitats: people living in these area are empowered to protect the forest ecosystem.
- However the effectiveness of management process is still a question mark due to the persistent of poverty among the forest communities and concerned ecosystem degradation.
- It needs to analyse effectiveness of the management regimes to understand loopholes in the management process to ensure livelihood and ecosystem conservation.

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Livelihood and Ecological Impacts

State Regulation

- Livelihood loss in Satakosiya Wildlife Sanctuary:
  - Before protection: household income Rs 5000 which come from various sources like bamboo trading, collection of NTFP, wage labour and agriculture.
  - After restriction: household income Rs 2250 and derive from various sources like daily wage, illegal trading of NTFP, and agriculture.
- Government also not recognised community rights over lands under shifting cultivation (5000-37000 sq km).
- About 25000 of fisherman voiced against a ban on fishing in the Gahirmatha Wildlife Sanctuary.

- It also created opportunity cost in terms of closing of ice-producing and boat-making industries.
- This period experienced death of several wild animals mainly due to poaching.
- Inadequate relocation process in Bhitarkanika, Chandaka and Similipal WLS:
  - out of 483 in Chandaka Wildlife Sanctuary, only 85 households were resettled within a period of 10 years.
  - Inadequate compensation payments due to paucity of funds
- Communities have helped to the government departments in mangrove regeneration near Bhitarkanika WLS

- PAs were also faced several threats due to :
  - encouragement of economic activities like ports (e.g. Bhitarkanika),
  - industrialisation (e.g. Bhitarkanika WLS),
  - mining (e.g. Karlapet WLS);
  - illegal settlements by Bangladeshi immigrants (e.g. Bhitarkanika and Debrigarh WLS);
  - commercialisation of forest resource (Balukhand-Konark WLS);
  - pest and weed (e.g. Similipal and Chandaka WLS);
  - forest fire (e.g. Bhitarkanika WLS).

Eco-Development Programme

- Odisha government invested a lump sum amount of Rs. 12 crore in each Bhitarkanika and Satakoshia sanctuary and 10 crore in Similipal for eco-tourism.
- The Sandhan Foundation in conjunction with the UNEP-GPA, NC-IUCNTRP, MAP-USA and Government of Odisha had initiated a project for Coastal Community Centre (CCRC) in Bhitarkanika WLS.
- About 20000 tribals of Satkosia WLS are benefited by NREGS.
- A study by Anthropological Survey of India, some villages inside the Similipal WLS are still remains undisturbed.

- Residences of Bhitarkanika WLS were donated about 500 hectares of their ancestral lands to the Forest Department for mangrove regeneration.
- People in Badrama WLS have lodged a complaint in Odisha High Court regarding growing forest cutting by timber mafias and inefficiency of the forest department to control them.
- There were continuation of poaching, illegal fishing activities and forest fires in most of the WLS.

Forest Rights Act, 2006

- Villagers of Karlapat WLS are protecting forest ecosystem after claiming their rights under the FRA, 2006.
- Women have seized three truck loads of timber from the official residence of the Range Officer in charge of the sanctuary.
- Some villages that in some time were encroached villages are now successfully protecting the area from forest fire.
- One community complained to MoEF against the DFO who was denied to lift river sand for the construction of a school.

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- However, communities in most of the PAs are deprived of enjoying various rights under FRA.
- Members of the committee appointed by the MoEF and MoTA to look into the implementation of the FRA in Similipal WLS in July, 2010.
- According to this report, the WLS shows poor performance towards implementation of FRA.

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Conclusion

- India also experienced a paradigm shift in the area of PAs management.
- Persistence of poverty put hurdles on the way of effective management.
- But it should not mean that these programmes are failed totally to tackle the problem.
- It is not the enactment of new programmes but their effective implementation that can make management policy successful.
- Convergence of various policy programmes to reduce transaction costs.

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- Creation of awareness among the communities.
- Coordination between government officials with local people.
- Creation of alternative livelihoods activities.
- Emphasis to ecological balance during livelihoods enhancement activities.

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TREE SPECIES COMPOSITION OF NATURAL FOREST AND PAN JHUM ECOSYSTEM IN BADSAHITILA RESERVE FOREST, KARIMGANJ DISTRICT, ASSAM

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INTRODUCTION

- North East India, a mega-biodiversity centre and a hotspot, comprises eight states including Assam. It can be physiographically categorized into the Eastern Himalayas, Northeast hills and the Brahmaputra and Barak Valley plains.
- The region is the abode of approximately 225 tribes in India, out of 450 in the country, the culture and customs of which have an important role in understanding biodiversity conservation and management issues (Chatterjee *et al*., 2006).
- Assam is one of the richest biodiversity centre in N.E. Region of India. The richness in overall biodiversity of Assam seems more because of its bio-geographical location.
- Betel leaf (*Piper betel* L.), a kind of pepper used in wrapping the pellets of betel nut and lime, which are commonly chewed in the Orient, popularly known as *Paan* in India (Guha, 2006) considered to be one of the ingredients for social entertainment.
- There is a tradition of betel leaf cultivation on host trees in some areas of the country. Forest dwellers especially tribes are practicing Pan Cultivation call as "Pan Jhum" in different forest areas (Jaintia and Rongmai Naga Tribes in Barak Valley, Nath *et al*., 2011). They maintain the Jhum area by clearing the ground floor, cutting the side brunches, small trees and shrubs.
- The present study focus on tree species composition, population status and community attributes of natural forest and Pan Jhum ecosystem of Badsahitila reserve forests in Karimganj district of Assam.

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STUDY SITES

Fig 1: Forest cover map of Assam

Fig.2. Location of the study sites in Karimganj District

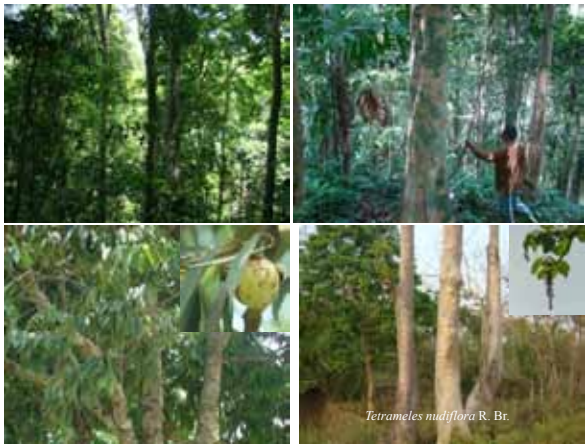
Badsahitila RF

13.78 % of total RF

Natural forest
Site I: 92° 22' 19.4″ E, 24° 19' 59.1″ N
Site II: 92°23' 04.1″E, 24° 18'01.8″ N

Pan Jhum ecosystem
Site I: 92° 20' 59.7″ E, 24° 21' 10.7″ N
Site II: 92° 21' 16.9″ E, 24°21'49.9″ N

Natural Forests



Pan-Jhum Ecosystems

Methodology

- Vegetation sampling was done during November, 2008 by delimiting four belt-transects of size (500m×10m) two each in Natural forests and Pan Jhum ecosystems respectively.
- Each transect was sub-divided into 50 quadrats of size (10m×10m) and all the trees above 10 cm gbh was recorded and identified.
- Phytosociological analysis of tree vegetation for Frequency, Density, and Basal cover were done following Muller-Dombois & Ellenberg (1974). The importance value index (IVI) is the sum of relative density, relative frequency and relative dominance. Dominance and diversity were determined by computing the diversity index (Shannon & Wiener, 1963) and concentration of dominance index (Simpson, 1949).

RESULTS AND DISCUSSIONS

Table -1: Consolidated details of families, genera, species, diversity indices, density and basal area of woody species (≥10 cm gbh) in two ecosystems of Karimganj district, Assam

Parameters	Natural forest	Pan Jhum
Number of species	78	77
Number of genera	58	56
Number of family	39	38
Density (stems/ha)	672	566
Basal area (m2/ha)	39.65	41.01
Shannon Diversity Index (H′)	1.49	1.61
Concentration of dominance (Cd.)	0.05	0.02
Sorensen's similarity index	0.696	

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Density and Basal Area

- In natural forest the mean stand density was recorded 672 tree ha^{-1} whereas in Pan Jhum ecosystem it was recorded 566 tree ha^{-1}. It may be due to the human interference in pan Jhum ecosystem.
- Pan Jhum ecosystem was slightly more voluminous (41.01 m2 ha-1) than natural forest (39.65 m^2 ha-1) though density was less, indicating to the existence of more big girth trees in Pan Jhum ecosystem

Species-area curve

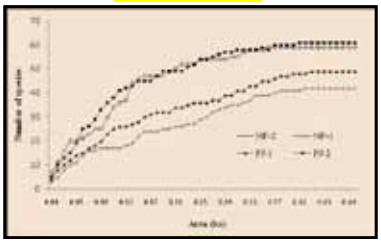
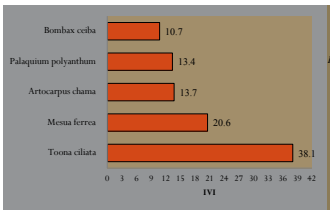


Table-2. Family richness in two forest system

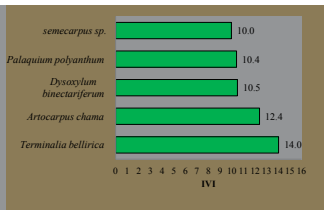
Family	Number of species	
	Natural forest	Pan Jhum
Euphorbiaceae	9	8
Moraceae	5	8
Verbenaceae	5	6
Meliaceae	4	5

- Species-area curve reached asymptote in all four sites suggesting the adequate site sampling in all sites.
- Euphorbiaceae was the dominant family both in natural forest (9 species) and Pan Jhum ecosystem (8 species).

IVI of top 5 species on Natural forest

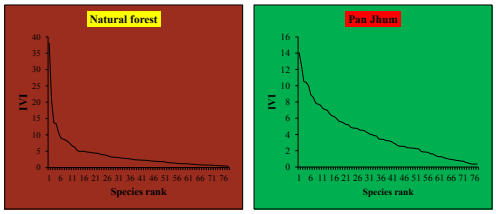


IVI of top 5 species on Pan Jhum Ecosystem



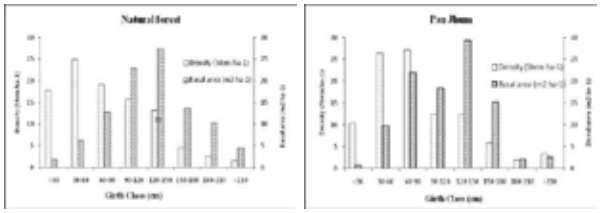
In natural forest *Toona ciliata* was the most dominant species with IVI value 38.1 followed by *Mesua ferrea* (20.6), *Artocarpus chama* (13.7) while in Pan Jhum *Terminalia bellirica* (14.0), *Artocarpus chama* (12.4), *Dysoxylum binectariferum* (10.5) were the dominant species.

Dominance diversity curve



- Dominance diversity curve showed that only few species (*Toona ciliata, Mesua ferrea, Artocarpus chama, Palaquium polyanthum*) share the maximum resource in natural forests whereas in Pan Jhum, almost all species share the major portion of resource more or less equally.

Population structure of Natural and Pan Jhum Ecosystem



- The density girth class distribution showed the dominance of lower-middle girth classes individuals depicting a inverted "J" shaped curve in natural forest while in Pan jhum ecosystem more individuals are coming in 60-90 girth classes and showed more or less reverse "J" shaped curve.
- In case of basal area maximum dominance occurred in 120-150 cm girth class in both Natural and Pan Jhum ecosystem).

Conclusion

- There is not so much difference in species richness and other community characters in Natural forest and Pan Jhum Ecosystem.
- Pan Jhum ecosystem plays a great role in conservation of tree species especially big girth trees and also provide financial support.

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Man animal interface

Thinking and Getting out of the conflict box

Vivek Menon*

*Executive Director,
Wildlife Trust of India*

International forestry congress
New Delhi
24 November 2011

Man animal interface- sharing a common boundary

- Sharing habitats

- Sharing habitats
- **Partners in Livelihood**

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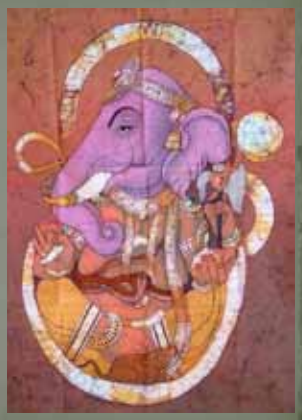
- Sharing habitats
- Partners in livelihood

- **Sharing cultures and beliefs**



- Sharing habitats
- Partners in Livelihoods
- Sharing Cultures and beliefs

- **Sharing resources**

- Sharing habitats
- Partners in Livelihood
- Sharing cultures and beliefs
- Sharing resources

- **Entertainment and recreation**

- Sharing habitats
- Partners in Livelihood
- Sharing cultures and beliefs
- Sharing resources
- Entertainment and recreation

- **Predator- Prey; sustenance**

- Sharing habitats
- Partners in Livelihood
- Sharing cultures and beliefs
- Sharing resources
- Entertainment and recreation
- Predator- Prey; sustenance

- **Commercial exploitation**

- Sharing habitats
- Partners in Livelihood
- Sharing cultures and beliefs
- Sharing resources
- Predator- Prey; sustenance
- Commercial exploitation

- **Accidents**

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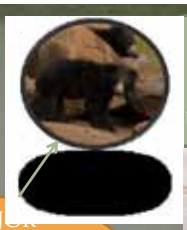
- Sharing habitats
- Partners in Livelihoods
- Sharing Cultures
- Sharing resources
- Entertainment and recreation
- Predator- Prey; sustenance
- Commercial exploitation
- Accidents

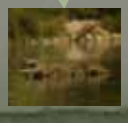
- **Retaliatory killings**


Of these, the negative interfaces or conflict exists from time immemorial

'Not the wounds, I seen, that my body suffers from my tight bonds,
Nor the blows of my master's hook,
Nor the shame of bearing him on my shoulders and enduring his strokes,
Nor the loss of my home, bring such sorrow to my heart ..(10th to 12th century AD. Ascribed to Pampaka by Cridharadasa, iv. 214.)

There is nothing to be lamented if a tiger eats a weaker animal, including a man, because that is the law of the Supreme Lord.
Srimad Bhagavatam Canto I Chapter 13 Verse 47

Large carnivores (Tiger, Leopard, Wolf)

Large Omnivores (Sloth Bear, Black bear, Brown Bear)

Mega Herbivores (Elephant, Wild buffalo & Rhinos)

MAJOR CONFLICTS WITH MAN FROM INDIAN FORESTS

Primates (Common langur, Rhesus Macaque)

Herbivores (Nilgai, Chital, Sambar, wild boar)

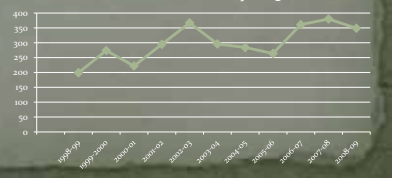
Reptiles (Crocodile and Snakes)

Impact on Humans

- Damage to properties including crop
- Livestock loss
- Loss of Human life or Injuries leading to disability

- Impact on Livelihood
- Impact on lives

Human death caused by elephants

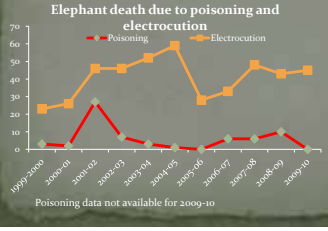


Impact on wildlife

- Retaliatory killing of wildlife
- Habitat destruction
- Apathy towards wildlife conservation

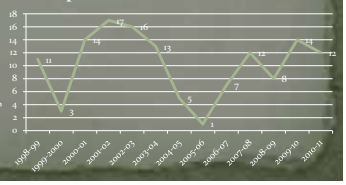
- Population decline
- Extinction of some of the species

Elephant death due to poisoning and electrocution



Poisoning data not available for 2009-10

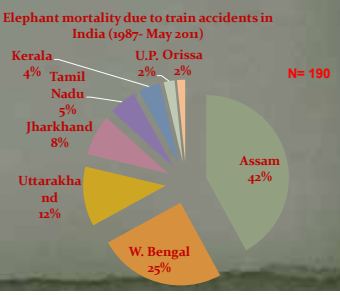
Elephant death due to train accident



Case study 1: Giant collisions

- In India more than 190 elephants have been killed by trains between 1987 and May 2011.
- Assam (42%), West Bengal (25%) and Uttarakhand (12%) have the highest recorded mortality.

Elephant mortality due to train accidents in India (1987- May 2011)



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Why does the elephant cross the track?

A. Anthropogenic factors

1. Railway track passing through elephant habitats & corridors
2. Garbage on the track

B. Ecological attractants:

1. Water; 2. Forests and grasslands; 3. Crops

Why does it get hit?

D. Physical features

1. Turnings: Decreases the visibility
2. Cuttings/ Embankments: Entrapment

E. Speed and Frequency of trains

Success: Zero elephant mortality in Rajaji NP from 2000-2011 (eleven years

Long-term solutions:

- Realignment of railway track
- Leveling of critical cuttings
- Fencing of railway track using old rails

Short-term solutions:

- Improvement in stakeholder coordination
- Installation of signage in accident prone area
- Improvement in water sources
- Improvement of visibility on curve (clearing bushes)
- Joint night patrolling by Forest, Railway and WTI
- Addressing the garbage problem
- Awareness for railway staff & passengers

Case Study 2: Killer Cats and Cat Killers

- Large number of humans deaths by large carnivores in Uttar Pradesh.
- Livestock killing in the state is also high.
- In retaliation several tigers and leopards killed.

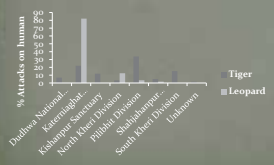
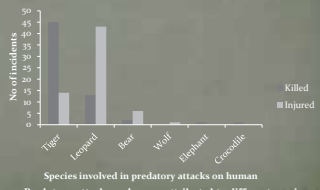


Fig. Area wise breakup of human attack incidents



Species involved in predatory attacks on human

Predatory attacks on human attributed to different species

Why does the tiger go to Lucknow?

- Habitat degradation and fragmentation
- Depletion of prey species
- Changes in traditional patterns of agriculture and expansion of agricultural activities and settlement to the forest boundary
- Increased anthropogenic pressures in forest
- Natural dispersal

Complete conservation, a holistic model

- Veterinary, biological and Social intervention by WTI in partnership with UPFD and NTCA
- Formation of Rapid Response Teams (RRTs) and Primary Reaction Teams (PRTs) to rescue, rehabilitate in wildlife emergencies.
- Capacity building of forest staff for conflict mitigation, emergency rescue and monitoring tigers.
- Involving local communities in conservation and conflict management.

Success: A holistic solution emerges

- Successfully handled eight conflict cases of tigers. Captured two conflict tigers that ended in captivity, one tiger killed
- Successfully captured three adult conflict leopards and released two; 3rd to be decided
- Intervention in ten leopard cases, three elephants cases, two bear cases, one case each of wolf and hyena providing safe passage to animal without any loss of human and animal life.

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Thinking out of the box Conceptual:

1. Conflict cannot be resolved forever, it needs constant work
2. Land is one of the only long term solutions to conflict
3. Conflict Prevention more important than Conflict Mitigation
4. Compensation is the wrong term for relief

Thinking out of the box Conceptual:

1. Speed of relief is more important than quantum of relief
2. Artificial local overabundance of wildlife has to be avoided
3. Welfare of individuals (animals and people) is paramount
4. Capture may increase conflict in case of social animals
5. Raising the bar of tolerance or keeping it at where it is particularly relevant to India

Out think conflict Projects:

Instant Relief: Grain for grain scheme

➢As a relief for crop depredation by elephants, instead of ex-gratia support in cash, the relief could be provided in form of grains lost

➢ Success: In Pakke Wildlife Sanctuary WTI in collaboration worth APFD has been implementing this scheme since 2005. No loss of elephant or human life in this period.

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Chemical control of adults of *Leptocybe invasa* Fisher & LaSalle (Hymenoptera: Eulophidae), an invasive gall inducer on Eucalyptus, in the Laboratory

By
Aparna Shri
Research Scholar,
Forest Entomology Division,
Forest Research Institute,
Dehradun

INTRODUCTION

- First planted around 1790 by Tippu Sultan, the ruler of Mysore, in his palace garden on Nandi hills near Bangalore, he received seed from Australia and introduced about 16 species.
- Eucalyptus meets requirements of people, industries.
- Paved the way to reduce pressure on natural forests.
- Backbone of afforested areas .
- Eucalyptus are planted for production of pulp to meet the increasing demand from paper and related industries

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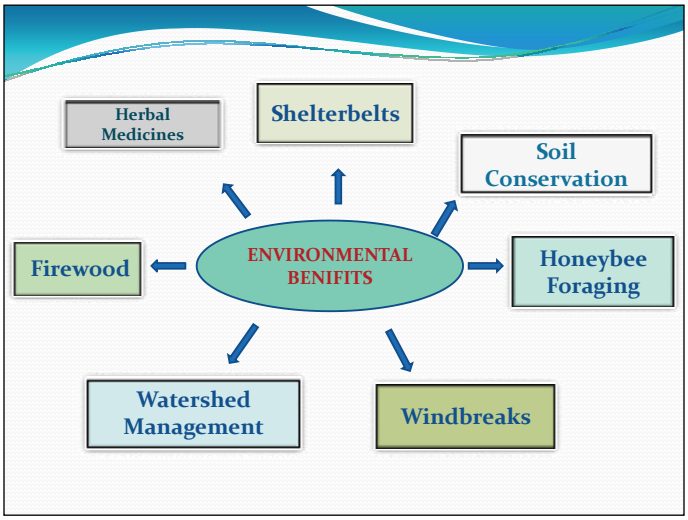
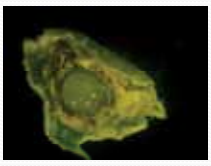


TRADIONAL THREATS To EUCALYPTUS

Phoracantha semipunctata
Quadrastichodella nova Girault
Flockiella eucalypti Timberlake
Epichrysocharis burwelli Schauff
Ophelimus eucalypti
Aprostocetus sp.

Leptocybe invasa : A New Threat To Eucalyptus Wealth

- *Leptocybe invasa* : A gall wasp
- A new pest : also know as blue gum chalcid of Eucalyptus



- In India, it was first noticed in 2001 at Mandya district in Karnataka and later in 2002 at Marakkanam in Villupuram district of Tamil Nadu
- The outbreak of this wasp in India was first reported in 2007 .

- Currently the insect attack assumed greater significance since it has spread to other states of the country
- *L. invasa* has a relatively narrow host range attacking eucalypt species

Eucalyptus saligna,	*E. grandis*
E. deanei	*E. globulus*
E. nitens	*E. maidenii*
E. botryoides	*E. camaldulensis*
E. gunnii	*E. robusta*
E. bridgesiana	*E. viminalis*
E. tereticornis	

- *Leptocybe invasa* induces galls on shoot tips, petioles, and midribs in seedlings maintained in nurseries, and on coppiced shoots and in juvenile plants in plantations.
- The affected seedlings show stunted growth and become unsuitable for planting.

- On heavily attacked young trees the canopy hangs due to the weight of gall.
- Its developmental time from oviposition to adult emergence is about 132 days with 2-3 overlapping generations in a year .

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OBJECTIVE

- Management of adult *Leptocybe invasa* in laboratory with insecticides

✓ Endosulfan
✓ Imidachlorprid
✓ Chloropyrifos

MATERIALS & METHODOLOGY

Survey & Collection was conducted March-May 2010 From U.P & Uttarakhand

↓

Collected gall infested material was placed in ventilated glass cages

↓

Soon after emergence wasps were collected and subjected to insectide application. Three conc. levels were decided to be applied i.e..025%, .0125% & .0625%.

↓

Each Treatment Replicated Three times

OBSERVATIONS & RESULTS

- Observations were recorded after every 15 min.
- Mortality % was calculated for all the concentrations.
- The data recorded was subjected to one way Anova.
- Insects subjected to endosulfan application shows
  - near to 99% mortality in 60 min with conc, 0.025%.:
  - 99% mortality in 75 min with conc. 0.0125%.
  - 100 mortality in 90 min with .00625%

Insects subjected to Imidaclorprid application shows
- 94% mortality in 45 min with conc, 0.025%.:
- 92% mortality in 60 min with conc. 0.0125%.
- 92 mortality in 75 min with .00625%

Insects subjected to Chlorpyrifos application shows
- 93% mortality in 75 min with conc, 0.025%.:
- 100% mortality in 90 min with conc. 0.0125%.
- 92 mortality in 90 min with .00625%

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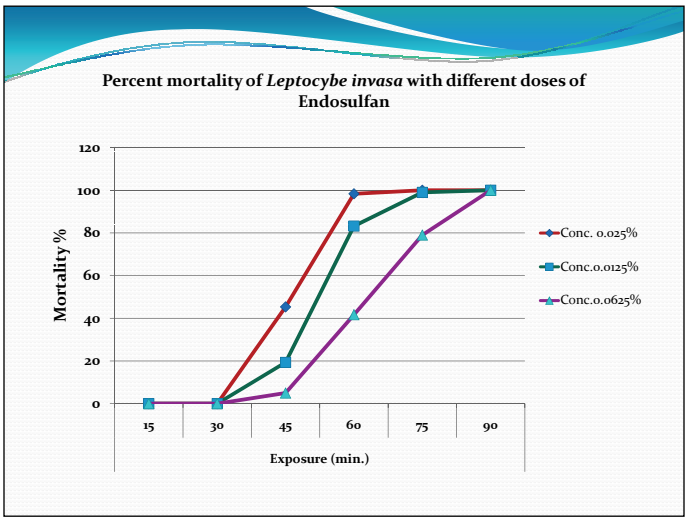

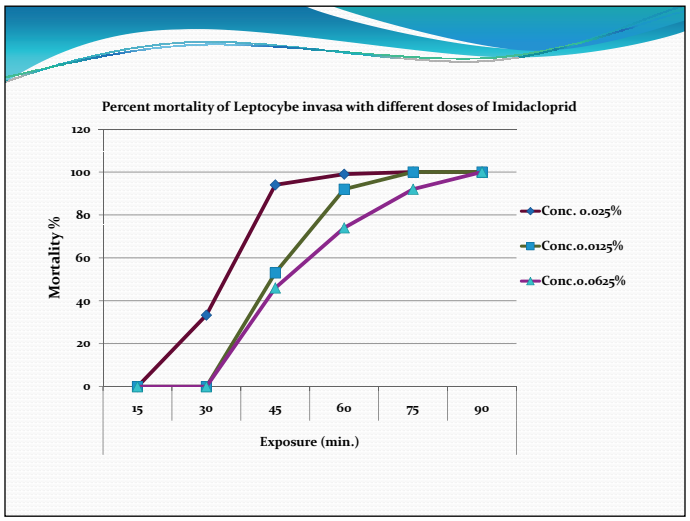

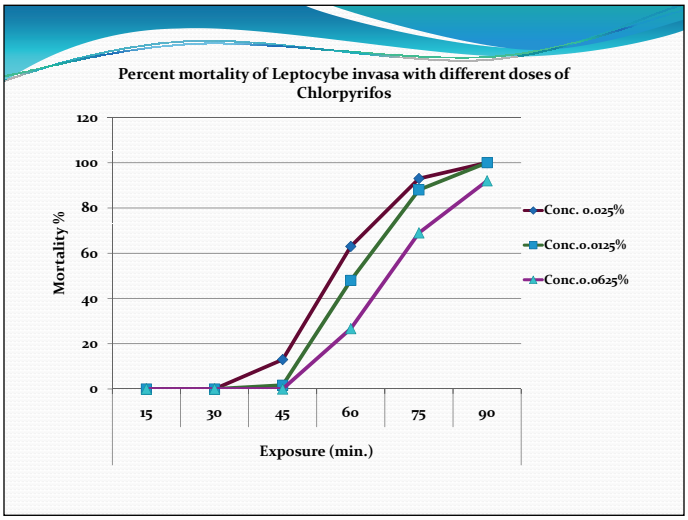

CONCLUSION

Resistant Clones should be used for plantation.

Planting material should be checked properly before plantation.

Quarantine should be strictly followed and practiced

Need to develop an integrated approach against the effective invasiveness of this species.

Insecticide	Conc.	Exposure(min.)	Mortality %
Endosulfan	0.025%	60	98
	0.0125%	75	100
	0.00625%	90	100
Imidacloprid	0.025%	45	94
	0.0125%	60	92
	0.00625%	90	100
Chlorpyrifos	0.025%	75	93
	0.0125%	90	100
	0.0625%	90	100

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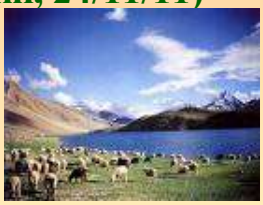
Valuation of Forest Biodiversity – A prerequisite for better financial devolution & developing markets for forest ecosystem goods and services

Theme: Forest Biodiversity and Landscapes

Indian Forestry Congress,

(New Delhi, 24/11/11)









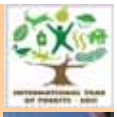
Madhu Verma,

Professor, Environment and Developmental Economics & Coordinator, Centre for Ecological Services Management

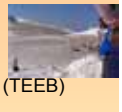
Indian Institute of Forest Management, Bhopal

Photos Credits : CSO project, IIFM, MA 2005, www.sacredland.org , http://images.google.co.in/

Presentation structure



- Ecosystem Goods and Services
- Objective and Scope of Valuation of Forest Biodiversity
- Recent Initiatives in Measuring Biodiversity
  - Millennium Assessment (MA)
  - The Economics of Ecosystems and Biodiversity (TEEB)
  - The Green Economy Initiative
- Forest Capital of India
- Valuation and Green Accounting
- Valuing Forest Biodiversity in India
- Valuation-Policy-Market and Institution Connect
  - Some Influential Global and Indian Examples
  - India-TEEB Study
- Conclusion



Key Words: ***Forest Ecosystem Services, Economic Valuation, Environmental Fiscal Federalism, Payment for Ecosystem Services***

Ecosystem Services (Ecosystem Goods & Services



- **Ecosystem services are the outcome of ecosystem functions that benefit human well being**
- **Ecosystem services are the benefits to households, communities and economies obtained from ecosystems. These include provisioning, regulating, and cultural services, which directly affect people, and supporting services needed to maintain the other services.**
- **Human well being is whole set of basic materials for good life, freedom to act and good social relation and security**

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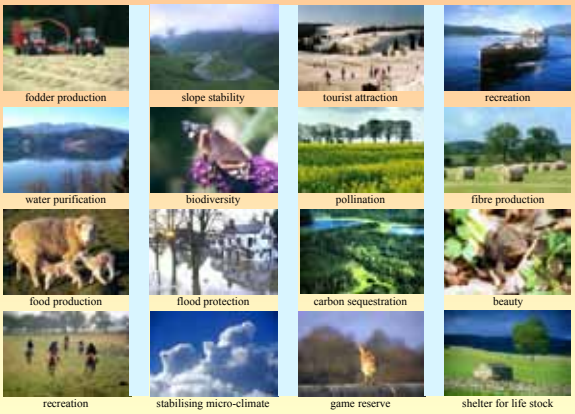
Ecosystems are capital assets!(Source: MA, 2005)



Provisioning Services

Goods produced or provided by ecosystems

- •Food
  - Crops
  - Livestock
  - Capture Fisheries
  - Aquaculture
  - Wild Foods
- •Fiber
  - Timber
  - Cotton, hemp, silk
  - Wood Fuel
- •Genetic resources
- •Biochemicals
- •Freshwater

Photo credit (top): Tran Thi Hoa (World Bank),

Regulating Services

Benefits obtained from regulation of ecosystem processes

- Air Quality Regulation
- Climate Regulation
  - Global (CO_2 sequestration)
  - Regional and local
- Erosion regulation
- Water purification
- Disease regulation
- Pest regulation
- Pollination
- Natural Hazard regulation

Cultural Services

Non-material benefits obtained from ecosystems

- Spiritual and Religious Values
- Knowledge Systems
- Educational values
- Inspiration
- Aesthetic Values
- Social Relations
- Sense of Place
- Recreation and Ecotourism

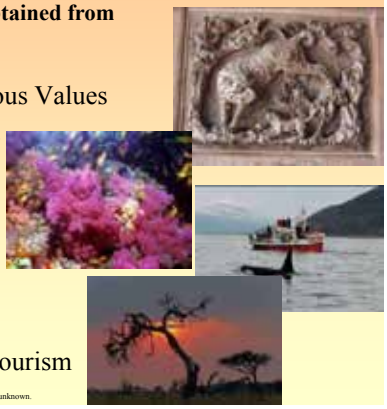
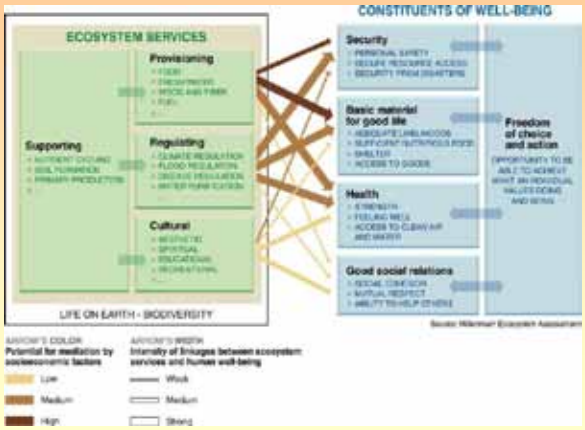


Photo credits (top to bottom): W. Reid, Mary Frost, Staffan Widstrand, unknown.

Forest Ecosystem Services

Provisioning	Regulating	Cultural	Supporting
Food	Climate regulation	Aesthetic	Nutrient Cycling
Fresh water	Flood regulation	Spiritual	Soil Formation
Wood, fuelwood	Disease Control	Educational;	Primary Production
Fibre	Detoxification	Inspirational	
Biochemicals		Symbolic	
Genetic Resources			

Fig. Ecosystem Services & their links to human well being; MA, 2006



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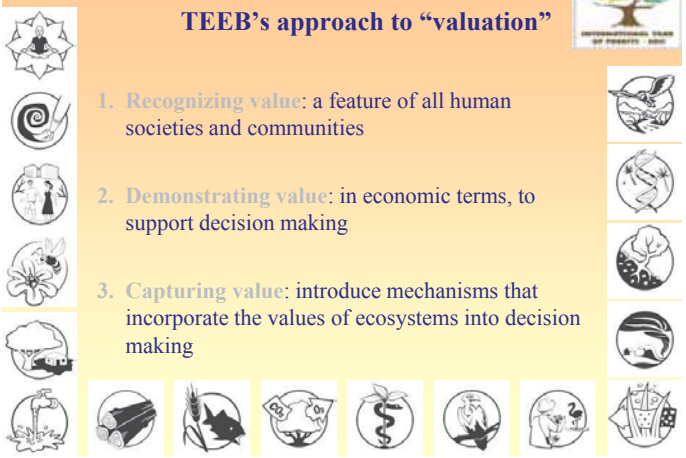
Objective and Scope of Valuation of Forest Biodiversity

- To Measure what we Manage
- To reflect the true contribution of Forest Ecosystem to the Economic System
- To generate an appreciation for ESs emanating from Forests amongst all Stakeholders
- To do full cost/value/price accounting not to charge for all services (may be for some services) but to provide incentives to the communities, other stakeholders conserving forests
- To make a claim for better allocation of funds for the states and to help the department and other SHs to achieve the intended outcome (1/3rd of GA under FTC)
- To reflect the real value of Investment in the forest sector i.e. outcome of expenditure and to influence the public policy to get benefits of International and national market mechanisms for conserving communities and to exercise appropriate Gender Budgeting)
- To suggest appropriate instruments to generate environmental and conservation finance for sustainable forest management

IIFM's Studies on Valuation and Accounting

TEEB's approach to "valuation"

1. Recognizing value: a feature of all human societies and communities
2. Demonstrating value: in economic terms, to support decision making
3. Capturing value: introduce mechanisms that incorporate the values of ecosystems into decision making



TEEB's origins ...

"Potsdam Initiative – Biological Diversity 2010"

.....the economic significance of the global loss of biological diversity....

TEEB Interim Report
CBD COP-9, Bonn, May 2008

TEEB Climate Issues Update
Strömstad September 2009.

TEEB Main Reports
Nov. 2009 – Oct. 2010

Towards The Green Economy (UNEP,2011)

- An economy that results in "*improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities is termed as a green economy*" (UNEP 2010).
- It is a low carbon, resource efficient, and socially inclusive economy leading to a shift towards enhanced well-being
- Growth driven by public and private investments that prevent the loss of biodiversity and ecosystem services.

Green economy and Forestry

- Valuation of forest eco-system services should be incorporated in the GDP in monetary terms as a step towards green economy
- System of Environmental and Economic Accounting (SEEA) by the UN Statistical Division, and the adjusted net national savings methods (World Bank 2006) are used as valuation methodologies for forest ecosystem services valuation
- For a sound ecological infrastructure, forest ecosystem services should be optimally managed, reflecting the valuation values in the national accounts

Forests Capital of India

Class	Area (km²)	% of Geographical Area
Forest Cover		
Very Dense Forest	83,510	2.54
Moderately Dense Forest	319,012	9.71
Open Forest	288,377	8.77
Total Forest Cover*	690,899	21.02
Non-Forest		
Scrub	41,525	1.26
Non-forest**	2,55,839	77.72
Total Geographical Area	**3,287,263**	**100.00**

*Includes 4,369 sq. km under mangroves
** Excludes scrubs and includes water bodies

Source: India-SFR, 2009

Class-wise Change in Forest Covers 2005-07 (km²)

Class	Assessment 2005	Assessment 2007	Change 2005-07
Very Dense Forest	83,472	83,510	38
Moderately Dense Forest	319,948	319,012	-936
Open Forest	286,751	288,377	1,626
Total Forest Cover	**690,171**	**690,899**	**728**

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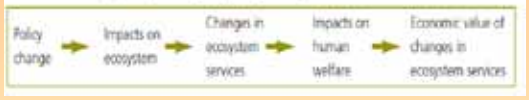
Diversion under FC Act 1980: Category Wise (1980-2010)
Source: MoEF (2010)

Valuing Forest Biodiversity in India
&
Valuation-Policy-Market and Institution Connect

Valuation Linkages

Overview of impact pathway of policy change



Valuation Steps (Source : DEFRA, 2007)

1. Establish the environmental baseline
2. Identify and provide qualitative assessment of the potential impacts of policy options on ecosystem services
3. Quantify the impacts of policy options on specific ecosystem services
4. Assess the effects on human welfare
5. Value the changes in ecosystem services

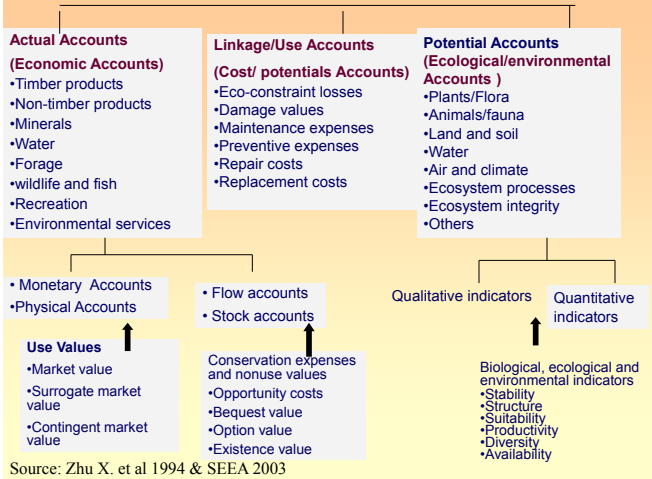
Recommended Framework for the Estimation of NPV of Forest Resources of India for its Use in Forest Resource Accounting System (Source: CSO project, IIFM, 2006)

Ecosystem Service	Annual Value (Benefit)	Annual Costs
1.Timber - logging, TDRs/Nistar and Salvage	Long run Stumpage value approach or Stumpage price of mature timber and salvaged timber	Costs of production (departmental), extraction and transport
2.Fuel wood	Total value of fuel wood collected in a normal year = No. of rural households collecting fuel wood from forest in last 365 days x Average value of collection per collecting household. (the value to be used is the relevant price in the nearest local market)	Cost of collecting fuelwood = (No. of rural households) X (Total annual time cost of collection per household valued at 15% of average agricultural wage rate).
3.Fodder Grazing	Total value of fodder collected in a normal year = No. of rural households collecting x fodder from forest in last 365 days x Average value of collection per collecting household. (the value to be used is the relevant price in the nearest local market) Total no. of livestock grazing in state forest x total fodder receipt	Cost of collecting fodder = (No. of rural households) X (Total annual time cost of collection per household valued at 15% of average agricultural wage rate). Management cost
4.Non Products (including grass) - extraction method Consumption method	Per hectare value of NTFP collected in each circle – Value of NTFP in each circle / Net forest area in each circle. Value of NTFP in each circle = Value of NTFP collected in a normal year per household x No. of rural households (the value to be used is the relevant price in the nearest local market) or cost function to get actual market value of medicinal herbs based on the royalty or permit value collected. Household survey using Village input-output model	Cost of collecting NTFP = (No. of rural households) X (Total annual time cost of collection per household valued at 15% of average agricultural wage rate). Wage rate for labour inputs
5.Carbon Sequestration	Value of carbon stock = carbon content x market rate of carbon. Carbon Content= Biomass x IPCC-GPG default value1. Biomass = Growing stock x Conversion factor	No. direct costs.
6.Ecotourism/Landscape beauty	Per hec. Value of Eco-tourism in each circle = Total value of Eco-tourism in each circle / Net forest area in each circle. Value of Eco-tourism dependent on forest ecosystems = No. of people visiting different circles per year mainly due to natural beauty X average expenditure incurred per person	Costs incurred by the Forest Department in the maintenance, preservation and development of national parks and wildlife sanctuaries. The per hectare cost were calculated to arrive at costs for each circle. See Step 6 for common departmental costs.

6.Ecotourism/Landscape beauty	Per hec. Value of Eco-tourism in each circle = Total value of Eco-tourism in each circle / Net forest area in each circle. Value of Eco-tourism dependent on forest ecosystems = No. of people visiting different circles per year mainly due to natural beauty X average expenditure incurred per person	Costs incurred by the Forest Department in the maintenance, preservation and development of national parks and wildlife sanctuaries. The per hectare cost were calculated to arrive at costs for each circle. See Step 6 for common departmental costs.
7. Watershed function - soil building, nutrient movement, Hydrological and climate regulations, floodplain benefits	Value per hectare for specific watershed function based on secondary site specific studies.	As per site specific secondary studies.
8. Biodiversity/Bioprospeting (i) Actual value approach (ii) Option value approach	(i) Potential value of drugs that can be obtained from the bio-diversity present in forests (ii) insurance premium paid to ensure the supply of an asset, the availability of which otherwise would be uncertain	Cost of collection R&D costs

Note: (1) The value for fodder, fuelwood, NTFP are based on the report of the NSSO 54th round Survey on Common Property resources in India, (2) Annual values in column 2 for items 1-8 are calculated as per methodology developed by Verma et.al. (2003-2006) at the IIFM, Bhopal in the Project on ' Natural Resource Accounting of Land and Forest excluding mining) in the States of M.P. and H.P. sponsored by the Central Statistical Organization (CSO) of the Ministry of Statistic a nd Program Implementation, GOI.(4) Annual Costs in column 3 were calculated for items1-7 except for TDRs/Nistar and Salvage, Grazing and household consumption of NTFPs in Empowered Committee's Report on NPV, New Delhi 2006.

System of Forest Resource Accounting



Source: Zhu X. et al 1994 & SEEA 2003

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Lessons from Influential Cases

Making Conservation Profitable: Water and Diamonds – New York watershed Steward Program (Municipal Planners as Environmental Activists)

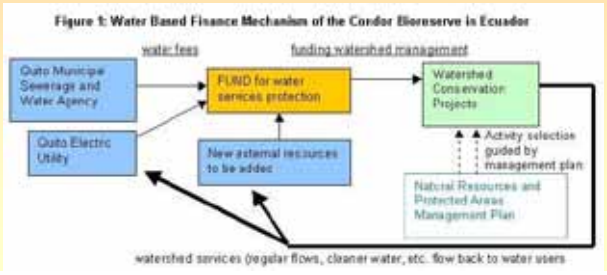
- The city gets 90% of its water supply from Catskill and Delaware watersheds.
- Forests constitute 75% of the area of these watersheds. Faced with increasing microbial and phosphorus pollution in 1997 the city had two alternatives - either to invest in a filtration plant costing US$6-8 billion (plus annual maintenance of US$ 300-500 million) or to invest US$ 1 - 1.5 billion in the improvement of management of watersheds, thereby reducing the pollution at source.
- The city choose the later and by raising money through additional taxes on water bills decided These funds were invested in promotion of soil and water conservation and improved forest management, which in turn improved the city's water supply
- New York to date remains as few of the large cities without a water treatment plant

Photos:: Catskill and Delaware watersheds

France, Perrier Vittel (EVIAN)

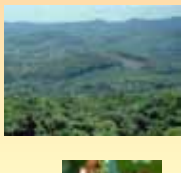
- World's largest bottler of natural mineral water, has been making payments to the upland landowners in the Rhine Meuse Watershed in northeastern France
- Objective has been to improve land management so that pollution is reduced. The company spent over US$ 24.5 million in the first seven years.

Finanacing Watershed Conservation :FONAG Quito , Ecuador



Using Fiscal Instruments to Encourage Conservation :Municipal Responses to the "Ecological" value added tax in Parana and Minas Gerais, Brazil

- Rewards to local governments (Municipalities) for their commitment to protecting forest and biological resoorces
- Economic Instrument to pay for services – Ecological Value Added Tax (ICMS-E)
- ICMS-E allocates part of the revenues derived from the ICMS to municipalities on the basis of their performance on various criteria, referred as Conservation Units(CU) eg. Biodiversity concentration coefficient (Parks and reserves, treatment of solid waste (Sanitation)



Bees for Water

- Site: Amboro National Park , Bolivia.
- Santa Rosa – Los Negros
- Problem – decreasing water quality and quantity
- Reasons –Deforestation for agri.
- Solution – Bees! 10ha for 1 Bee box

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Examples : Integrating ecosystem services into land use plans in Baoxing County, Sichuan, China

REGIONAL PLANNING

*An ecosystem service mapping and modeling tool **(InVEST)** used to plan development zones that avoid areas of high ecosystem service provision and conservation importance*

*Developments were reconsidered by local government officials during the making of the next **Baoxing County Land Use Master Plan 2010** where mapping had highlighted that activities were planned in areas of several critical ecosystem services*

Examples : Tubbataha Marine Park, Philippines

UNESCO World Heritage site, contains 396 species of corals & has higher species diversity per square metre than the Great Barrier Reef

LEGISLATIONS

After1998 Bleaching – Stakeholders meeting

"No-take" areas agreed, & later, President passed the Tubbataha Reefs Natural Park Act in 2010 (10 mile buffer zone around the no-take marine reserve) thus increasing Park by 200%

- *10% annual increase in live coral cover.*
- *fish biomass is four-folds better than the average healthy reef*

Examples : Kampala Wetland

Services provided by the Nakivubo swamp include natural water purification and treatment & supporting small-scale income activities of slum dwellers

PROTECTED AREA EVALUATION

(Nakivubo designated a part of the city' s greenbelt zone)

Ecosystems services provided by the swamp equal USD 1 million -1.75 million / year

If the swamp is converted then additional investment into a sewage treatment plant would be required with running costs of over USD 2 million / year

Examples : 'Satoyama' Landscapes

75 - 100% reduction in pesticides, traditional winter flooding rice farming adopted, & White Stork rice & other certified products sold at a "premium"

PES

2003 - 2007: farmers paid 40,000 JYen per 1,000m² of rice paddies .Currently granted 7,000 JYen per 1,000m² by Toyo-oka City

Konotori no Mai / Flying Oriental White Stork

CERTIFICATION

Rice sold at 23 % higher rate for reduced pesticide use, and 54 % more for organic farming

- *White Stork habitat increased from 0.7 ha in 2003 to 212.3 ha*
- *Extinct in 1971, now has over 40 breeding pairs*
- *1 billion JPY annually in tourism, & municipal income raised by 1.4 %*

Markets for Bioprospecting

- In India, the Kani tribe of Kerala has received payments for its traditional knowledge regarding medicinal uses of the plant arogyapacha (*Trichopus zeylanicus*).
- The Tropical Botanical Gardens and Research Institute (TBGRI) successfully developed a drug from the arogyapacha plant and sold the technology to a Coimbatore based drug company.
- The company agreed to pay Rs. 1 million and a 2% share in the royalty, which is being shared equally by TBGRI and the tribal community.

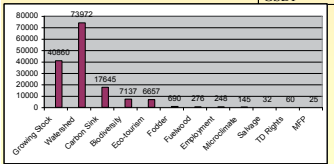
Valuation of Ecosystem Services & Green Accounting

Economic Valuation of Himachal Pradesh Forest for HPFSR (Verma, 2000)

TEV of HP forests Rs. 106664 crores (Rs. 7.43 Lakhs /Ha for entire forest area and Rs. 7.89 Lakhs /Ha for area under forest cover which led to the introduction of Compenstion for the Loss of Ecological Values **(CLEV)** in 2002 and currently used in preparing a case for carbon credits

I. Forest Resource contribution vs. Investment	
1. Value of Growing Stock	Rs. 40860 Crore
2. Total Economic Value of Forests	Rs. 106664Crore (2.61 times of item 1, 980 times of item 3 And 2607 times of item 4).
3. Total Expenditure incurred in forest (Annual Budget)	Rs. 109 Crore
4. Revenue realised by forests	Rs. 41 Crore
II. Contribution of Forsts to the GSDP	
5. Total GSDP	Rs. 9258 Crores
6. Forestry & Logging	Rs. 487
7. Forestry as % of GSDP	5.26%
8. TEV of forests of HP (as per current estimate)	Rs. 106664 Crores
9. Corrected GSDP	Rs. 115434 Crores
10. Forestry as % of corrected GSDP	92.40 %

Bar diagram depicting comparative picture of economic value of forestry goods & services



Based on HP study CSE projected annual value of India's Forest – Rs. 59,00,192 crores (2003)

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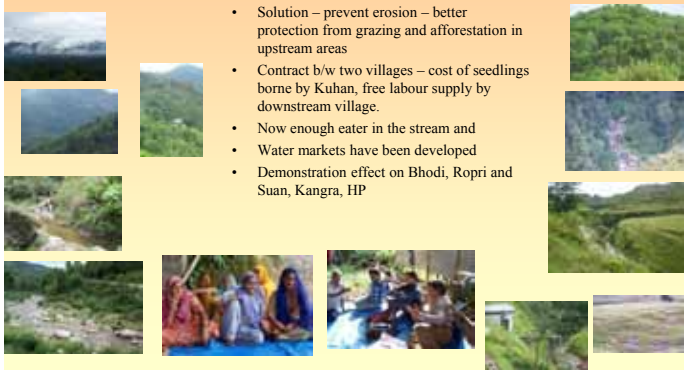
Annual Values of Ecosystem Services from Uttarakhand Forest Based on Estimates of Costanza *et. al.*, 1997 Framework (Source: Report for the Lead India, Verma 2007)

Ecosystem Service	Value in US$ ha/ yr (US$ 1 = Rs. 44.5)
Climatic regulation	167.6 (14.6%)
Disturbance regulation	2.3
Water regulation and water supply	5.2
Erosion control	114.6 (10.0%)
Soil formation	11.6
Nutrient cycling	429.6 (37.4%)
Waste treatment	102.7 (8.9%)
Biological control	2.3
Food production	50.7
Raw material	164.0 (14.3%)
Genetic resource	18.5
Recreation	78.6
Cultural	2.3
TOTAL	1150 (100%)

Value being used for preparing case for the 13th Finance Commission

Biodiversity and Livelihoods : PES in Bhodi - Suan & Oachkalan – Kuhan, Kangra, HP (IIED, DFID , WII, IIFM, 2006)

- LIS at Kuhan – bottom end of watershed
- Problem- siltation – water quantity
- Solution – prevent erosion – better protection from grazing and afforestation in upstream areas
- Contract b/w two villages – cost of seedlings borne by Kuhan, free labour supply by downstream village.
- Now enough eater in the stream and
- Water markets have been developed
- Demonstration effect on Bhodi, Ropri and Suan, Kangra, HP



Study on Developing Mechanisms for Compensating States for Managing Large Geographical Areas under Forests

A Case for Environmental and Conservation Finance by IIFM for the 13th Finance Commission (2008-09)

To build a case of ***Environmental & Conservation Finance*** for the states which are mandated to keep large geographical areas under forests by internalizing environmental externalities of forest ecosystems

for partial realization of

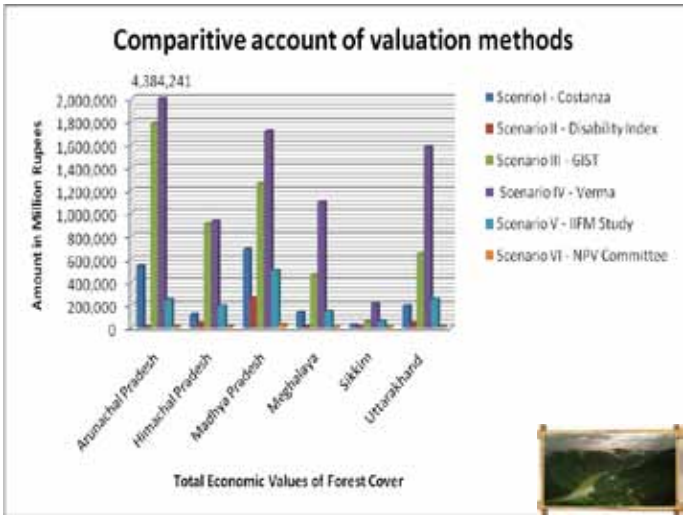
the mandate of the Thirteenth Finance Commission to make its recommendations that ***"help in managing ecology, environment and climate change consistent with sustainable development"***

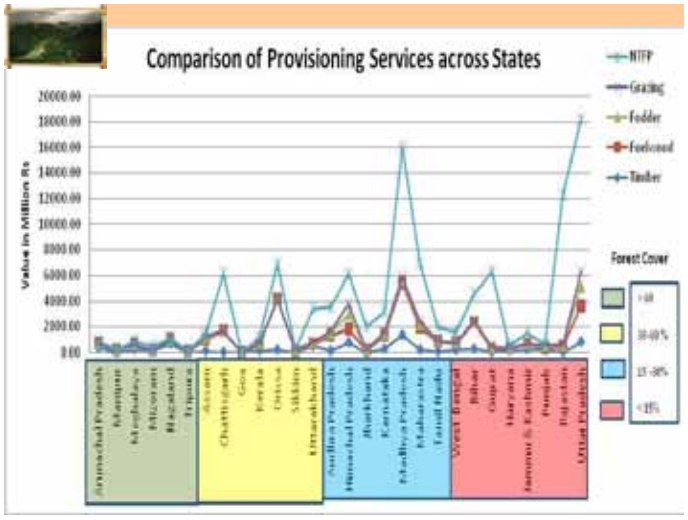
Core Objectives

- To prepare a case for **the increased allocation of budgets** to the States with large geographical areas under forests from the finance commission
- To **propose a formula or set of recommendations** for appropriate budgetary allocation by the 13th Finance Commission to these states for conserving their forest that is **needed to manage ecology, environment and climate change consistent with sustainable development**
- To suggest a set of economic instruments to promote conservation of forest resources in accordance with sustainable management practices

THFC requirement

- ***Range of values/estimates/guesstimates***
- ***National Figure (Increased budget for the country as a whole)***
- ***Hilly and Plain state specific (Increased budget specific to terrain)***





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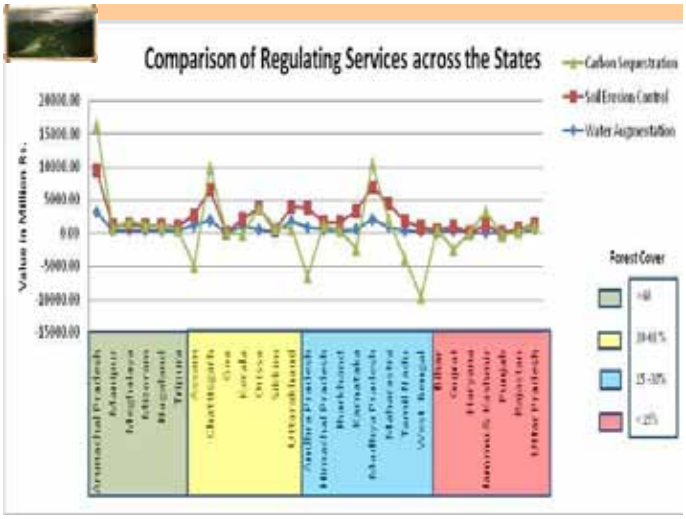

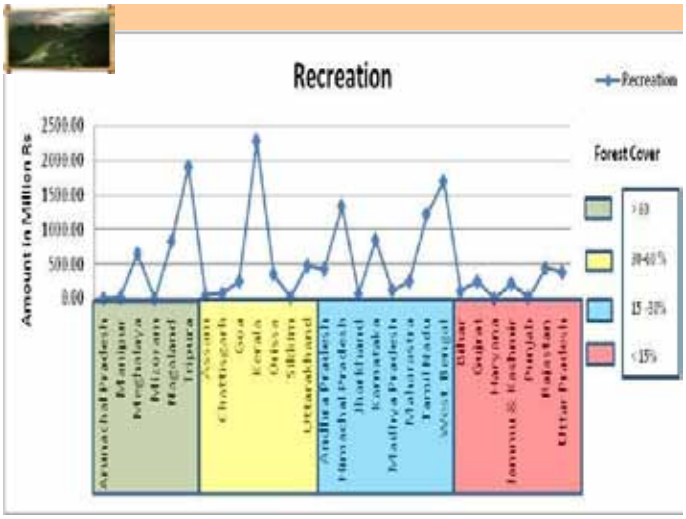

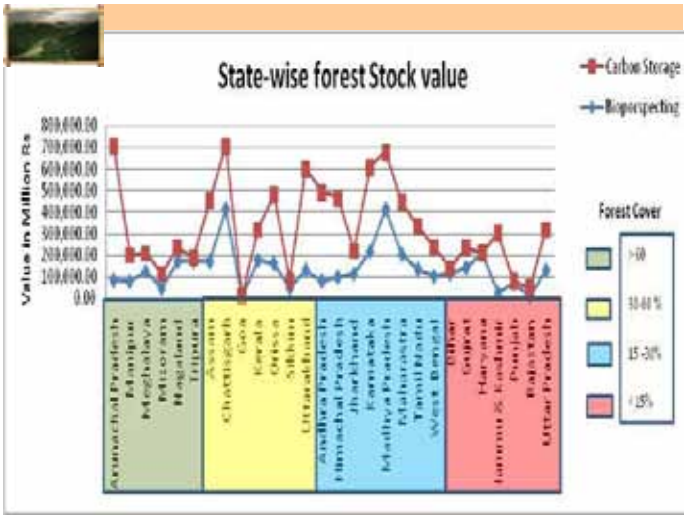

$$A = \frac{1}{4}\sum_{i=1}^{20} GS_i X + \frac{1}{4}\sum_{i=1}^{20} DC_i X + \frac{1}{4}\sum_{i=1}^{20} BPS_i X + \frac{1}{4}\sum_{i=1}^{20} CS_i X$$

$$X = Equalization\ Factor$$

$$GS_i = \frac{Total\ Growing\ Stock\ of\ the\ i^{th} state\ according\ to\ SFR\ 2005}{Total\ Growing\ Stock\ of\ the\ Country\ according\ to\ SFR\ 2005}$$

$$Growing\ Stock\ of\ a\ state = \sum_{j=1}^{n} \frac{Geographical\ area\ of\ all\ the\ districts\ of\ the\ state\ lying\ completely\ in\ j^{th}\ physiographic\ zone}{Total\ geographical\ area\ of\ the\ j^{th}\ physiographic\ zone} \times Growing\ stock\ of\ j^{th}\ physiographic\ zone + \sum_{j=1}^{n} \frac{Geographical\ area\ of\ all\ the\ districts\ of\ the\ state\ lying\ partially\ in\ j^{th}\ physiographic\ zone}{Total\ geographical\ area\ of\ the\ j^{th}\ physiographic\ zone} \times Growing\ stock\ of\ j^{th}\ physiographic\ zone \times 0.5$$

$$CS_i = \frac{Total\ Carbon\ Storage\ value\ of\ the\ i^{th} state}{Total\ Carbon\ Storage\ value\ of\ the\ Country}$$

Actual Allocation Formula by the THFC

$$G_i = \frac{\left[\left\{\frac{F_i}{\sum F_i} + R_i\right\} \times \left\{1 + \frac{M_i + 2H_i}{A_i}\right\}\right]}{\sum_{i=1}^{n}\left[\left\{\frac{F_i}{\sum F_i} + R_i\right\} \times \left\{1 + \frac{M_i + 2H_i}{A_i}\right\}\right]}$$

$G_i = Share\ for\ state\ i$
$A_i = Geographical\ area\ of\ state\ i$
$F_i = Total\ forest\ area\ of\ state\ i$
$M_i = Moderately\ dense\ forest\ area\ of\ state\ i$
$H_i = Highly\ dense\ forest\ area\ of\ state\ i$
$R_i = \max\left[0, \left\{\frac{F_i}{A_i} - \frac{\sum F_i}{\sum A_i}\right\}/100\right]$

Interesting Trends

- Regulating services have higher value than provisioning services
- Increasing economic value of the provisioning services with decreasing forest cover
- Low recreation values for forests in north eastern States despite huge protected areas
- High timber stock in southern States

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Conclusion: Need for Forest Ecosystem Services Based Approach

- Need to utilise economic values for conservation through Payments for Ecosystem Services…..
- Investment in conservation should be proportional to returns from packaged value of ecosystem services
- Climate Change mitigation is only one of the services
- Fiscal policy reforms (Environmetal Fiscal Federalism) and Economic Instruments as a catalyst for greening the forest sector

India TEEB Initiative

Objectives

- survey of biodiversity and ecosystem services
- a framework of what to value and how to value
- a spatially explicit matrix of service flows and respective values,
- guidance for natural capital based adjustments to national accounts
- recommendations for economic instruments for conservation.

Initial Focus

- On three broad ecosystems - Forests, Inland Waters & Wetlands, Marine and Coastal Areas.

Deliverables

- **First Phase** - To prepare a toolkit of exemplary case studies across the country of successful application of ecosystem services in real life situations - for showcasing in COP-11 (2011-12)
- **Second phase** - of the study will entail location-specific and context-specific primary studies and adjustment mechanism in National Accounts (2012-2016)

Execution Agency

- IIFM as the National Host Institution under the guidance of MoEF

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Morphological, Biochemical and Genetic Variability in *Commiphora wightii* (Arn.) Bhandari in western India

Arti Gaur & U.K.Tomar

FOREST GENETICS AND TREE BREEDING DIVISION
INDIAN COUNCIL OF FOREST RESEARCH AND EDUCATION
ARID FOREST RESEARCH INSTITUTE, JODHPUR

INTRODUCTION

- *Commiphora wightii* (Arnott), Family: Burseraceae
- Important traditional medicinal plant
- Grows well in arid and semi arid region of India
- Resin commonly known as guggal gum
- Important constituents of guggul gum are E & Z guggalsterone
- Endangered species listed in Red Data Book
- Apomixis and polyembryony reported (Gupta et al, 1996) leads to narrow genetic base
- Dimorphic bisexual flowering plant but sometimes purely male/female and andromonoecious plants were also seen
- Poor seed germination (Yadav *et al.*, 1999; below 5%) in Rajasthan and high percentage of seed germination has also been recorded.
- Propagated mainly by vegetative means and seeds

Distribution of *Commiphora wightii* in India

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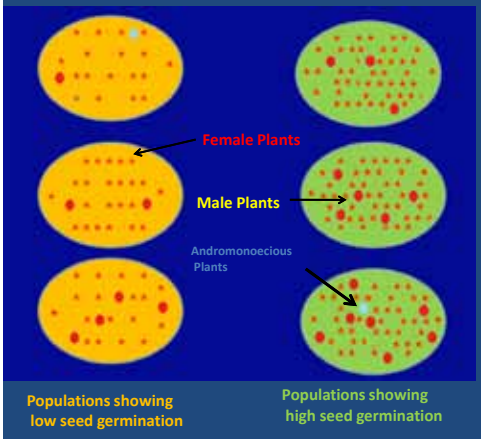
Concept of Proposed Study



Questions ?

Seed germination depends on male female ratio in populations?

What is the difference in concentration of E & Z guggulsterone in male, female and andromonoecious plants?

What extent of Genetic diversity exists in different populations using isozyme & DNA marker studies?

Mother trees and Progenies studies to assess breeding behavior of guggul populations

OBJECTIVES

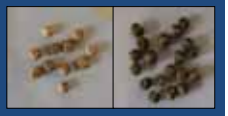
- To assess morphological, biochemical and molecular variability in *Commiphora wightii* growing in different areas of Rajasthan and Gujarat.
  - To study the male, female and andromonoecious plants percentage occurrence and their morphological characters in different sources.
  - To study the genetic variation in selected mother plants and their progenies using isozymes and DNA profiles.
  - Comparative analysis of variation in E and Z guggulsterone production in male, female and andromonoecious plants.

SELECTION AND SURVEY OF SITE

- Three sites having natural population of Guggul were selected and studied. These are-
- Kayalana guggul field Jodhpur.
- Nardas ka gurha guggul field Rajsamand.
- Madaria Rajsamand.

Site details ↓ Sites →	Kayalana guggul field jodhpur	Nardas ka gurha guggul field rajsamand	Madaria guggul field rajsamand
GPS location	26°20 N, 73°15 E	24°46 N, 73°28 E	25°22 N, 73°55 E
Area	40 ha	200 ha	80 ha
Area under study	1 ha	2.2 ha	1.8 ha
No. of plots (30X30m each)	10	22	18
Total no. of plants studied	66	25	81
Population density	66.00 p/ha	11.36 p/ha	45.56 p/ha
Female plants	100%	100%	100%
Male & andromonoecious plants	0%	0%	0%
Rainfall	358 mm	624.5mm	623mm
Temperature	1°C to 48°C	1°C to 45°C	1°C to 46°C
Soil	Fine, reddish gritty	Sandy loam	Sandy loam
Soil pH	7.26	6.69	6.53
Electric conductivity	0.05mS	0.09mS	0.13mS
Organic matter	1.39 ppm	ppm	ppm
Inorganic matter	0.02 ppm	ppm	Ppm
Ammonia	14.73 ppm	2.15ppm	2.94 ppm
Nitrate	15.89 ppm	2.48 ppm	1.50 ppm
Phosphorous	4.8 ppm	0.11 ppm	0.94 ppm

SEEDS AND GERMPLASM COLLECTION



- 5 mature healthy plants from each field were selected as mother plants.
- During February to March mature seeds and germplasm were collected for the establishment of progenies.

ESTABLISHMENT OF PROGENIES

- Black colored viable seeds were germinated within 15-20 days.
- Due to its polyembryonic nature more than one seedlings from a single seed.

E AND Z GUGGULSTERONE ESTIMATION FROM AERIAL BRANCHES:-

- A non destructive method i.e. isolation of guggulsterone from aerial branches was performed.
- Steps:-
- Aerial branches were powdered and 50 gms of each sample was extracted with 300ml ethyl acetate.
- It was repeated three times and then extract was concentrated on water bath.
- Green colored thick viscous extract dissolved in 100 ml methanol then centrifuged for two times at 5000rpm for 10 min.
- Supernatant was directly used as sample for HPLC analysis.
- 10µl of sample was loaded in HPLC.
- HPLC conditions- mobile phase- acetonitrile-0.1% formic acid/H_2O (60:40).
  Flow- 1.0ml/min.
  Column description-RP-18(250mmX4.6mm.5µm)
  Wave length- 242nm.

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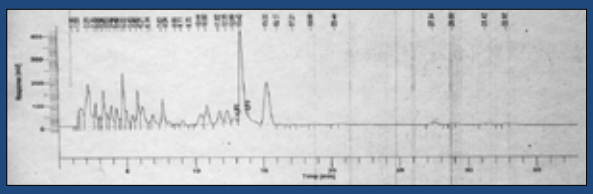
A.) Dried powder of guggul aerial branches.

B.) Sample dissolved in ethyl acetate extracted on water

C.) Extracted sample concentrated on rotar evaporator.

D.) Centrifuged sample loaded in HPLC for estimation of Z

Chromatogram showing peak for Z guggulsterone



Percentage of Z guggulsterone in different plant samples

SAMPLE	WEIGHT	GUGGULSTERONE-Z(µg/g)	GUGGULSTERONE-Z %
1-Female	50.1862	289.17	0.029
2-Female	50.0262	139.93	0.014
3-Female	50.1674	140.96	0.014
4-Male	50.1402	n.d.	n.d.
5-Male	20.0720	n.d.	n.d.

MORPHOLOGICAL STUDIES OF PLANTS OF DIFFERENT SITES

- Three types of plants are found in *Commiphora wightii* viz. male, female and andromonoecious.
- Flowers- main characteristic feature but flowering season is very small.

FEMALE FLOWER

MALE FLOWER

Compararive chart

MORPHOLOGICAL CHARACTERS	FEMALE PLANTS	MALE PLANTS
flower	Developed pistil, rudimentary stamens	Developed stamens, rudimentary pistil
Flower size	small	large
Leaf shape	ovate	Obovate
Leaf margin	dentate	crenate
Leaf thickness	more	less
No. of stomata	high	Less
canopy	Weeping	divergent

Canopy- During studies on growth habits of both male and female plant it was found that the canopy of the plants also have some difference like female plant's branches were bending over and hanging down (weeping type of growth habit) and male plant's branches were spreading away from each other (divergent type of growth habit). So they form different types of canopy structures.(newsletter, NRCMAP, vol.6 no.2, July-Dec 2005)

MALE PLANT

FEMALE PLANT

ISOENZYMES STUDIES

- To understand mating behaviour and to assess genetic variability between mother plants and their progenies, isoenzyme studies are under progress.
- Steps:-
- Preparation of stock solutions.
- Preparation of sample from fresh leaves.
- Preparation and casting of poly acrylamide gel.
- Loading and running of sample .
- Staining of gel and observation of banding patterns.

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- Preparation and casting of poly acrylamide gel.

CONTENTS	RESOLVING GEL(7.5%) 25 ML	STACKING GEL (4%) 10 ML
Distilled water	12.125 ml	6.1 ml
Stock B (resolving gel buffer	6.25 ml	-
Stock C (stacking gel buffer)	-	2.5 ml
Acrylamide/Bisacrylamide	6.5 ml	1.3 ml
10% APS	125µl	50µl
TEMED	12.50µl	10µl

- Loading and running of sample.
- 15µl of protein sample was loaded(prepared by crushing 500mg of plant leafs in 5 ml of 0.2M phosphate buffer).
- For running the assembly was attached to power unit at constant current of 40 mA. temperature(10°C to 11°C)

- Staining of gel and observation of banding patterns.
- Peroxidase- for peroxidase the gel was stained with saturated solution of o-diansidine(in 25% acetic acid) and α Naphthol solution. Then 1% H_2O_2 solution was added in a dropwise manner till green coloured bands appear.
- Catalase- for catalase method was adapted from Woodbury *et al.*,(1971). The gel was incubated in 0.003% H_2O_2 solution for 10 minutes. Rinse briefly with distilled water and incubate the gel in 1% ferric chloride and 1% potassium ferricyanide solution for 10 minutes with shaking to detect catalase isoforms.
- Acid Phosphatase- for acid phophatase the gel was stained with saturated solution of p- Nitro phenyl phosphate. Rinse thoroughly with distilled water then incubate it in NaOH solution for 10 minutes with shaking to detect bands.

EXPECTED RESEARCH OUTCOME

- **Diversity and Genetic base of *Commiphora wightii* in studied population.**
- **Assessment of Variation in E and Z guggalsterone production in male, female and andromonoecious plants.**
- **Germplasm of rare male and andromonoecious plants.**
- **Knowledge of breeding behavior in different populations can be useful for plantations in desired ratio of male and female plants**

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Medicinal Plants of Padder Valley, Jammu & Kashmir A Quantitative Study

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Rationale of Study

1. The State of J&K has a rich repository of medicinal plants.
2. Many of these plants are of high repute in medicinal system and also enlisted as endangered plants.
3. Unfortunately, no in-situ quantitative studies have been undertaken. Therefore the present study attempts to quantify the estimated productivity of important medicinal plants in the Padder valley, Kishtwar district of the state.

Methodology

Study Area :

- Padder valley falls in the jurisdiction of newly created Kishtwar District 33°06'8" to 34 ° 13'35" N and 75 ° 23'40" to 76 ° 46'40" E.
- The present study was conducted with a view to access the present status of diversity & productivity of some important medicinal herbs and throw light on the environmental factors leading to dwindling of species composition & medicinal plant productivity in the Padder valley.
- The study was conducted during August-September 2009. Various phytosociological parameters were recorded following standard methods (Curtis and McIntosh, 1950; Misra, 1989). Random sampling plots (1x1 m) were laid on each of the sites. 250 plots were laid at each site (1000 plots in total). For estimation of productivity study fresh samples of the plants were collected and were weighed in the field. After that these samples were then oven dried to get their dry weight.
- The total number of each medicinal plant per hectare was estimated using abundance data.

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Results

The following table is showing the comparative estimated total dry biomass of all the four sites of the study area.

Comparative Dry Biomass Productivity in Padder Valley

Species	Pilali (kg/ Ha)	Karzaidar (kg/ Ha)	Ishtiyari (kg/ Ha)	Batwas (kg/ Ha)
Aconitum heterophyllum	78.54	62.32	69.13	86.15
Angelica glauca	285.94	133.48	156.67	202.24
Artemisia brevifolia	1228.80	1354.24	848.20	1004.72
Bunium persicum	7.06	7.21	7.56	7.24
Dactylorhiza hatagirea	91.33	79.66	72.05	29.97
Dioscorea deltoidea	2254.12	785.04	1048.40	884.64
Jurinea macrocephala	381.34	309.02	285.03	438.88
Picrorhiza kurrooa	85.74	79.25	90.41	182.66
Podophyllum hexandrum	113.75	77.08	96.97	126.07
Rheum webbianum	343.06	319.56	329.58	372.10
Saussurea lappa	935.24	859.02	837.69	943.16

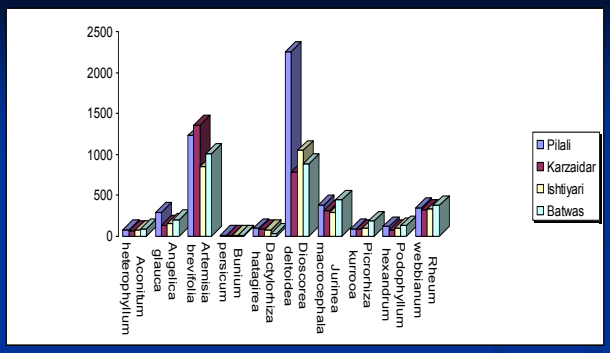

Figure- Bar Diagram for Comparative Dry Biomass Productivity in Padder Valley

Conclusions

- For *Aconitum heterophyllum* the maximum estimated total dry biomass(86.15) was found in Batwas (Site IV) and the minimum(62.32) in Karzaidar (Site II).
- The maximum estimated total dry biomass for *Angelica glauca* (285.94) was found in Pilali (Site I) and the minimum (133.48) in Karzaidar (Site II).
- For *Artemisia brevifolia* the maximum estimated total dry biomass (1354.24) was found in Karzaidar (Site II) and the minimum in Ishtiyari (Site III).
- The maximum estimated total dry biomass for *Bunium persicum* (7.56) was found in Ishtiyari (Site III) and the minimum (7.05) in Pilali (Site I).
- *Dactylorhiza hatagirea*'s maximum estimated total dry biomass (91.33) was found in Pilali (Site I) and the minimum (29.976) in Batwas (Site IV).
- The maximum estimated total dry biomass for *Dioscorea deltoidea* (2254.12) was found in Pilali (Site I) and the minimum (785.04) in Karzaidar (Site II).

- For *Jurinea macrocephala* the maximum estimated total dry biomass (438.88) was found in Batwas (Site IV) and the minimum (285.03) in Ishtiyari (Site III).
- The maximum estimated total dry biomass for *Picrorhiza kurrooa* (182.66) was found in Batwas (Site IV) and the minimum (79.25) in Karzaidar (Site II).
- For *Podophyllum hexandrum* the maximum estimated total dry biomass (126.07) was found in Batwas (Site IV) and the minimum (77.08) in Karzaidar (Site II).
- *Rheum webbianum*'s maximum estimated total dry biomass (372.10) was found in Batwas (Site IV) and the minimum (319.56) in Karzaidar (Site II).
- For *Saussurea lappa* the maximum estimated total dry biomass (943.16) was found in Batwas (Site IV) and the minimum (837.69) in Ishtiyari (Site III).
- The overall maximum estimated total dry biomass for all the species was found in Pilali (5804.94) followed by Batwas (4277.86), Karzaidar(4065.93) and Ishtiyari (3841.74).

Table - Productivity of selected medicinal plants in Pilali (Site 1) area of Padder valley

Species	Average wet biomss (gm/plant) n=10	Average dry biomss (gm/plant) n=10	Abundance	No. of plants/ha	Estimated Total wet biomass	Estimated Total dry biomass
Aconitum heterophyllum	10.773	5.236	1.5	15000	161.595	78.54
Angelica glauca	22.955	13.177	2.17	21700	498.124	285.941
Artemisia brevifolia	166.881	93.091	1.32	13200	2202.829	1228.801
Bunium persicum	0.57	0.36	1.96	19600	11.172	7.056
Dactylorhiza hatagirea	12.082	5.569	1.64	16400	198.145	91.332
Dioscorea deltoidea	173.066	103.4	2.18	21800	3772.839	2254.12
Jurinea macrocephala	54.418	22.301	1.71	17100	930.548	381.347
Picrorhiza kurrooa	14.367	7.086	1.21	12100	173.841	85.741
Podophyllum hexandrum	15.262	7.292	1.56	15600	238.087	113.755
Rheum webbianum	51.277	21.047	1.63	16300	835.815	343.066
Saussurea lappa	159.69	61.529	1.52	15200	2427.288	935.241

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Constitution of Forest Ecosystem Services Regulatory Authority for developing Effective Market Mechanism for the Ecosystem Services provided by Forests

Dr. Dvijendra K. Sharma,
Dr. Vinay Sinha, Prof. HS Gupta

Introduction

- Forests- tangible, intangible services
- National Goal of 33% area under forest cover.
- Considering 60 million hectares degraded land, Rs. 1200 billion will be required.
- Where from to get money?
- In Costa Rica “Environmentally adjusted water tariff”
- In India, FCA, 1980- NPV, CAT, CA, Rehabilitation of mined out area, Clean Energy Cess

How to generate fund ?

- Cost of Forest Conservation is local but benefits flow at all levels-local to global.
- Possibility is by evolving market based system for ecological services.
- It requires independent regulator “Forest Ecosystem Services Regulatory Authority (FESRA)”

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Valuing Forest Ecosystem Services

Selected Benefit	Value of Annual flow	Location	Source
Recreation / Eco-tourism	**Rs. 16197** / hectare	Keoldeo National Park, Bharatpur	Chopra (1998)
Eco-tourism	**Rs. 676** / hectare for locals	Periyar Tiger Reserve, Tamil Nadu	Manoharan (1996)
Water Supply	Annual rental Rs. **4745 / hectare**	Almora forests	Chaturvedi (1992)
Soil Conservation	**Rs. 21583** / hectare	Doon Valley	Kumar, (2000)
Ecological function for locals	**Rs. 624 / hectare**	Yamuna Basin	Chopra & (1997)
Carbon Store	**Rs. 20125/ hectare**	Indian Forests	Haripriya (1999)
Soil Conservation	**Rs. 2.0 lakh** / hectare meter of soil	Lower Siwalik (Yamuna basin)	Chopra and Kadekodi (1997)

Creation of Forest Ecosystem Services Regulatory Authority (FESRA) for Market Mechanism for Ecological Services to Operate

- **Identification and quantification of Forest Ecosystem Services.**
- **Identification of key beneficiaries.**
- **Designing Forest Ecosystem Services charges for beneficiaries.**
- **Development of a system for payment to landowners.**
- **Deciding Forest Ecosystem Adjusted Water / Electricity Tariff, Pollution Tax on petroleum, minerals and ores etc.**
- **Political, legal and institutional issues.**

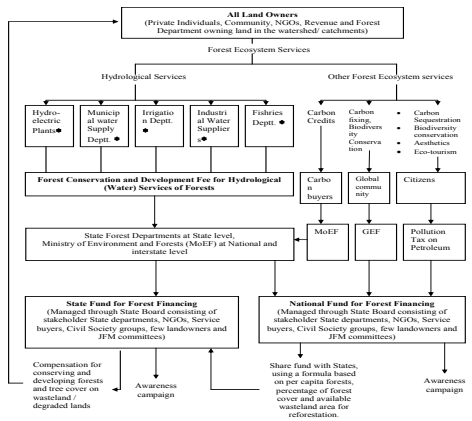

Figure 1: Proposed Structure for payment of Forest Ecosystem Services to Landowners in Watershed / Catchments
(Modified and developed after Costa Rican Eco-markets Program). Source: Pagiola. 2002

Learning experiences

- **A case for Conservation of Watershed Areas for providing Water supply to Mumbai Metropolitan area**

125 Lts*18 million*365 days* Rs. 1/1000 lts. =Rs. 82 crores per year from drinking water. Another 50-60 crores from Ind. water

- **Afforestation Programme by Tirupati Thirumala Devasthanam(TTD)**
- **Pollution Tax on Petroleum**
- Clean Energy Cess by GoI on Fossil Fuels.

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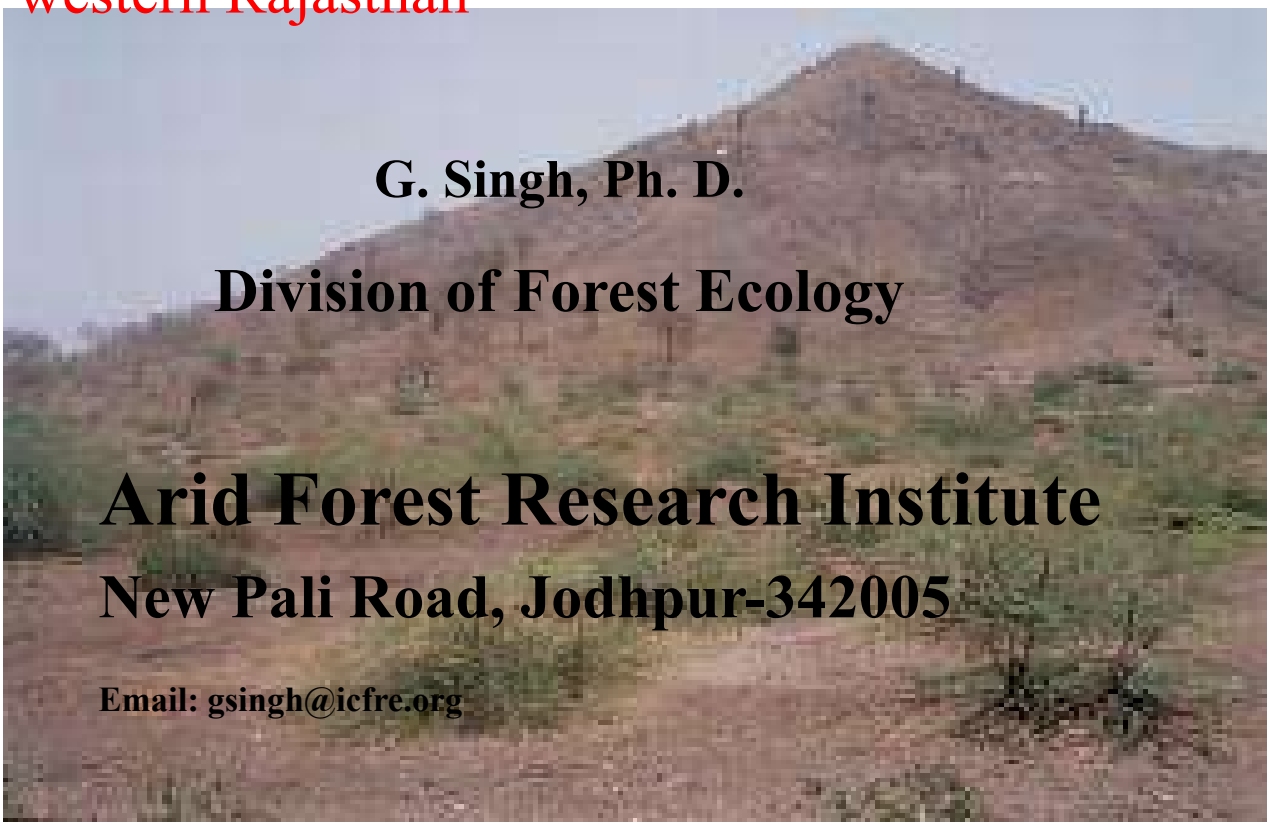
Rainwater harvesting enhances restoration process and carbon storage in degraded hills in south-western Rajasthan



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LAY OUT PLAN OF EXPERIMENT

Slope category

Violet: < 10%

Red: 10 - 20%

Blue: >20%

RWH devices (5)

Control

Contour trench

Gradonie

Box trench

V-ditches

Replicates: 5

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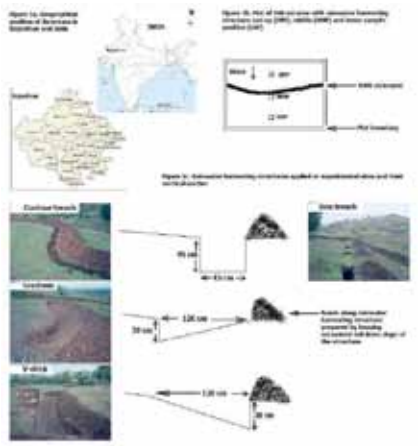
RAINWATER HARVESTING STRUCTURES & PLANTED SPECIES



Species planted

Acacia catechu,

Azadirachta indica,

Embilca officinalis,

Holoptelia integrifolia

Zyziphus mauritiana

RESEARCH METHODS

- The experiment was laid in **complete randomized block design** with five replications.
- Seventy-five plots of 700 m^2 area with **slope gradient** of <10%, 10-20% and >20% and rainwater harvesting treatments of **Contour trench**, **Gradonie**, **box trench** and **V-Ditch** along with a control as 'no RWH'.
- Each plot was planted with 35 numbers of seedlings (@ 500 plants per ha) of different tree species e.g. *Acacia catechu*, *Azadirachta indica*, *Emblica officinalis, Holoptelia integrefolia* and *Zizyphus mauritiana* under mixed plantation in August 2005.
- **Height and collar diameter** were recorded in September 2005 and again in December and June of each year to monitor seasonal growth i.e., monsoon and spring.

RESEARCH METHODS.....

Soil water content

- Soil water content was determined in June (i.e., before monsoon), July to November (during monsoon period) and in December (after monsoon and water utilization by growing vegetation) to monitor soil water status and utilization by the growing vegetation.

Soil nutrients

- Soil samples were collected from 0-40 cm soil layer for texture and nutrient analysis. Soil pH, SOC, NH_4-N, NO_3-N and PO_4-P were determined to monitor changes in these variables due to water harvesting, plantation and herbage growth.

Photosynthetically active radiation

- PAR was monitored at ground surface and above –vegetation in September 2007, 2008 and 2010 to examine the extent of light intercepted by tree and grasses.

SEASONAL CHANGES IN SOIL WATER

Slope	Treat	Soil water content (%)									
		Dec05	June06	Dec06	June07	Dec07	Dec08	June09	Dec09	June10	Mean
<10%	C	4.19	1.08	5.87	1.85	4.04	4.81	0.59	3.76	0.64	2.97
	CT	6.29	1.35	6.07	1.50	4.17	4.57	0.79	2.89	0.95	2.98
	G	5.93	0.89	5.92	1.36	3.40	4.15	0.59	3.47	0.89	2.80
	BT	6.57	1.33	6.57	1.81	5.03	5.56	0.69	4.18	1.59	3.56
	VD	5.93	1.08	6.90	1.29	5.61	5.69	0.75	3.84	1.01	3.38
10-20%	C	1.68	0.64	2.64	1.42	2.03	1.96	0.29	2.97	0.75	1.57
	CT	3.21	1.48	4.44	1.00	3.21	3.13	0.62	3.42	1.03	2.32
	G	3.34	1.19	5.48	1.26	3.53	2.91	0.41	3.79	0.68	2.42
	BT	3.63	1.07	4.91	1.47	2.39	2.36	0.55	2.33	0.88	2.27
	VD	3.52	0.74	3.59	0.99	2.48	1.58	0.26	2.63	0.68	1.80
>20%	C	1.76	1.21	4.65	0.93	4.00	3.50	0.78	2.41	0.82	2.11
	CT	3.45	1.56	6.00	1.22	3.62	3.35	0.79	2.79	1.30	2.53
	G	2.55	1.39	6.16	1.25	2.59	4.14	0.72	2.89	0.99	2.42
	BT	2.56	1.67	7.53	1.51	2.38	3.88	0.67	1.69	0.84	2.40
	VD	2.39	2.07	4.67	1.21	3.06	3.40	0.72	3.24	1.25	2.38

Result

- Soil water content depended on rainfall. It was highest in December 2006 and lowest in June 2009 .
- There is a decrease in variability in SWC between different slopes

CHANGES IN SOIL WATER CONTENT

Slope	RWH treatment	Average soil water content (%)			Soil water depletion (%)
		December	June	Average	
<10%	Control	4.61±0.42	1.42±0.12	3.16±0.25	67.88±4.47
	Contour trench	4.99±0.68	1.17±0.31	3.25±0.51	77.84±2.41
	Gradonie	4.71±0.48	1.02±0.14	3.03±0.31	78.18±1.75
	Box trench	5.77±0.37	1.55±0.25	3.85±0.31	73.86±2.74
	V-ditch	5.93±0.31	1.17±0.09	3.77±0.19	80.15±1.56
10-20%	Control	2.49±0.48	0.88±0.17	1.76±0.33	63.03±4.01
	Contour trench	3.74±0.56	1.15±0.21	2.56±0.39	69.47±2.25
	Gradonie	3.96±0.71	1.04±0.21	2.63±0.48	73.85±1.32
	Box trench	3.40±0.37	1.42±0.43	2.50±0.25	55.25±16.59
	V-ditch	2.91±0.44	0.84±0.15	1.98±0.30	70.95±3.01
>20%	Control	3.72±0.78	0.95±0.19	2.46±0.49	72.89±3.58
	Contour trench	4.24±0.59	1.22±0.14	2.87±0.37	70.15±3.04
	Gradonie	4.28±0.51	1.16±0.12	2.86±0.32	72.11±2.64
	Box trench	4.01±0.62	1.19±0.15	2.72±0.39	69.32±3.31
	V-ditch	3.99±0.43	1.23±0.08	2.73±0.27	68.43±1.88
	Average	4.18±0.16	1.16±0.05	2.81±0.11	70.89±1.37

PLANT SURVIVAL

Slope	RWH treatment	Tree species				
		A. catechu	*A. indica*	*E. officinalis*	*H. integrifolia*	*Z. mauritiana*
<10%	Control	91.67±8.33	86.00±4.00	74.85±10.52	83.33±16.67	75.83±15.83
	Contour trench	86.67±6.67	90.00±10.00	84.86±8.13	100.00±0.00	73.57±3.57
	Gradonie	85.71±14.28	68.75±13.77	91.11±8.89	69.05±2.38	75.57±11.93
	Box trench	75.00±25.00	78.67±8.79	84.39±6.46	40.00±0.00	88.89±5.56
	V-ditch	100.00±0.00	78.00±13.57	86.98±8.09	75.00±25.00	88.14±3.56
10-20%	Control	83.33±16.67	61.45±14.17	73.33±13.73	65.51±12.74	80.00±6.39
	Contour trench	79.17±12.50	70.83±17.18	78.26±7.55	64.58±17.80	87.78±9.68
	Gradonie	72.14±9.87	73.33±13.33	98.46±1.54	61.11±20.69	48.33±1.67
	Box trench	81.67±9.28	76.79±13.48	88.06±6.14	47.68±5.34	90.92±3.97
	V-ditch	90.63±9.38	80.59±12.53	82.06±9.57	53.18±9.54	89.33±6.86
>20%	Control	60.45±2.63	45.83±4.17	82.64±11.14	75.00±25.00	71.71±10.87
	Contour trench	88.87±4.96	87.50±12.50	69.64±9.76	68.33±4.41	82.62±5.84
	Gradonie	91.50±5.89	75.00±25.00	71.61±10.37	56.35±3.46	92.86±7.14
	Box trench	79.51±8.95	83.33±16.67	92.14±5.10	63.33±18.56	79.77±18.31
	V-ditch	91.81±3.45	83.33±16.67	92.26±4.49	45.23±11.90	82.50±11.81
	Average	81.06±2.64	77.06±3.27	83.34±2.21	59.20±3.55	84.16±3.54

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PLANT GROWTH

- Growth data showed taller and thicker plants in the plots with <10% slope that decreased with increase in slope gradient.
- Performance of *H. integrifolia* was better in the plots with 10-20% slope showing its preference to light soil condition.
- Growth of *A. catechu* was highest in >20% and <10% slope was due to clayey nature of the soil in these slopes.
- *Azadirachta indica* and *A. catechu* performed better in V-ditch plots; *E. officinalis, H. integrifolia and Z. mauritiana* performed better in contour trench plots.

MEAN ANNUAL INCREMENTS

Slope	Treat	*A. catechu*		*A. indica*		*E. officinalis*	
		Height	Collar dia	Height	Collar dia	Height	Collar dia
S1	C	61.4±2.63	0.9±0.12	53.1±2.78	0.8±0.07	36.8±2.80	0.8±0.06
	CT	55.1±7.15	1.0±0.13	57.2±9.17	0.9±0.13	45.9±5.85	0.9±0.06
	G	55.5±5.55	1.2±0.08	58.3±7.02	0.9±0.08	41.6±3.80	0.9±0.07
	BT	51.4±0.00	0.9±0.06	53.7±8.81	0.9±0.13	45.8±4.93	1.0±0.08
	VD	76.8±2.82	1.4±0.12	67.2±7.72	1.1±0.12	44.3±4.54	1.0±0.08
S2	C	14.5±0.50	0.5±0.01	26.7±9.09	0.6±0.11	28.7±4.33	0.7±0.06
	CT	58.1±8.70	1.2±0.12	48.0±2.16	0.8±0.04	45.5±4.24	1.0±0.11
	G	45.9±6.54	0.8±0.13	43.2±2.67	0.8±0.02	30.9±1.20	0.7±0.01
	BT	57.6±7.95	1.0±0.07	44.7±2.87	1.0±0.08	32.7±1.95	0.8±0.07
	VD	52.2±4.68	0.9±0.07	61.0±3.02	1.0±0.10	32.0±3.90	0.7±0.07
S3	C	49.1±6.73	0.9±0.10	36.5±2.50	0.6±0.02	26.8±1.78	0.7±0.03
	CT	55.6±4.90	1.1±0.09	44.6±4.00	0.8±0.13	40.8±4.21	0.9±0.06
	G	43.8±7.21	1.0±0.12	42.4±8.28	0.8±0.09	36.6±6.34	0.8±0.05
	BT	57.9±5.79	1.1±0.09	50.9±4.00	0.8±0.04	29.3±4.97	0.8±0.07
	VD	57.8±8.86	1.0±0.08	49.2±2.49	0.7±0.03	35.2±4.88	0.7±0.04

MEAN ANNUAL INCREMENTS

Slope	Treat	*H. integrefolia*		*Z. mauritiana*	
		Height	Collar dia	Height	Collar dia
<10%	C	21.4±2.80	0.7±0.15	37.2±5.58	0.5±0.06
	CT	27.2±2.44	0.6± 0.05	42.9±1.63	0.8±0.01
	G	18.4±0.00	0.7±0.10	35.8±3.34	0.5±0.01
	BT	20.6±0.00	0.6±0.00	38.6±3.70	0.5±0.01
	VD	8.8±0.00	0.4±0.06	51.2±2.51	0.7±0.02
10-20%	C	7.8±1.00	0.5±0.04	19.3±5.59	0.4±0.07
	CT	26.3±1.67	0.6±0.03	36.8±4.86	0.6±0.03
	G	17.6±2.91	0.6±0.02	29.3±1.58	0.3±0.05
	BT	20.4±3.19	0.6±0.02	38.7±3.12	0.6±0.05
	VD	16.6±1.61	0.5±0.02	34.7±3.40	0.5±0.06
>20%	C	17.5±3.82	0.5±0.06	37.5±9.02	0.4±0.09
	CT	19.4±2.83	0.5±0.03	34.7±4.28	0.4±0.03
	G	14.5±2.55	0.6±0.07	32.8±3.28	0.5±0.06
	BT	18.4±1.11	0.5±0.02	29.6±1.91	0.4±0.03
	VD	18.0±1.42	0.5±0.01	36.2±1.51	0.5±0.04

CHANGES IN SOIL CARBON AND ITS STORAGE

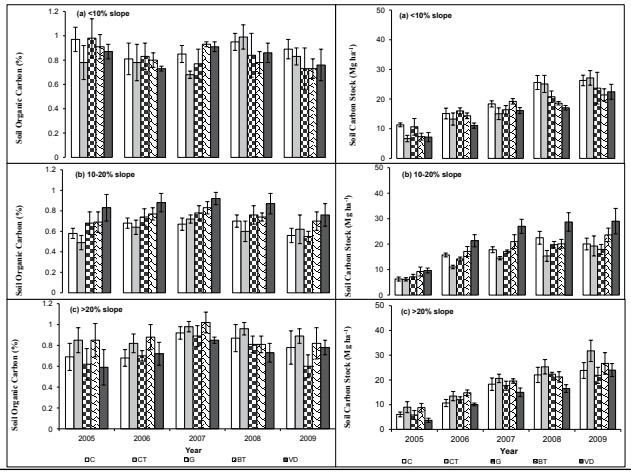
Slope	RWH treatment	Soil content (%)		Soil Organic Carbon (%)		Soil carbon stock (Mg ha^{-1})	
		June 2005	June 2010	June 2005	June 2010	June 2005	June 2010
<10%	Control	18.69±2.43	53.73±2.38	0.98±0.10	0.87±0.05	11.31±0.65	30.36±2.71
	Cont. trench	14.27±0.90	63.54±2.16	0.78±0.14	0.88±0.02	6.69±1.08	34.48±1.16
	Gradonie	17.81±3.26	60.31±2.33	0.98±0.16	0.86±0.15	10.64±2.81	31.95±5.26
	Box trench	14.79±3.58	59.06±4.77	0.92±0.10	0.90±0.08	7.34±1.16	30.60±1.78
	V-ditch	13.72±2.13	58.04±3.96	0.87±0.06	0.88±0.07	7.17±1.54	29.29±2.52
10-20%	Control	18.54±3.52	66.92±1.09	0.58±0.05	0.93±0.10	6.29±0.80	24.93±3.55
	Cont. trench	21.19±2.35	59.19±2.28	0.48±0.08	0.74±0.16	6.16±0.64	26.72±5.04
	Gradonie	18.15±2.48	63.90±3.02	0.68±0.11	0.85±0.10	7.14±0.98	32.21±3.87
	Box trench	21.60±1.69	63.64±0.93	0.69±0.10	0.93±0.10	9.24±1.76	35.70±3.47
	V-ditch	19.54±2.24	66.36±3.04	0.83±0.13	0.83±0.09	9.64±0.96	35.06±3.73
>20%	Control	15.84±1.88	58.77±0.93	0.69±0.13	0.95±0.10	6.06±0.97	31.62±2.63
	Cont. trench	16.91±2.07	70.45±2.43	0.86±0.12	1.11±0.09	8.99±2.23	45.09±2.27
	Gradonie	16.59±2.70	71.98±1.18	0.62±0.14	1.08±0.24	5.83±1.79	44.52±9.18
	Box trench	18.68±2.79	70.66±2.24	0.85±0.16	0.93±0.08	8.79±1.72	37.57±1.79
	V-ditch	12.26±1.36	64.53±2.05	0.59±0.17	1.03±0.04	3.69±0.85	36.49±1.21
	Average	17.24±0.65	63.41±0.83	0.76±0.03	0.92±0.03	7.67±0.41	34.63±1.08

There is continuous increase in soil content, which is relatively greater in >20% slope up to June 2008 and in >20% slope in 2009 and 2010. Among RWH, it was highest in Gradonie plots in 2009 and 2010

LIGHT INTERCEPTION

Slope	RWH treatment	Light interception (%)		
		Int_{Total}	Int_{Tree}	$Int_{Herbage}$
<10%	Control	87.49±6.33	45.22±8.78	42.26±6.66
	Contour trench	94.00±0.33	31.59±9.50	62.41±9.77
	Gradonie	91.43±1.17	31.94±10.92	59.49±11.73
	Box trench	85.62±6.63	42.88±5.76	42.74±6.94
	V-ditch	90.99±1.77	42.14±11.69	48.85±10.35
10-20%	Control	61.49±12.95	18.73±8.51	42.75±11.18
	Contour trench	84.65±4.24	20.37±6.50	64.27±5.43
	Gradonie	85.44±3.15	10.55±3.65	74.90±2.76
	Box trench	85.43±5.14	31.30±6.95	54.14±6.88
	V-ditch	75.40±6.97	17.34±3.78	58.05±4.52
>20%	Control	82.64±6.71	29.94±8.38	52.69±4.94
	Contour trench	85.93±3.31	34.74±7.75	51.19±6.92
	Gradonie	82.30±6.20	30.15±8.33	52.16±5.98
	Box trench	90.48±1.49	36.16±7.37	54.33±6.45
	V-ditch	86.35±4.50	27.08±9.43	59.28±8.23
	Average	84.64±1.58	30.01±2.19	54.63±2.04

TEMPORAL CHANGES IN SOC AND CARBON STOCK IN SOIL



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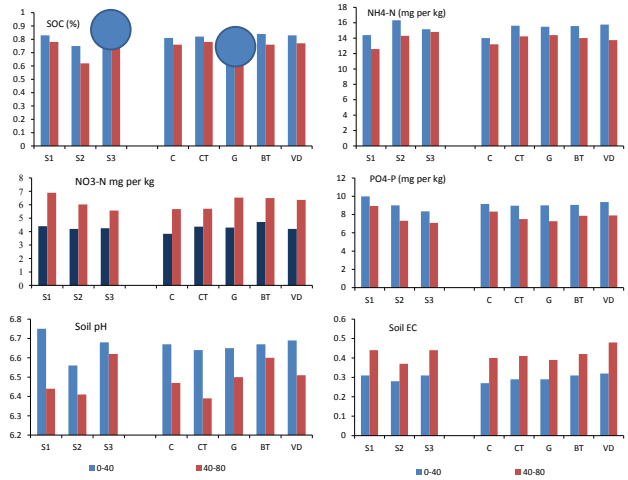

CONCLUSION AND RECOMMENDATIONS

- Protection measures and afforestation supported by rainwater harvesting enhanced vegetation status and biomass production.
- V-ditch and gradonie rainwater devices had greater influences on soil water status than CT and BT devices in December, but reverse trend was in observed in June.
- V-ditch and gradonie facilitated water distribution in upper soil layers and suitable for herbaceous growth and soil carbon storage.
- Contour trench facilitated water storage in deep soil profile and was utilized by the deep rooted woody perennials.
- BT structures facilitated water distribution in both surface layer favourable for herbage growth during monsoon and deep storage of water utilized by woody growth after monsoon.

CONCLUSION AND RECOMMENDATIONS

- Area with <10% slope had higher availability of soil water, greater survival and growth of the planted seedlings.
- *H. integrifolia* prefers light soil, whereas *A. catechu* preferred heavy soil conditions.
- Foot hills are more suited for plant growth but rainwater harvesting facilitates the growth of trees and herbaceouse vegetation even in hillslope enhancing the rate of rehabilitation.
- V-ditch and gradonie structures are best suited to increase herbaceous layer production, though *A. catechu* and *A. indica* also suited to V-ditch for their growth.
- Contour trench is best suited to *E. officinalis*, *H. integrifolia* and *Z. mauritiana*.

A VISUAL CHANGE AT SITE

Changes in vegetation pattern due to RWH and Afforestation

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Population estimation of some important tree species of Asola Bhatti Wildlife Sanctuary

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Background

- Asola Bhatti Wildlife Sanctuary (WLS) consists of two areas,
  - ✓ Notified Gaon Sabha Lands of **Asola** with an area of 1905 ha and
  - ✓ Abandoned Mine Pits of **Bhatti** with an area of 853 ha
- Situated in the undulating hilly and rocky terrain of North Western terminal of Arawali Mountains in South Delhi

- Asola – Bhatti Wildlife Sanctuary spreading over 2757 ha falls in South district of Delhi state
- Sanctuary lies between 77° 7' – 77° 15' longitude and 28° 25' - 28° 30' latitude
- Active mining of quartzite sand (commonly known as **Badarpur**) lead to severe degradation of the Southern Ridge
- Mining activity continued across the border in Haryana (adjoining Bhatti WLS) and near Gujriwala in Delhi till – 1995.

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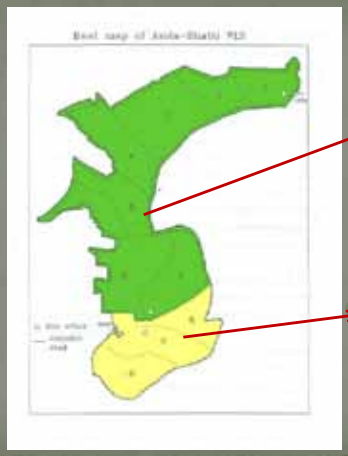
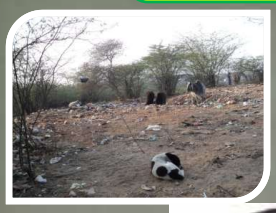


- Altitudinal variation in the sanctuary ranges from 130 to 320 meters above mean sea level
- According to Champion & Seth Classification (1968) it belongs to Northern Tropical Thorn Forests type (6B/C).
- Vegetation of the area is predominantly an open canopied thorny scrub

Human Infringement



Dumping site

Construction

Sampling Methodology

- Map of the Asola Bhatti WLS was divided into different imaginary grids (Size 50 X 50 meter)
- Map of the PA along with the grids was calibrated with the toposheet
- Each grid were assigned a unique number
- Simple Random Sampling was used to identify the grids
- Sample grids were selected with Random Number Table
- Latitude and longitude of the selected grids were found

- With the help of GPS, the selected grids were indentified in the field with the latitude and longitude
- Number of sample grids were decided based on the variability available in the study area
- A total of **119** sample grids were selected for this study, which is approximately **29.75 ha (1.1%)** of the total geographical area
- Complete enumeration of all the trees species in different diameter class in the selected grids were carried out.

Number of sample grids

- Number of sample grids required for the detailed field inventory by using the following formula
- For sufficiently large N, the sample size can be estimated as

$$n = \left(\frac{t_\alpha \times CV(Y)}{r}\right)^2$$

Where

- ✓ *CV(Y)* - Coefficient of Variation
- ✓ r - Permissible Error
- ✓ t_a - Value of t distribution at level of significance

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Estimation of tree population

- Ratio Estimation technique was used for estimating the number of different trees species
- Estimated number of trees say T, is given by

$$\hat{T} = A\hat{R} = A\frac{\bar{y}}{\bar{x}}$$

Where

$$\hat{R} = \frac{\frac{1}{n}\sum_{i=1}^{n} y_i}{\frac{1}{n}\sum_{i=1}^{n} x_i} = \frac{\bar{y}}{\bar{x}}$$

$\bar{y}$ = Average number of trees per sample plot

$\bar{x}$ = Average area of the sample plot

Standard Error for $\hat{T}$

$$SE \text{ of } \hat{T} = \sqrt{V(\hat{R})}$$

Results

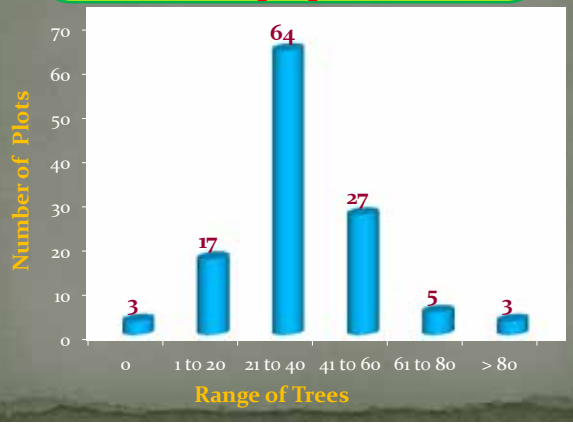
Different tree species found in the selected plots/grids

Common Name	Botanical Name
Keekar	*Prosopis juliflora*
Ronj	*Acacia leucophloea*
Hingot	*Balanites aegyptiaca*
Pasendu	*Diospyros montana* var. *cardiafolia*
Dhak	*Butea monosperma*
Kakeda	*Maytenus senegelanses*
Dhau	*Anogeissus pendula*
Kareel	*Capparis decidua*
Neem	*Azadirachta indica*
Heens	*Capparis sepiaria*
Karounda	*Carissa opaca*
Shisham	*Dalbergia sissoo*

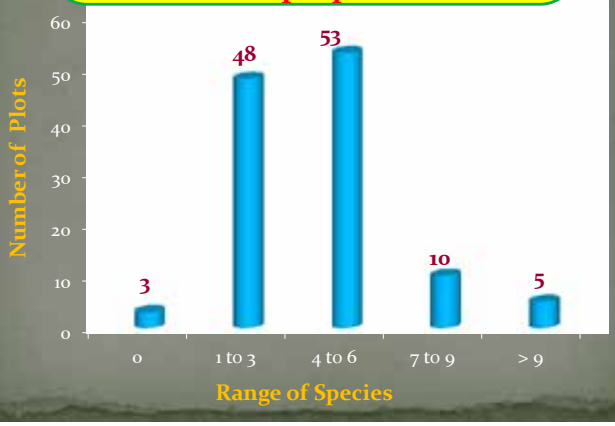
Species wise number of trees in different diaclasses in the sample plots

Species	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	No of Trees
Prosopis juliflora	1346	803	175	48	20	8	4	2	2406
Acacia leucophloea	143	203	118	39	7	5	1	0	516
Balanites aegyptiaca	186	72	23	5	1	0	0	0	287
Diospyros montana var. cardiafolia	113	131	32	5	6	0	0	0	287
Butea monosperma	37	43	27	11	4	9	0	0	131
Maytenus senegelanses	70	35	4	0	0	0	0	0	109
Anogeissus pendula	34	34	13	6	0	0	0	0	87
Capparis decidua	76	24	4	1	0	0	0	0	105
Azadirachta indica	15	24	3	6	3	0	0	0	51
Capparis sepiaria	23	6	2	1	0	0	0	0	32
Carissa opaca	26	4	0	0	0	0	0	0	30
Dalbergia sissoo	7	16	3	0	1	0	0	0	27
Ficus religiosa	1	5	2	0	4	7	0	0	19
Holoptelia integrifolia	2	5	2	2	1	1	2	0	15
Sasbania sesban	0	5	1	3	2	0	0	0	11

Tree distribution across the sample plots



Species distribution across the sample plots



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Estimation of diaclass wise tree population

Species	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45
Prosopis juliflora	124761	74430	16221	4449	1854	742	371	185
(Kabuli Kikar)- SE(%)	11.653	12.075	16.658	36.778	51.338	65.538	71.959	83.328
Acacia leucophloea	13255	18816	10937	3615	649	463	93	0
(Raunj) - SE(%)	15.882	14.656	19.295	30.810	49.756	61.937	118.347	0.000
Carissa opaca	2410	371	0	0	0	0	0	0
(Karounda) - SE(%)	40.453	58.416	0	0	0	0	0	0
Balanites aegyptiaca	17240	6674	2132	463	93	0	0	0
(Hingot) - SE(%)	30.438	29.363	41.517	61.937	118.347	0	0	0
Holoptelia integrifolia	185	463	185	185	93	93	185	0
(Chudail papdi) -SE(%)	83.328	70.471	83.328	118.347	118.347	118.347	83.328	0
Diospyros montana var. *cardiafolia*	10474	12142	2966	463	556	0	0	0
(Pasendu) - SE(%)	21.700	17.842	34.720	78.078	61.683	0	0	0
Capparis sepiaria	2132	556	185	93	0	0	0	0
(Heens) - SE(%)	40.869	73.309	83.328	118.347	0	0	0	0
Capparis decidua	7044	2225	371	93	0	0	0	0
(Kareel) -SE(%)	37.00	38.1	93.3	118.3	0	0	0	0

Contd.....

Butea monosperma	3430	3986	2503	1020	371	834	0	0
(Dhak) - SE(%)	46.933	36.402	49.188	43.194	58.416	67.746	0	0
Anogeissus pendula	3151	3151	1205	556	0	0	0	0
(Dhau) - SE(%)	50.930	45.345	46.237	73.309	0	0	0	0
Dalbergia sissoo	649	1483	278	0	93	0	0	0
(Shisham) - SE(%)	49.756	46.890	118.347	0	118.347	0	0	0
Azadirachta indica	1390	2225	278	556	278	0	0	0
(Neem) - SE(%)	53.215	40.582	67.746	61.683	87.911	0	0	0
Maytenus senegelanses	6488	3244	371	0	0	0	0	0
(Kakera) - SE(%)	30.974	59.854	93.323	0	0	0	0	0
Ficus religiosa	93	463	185	0	371	649	0	0
(Peepal) - SE(%)	118.347	61.937	83.328	0	83.328	69.150	0	0
Crateva adansonii DC. ssp. *odora*	0	278	278	371	0	0	0	0
(Barna) - SE(%)	0	87.911	118.347	118.347	0	0	0	0
Sesbania sesban	0	463	93	278	185	0	0	0
(Jhot) - SE(%)	0	52	118	88	118	0	0	0

Estimation of tree population of PA

Botanical Name	Species	Estimated Trees	SE(%)
Prosopis juliflora	Kabuli Kikar	221,154	09.53
Acacia leucophloea	Raunj	47,430	12.62
Diospyros montana var. *cardiafolia*	Pasendu	26,380	16.78
Balanites aegyptiaca	Hingot	26,380	25.47
Butea monosperma	Dhak	12,041	34.00
Maytenus senegelanses	Kakera	10,019	36.37
Capparis decidua	Kareel	9,732	34.42
Anogeissus pendula	Dhau	7,997	38.40
Carissa opaca	Karounda	2,758	39.47
Capparis sepiaria	Heens	2,941	41.09
Azadirachta indica	Neem	4,688	41.68
Sasbania sesban	Jhot	1,011	43.38
Dalbergia sissoo	Shisham	2,482	43.51
Ficus religiosa	Peepal	1,746	44.40
Holoptelia integrifolia	Chudail papdi	1,379	51.02
Pongamia pinnata	Papdi	368	58.66
Acacia nilotica ssp. *indica*	Babool	735	62.34
Leucaena leucocephala	Su Babool	460	70.77

Discussion and Conclusion

- Pattern of tree and species distribution reveals that the WLS is well represented by good vegetative cover.
- Widly available tree species is *Prosopis juliflora* (Kabuli Kikar) followed by *Acacia leucophloea* (Raunj), *Diospyros montana* var. *cardiafolia* (Pasendu), *Balanites aegyptiaca* (Hingot) etc.
- Estimated population for *Prosopis juliflora* is 2,21,154 with Standard Error 9.5%.

- Analysis facilitates management decisions on species of conservation priority.
- Analysis makes the basis for estimating the growing stock of the PA.
- Also helps to assess the plant species diversity, estimation of carbon sequestration.

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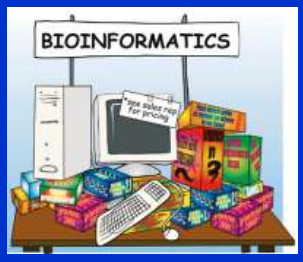
Biodiversity Informatics



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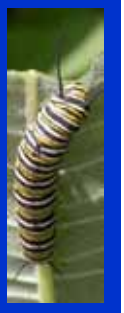
Biodiversity

Biodiversity is the variety of species, their genetic make-up, and the natural communities in which they occur, processes that sustain life on Earth.



Biodiversity Informatics ?

- **Biodiversity Informatics** is the application of informatics techniques to biodiversity information for improved management, presentation, discovery, exploration and analysis.
- It typically builds on a foundation of taxonomic, biogeographic, or ecological information stored in digital form, which, with the application of modern computer techniques.
- Biodiversity informatics is a relatively young discipline (the term was coined in or around 1992) but has hundreds of practitioners worldwide, including the numerous individuals involved with the design and construction of taxonomic databases.

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A Newfield in science

- Biodiversity Informatics. This is a broad field of applying ICT to all kinds of biological sciences using computer software, digital high capacity dissemination media and fast electronic networks to exchange and combine information.

4

The Role of Biodiversity Informatics

- **Biodiversity Informatics offers new tools and technologies for speeding up inventories / information on biodiversity and forging collaboration among the many agencies and individuals collecting and holding data**

5

Opportunities in Technology by Biodiversity Informatics

- **Increasing access to technology tools**
- **Internet more accessible**
- **Increasing use of the web for information exchange**
- **Development of innovative mobile applications**
- **Ability to have shared data and shared services**
- **Global efforts and tools to compile biodiversity information**

6

How Biodiversity Informatics help to conserve Forests

- Biodiversity Informatics provide the **"Knowledge"** of each and every aspect of biological data in a scientific manner.
- Information of primary biodiversity data would be accessible for biodiversity management.
- If we have data and knowledge, then any forest ecosystem can be conserve using proper tools and techniques.

7

Biodiversity Informatics in FRI

- The Digitization work of Biological / Natural History Collection in progress (i.e. Botany Herbarium Digitization,Insects Collection Database, Medicinal Plants Database etc.)
- DNA Marker Data basing of *cedrus deodara* species has completed.
- National Forest Informatics web-portal development is the process (All forests biodiversity / research information will be on the internet.)
- Educational & awareness programme going to motivate the development of Biodiversity informatics.

8

What do we mean by primary biodiversity data?

- Label data on ~ 1.5 - 3.0 billion specimens in natural history collections, herbaria, botanical gardens, etc.

- Associated notes, recordings, publications, etc.
- Observational data (e.g. bird banding data)
- These data have been amassed over ~ 300 years; most not digital

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Biodiversity and information about it are unevenly distributed….

- biodiversity hotspot
- holder of large amounts of biodiversity data

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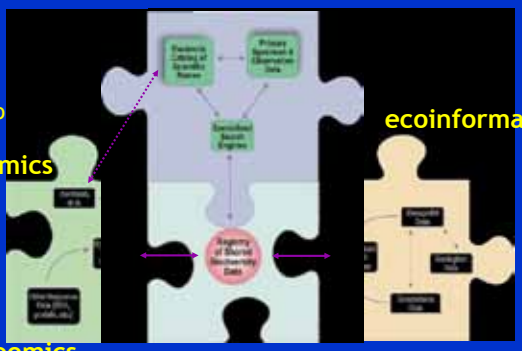
True bioinformatics …

"bioinfo

genomics



ecoinformatics

proteomics

biodiversity informatics

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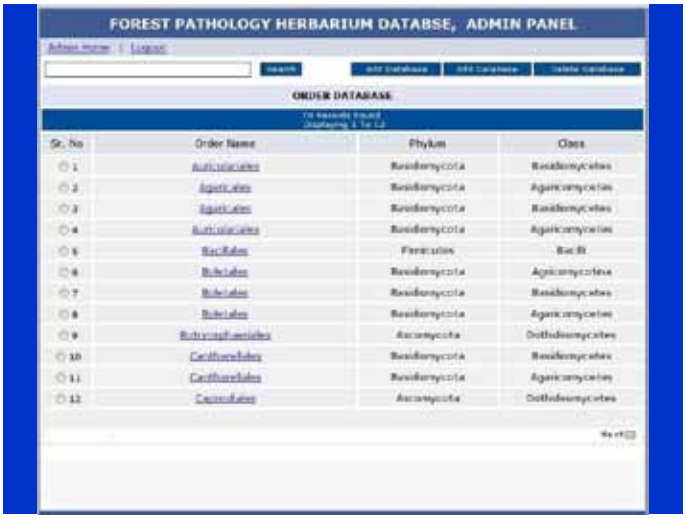

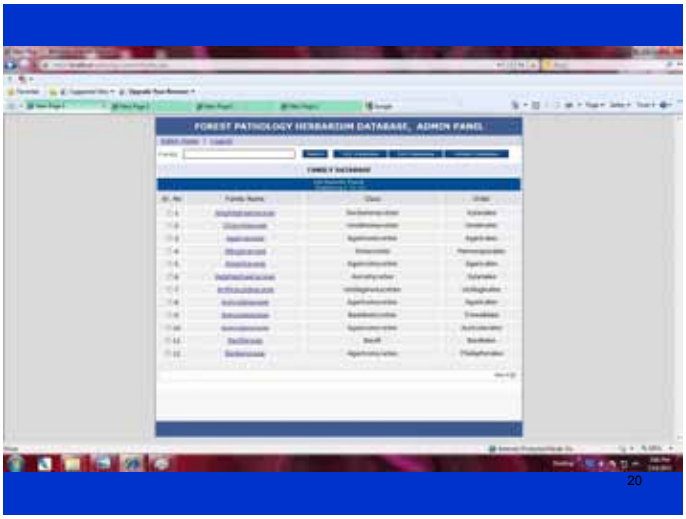

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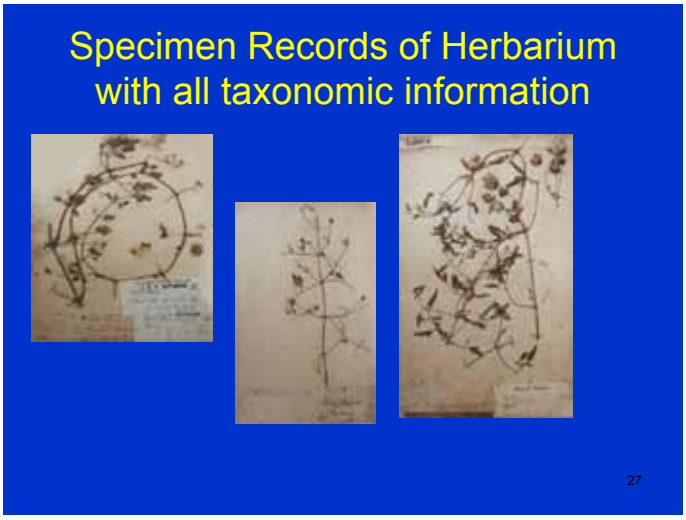

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Population Genetic Analysis and characterization of *Cedrus deodara* Germplasm through DNA Based Markers

Objective

- Analysis of population genetic structure and diversity in *Cedrus deodara* forests of Himalayas.
- Characterization of the selected germplasm of deodar through DNA based markers for genetic relatedness.
- **Generating the fingerprints of deodar germplasm using DNA markers for development of DNA fingerprint database.**

DNA Fingerprints Database of *cedrus deodara*

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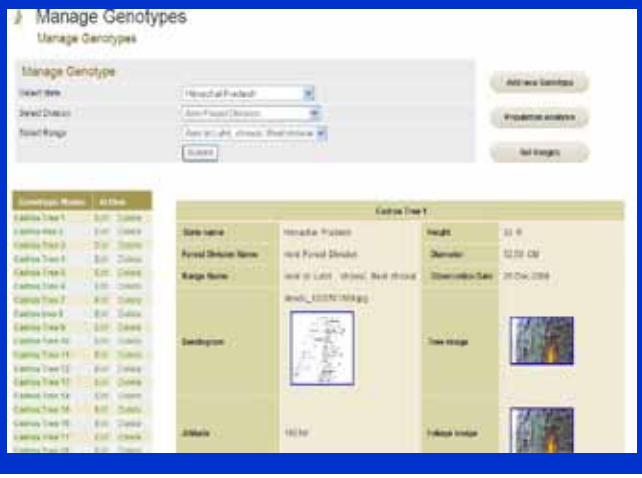

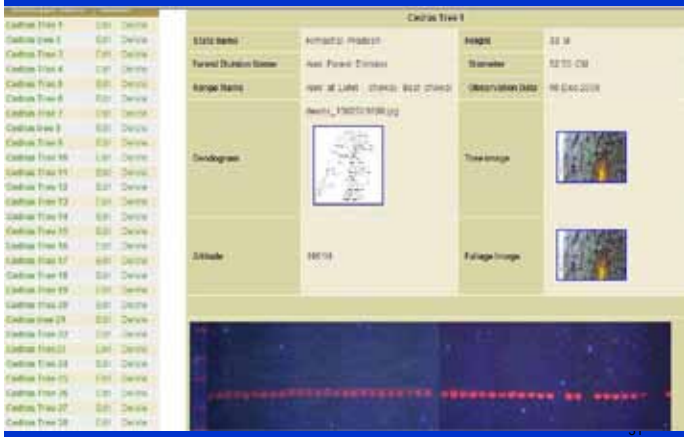

Mobilizing Primary Biodiversity Information

"Primary" biodiversity information can be considered the basic data on the occurrence and diversity of species (or indeed, any recognizable taxa), commonly in association with information regarding their distribution in either space, time, or both.

Such information may be in the form of retained specimens and associated information, for example as assembled in the natural history collections of museums and herbaria, or as observational records

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Current Biodiversity Informatics activities

- Application: Conservation / Agriculture / Fisheries / Industry / Forestry
- Application: Invasive Alien Species
- Application: Systematic and Evolutionary Biology
- Application: Taxonomy and Identification Systems
- New Tools, Services and Standards for Data Management and Access
  - New Modeling Tools
  - New Tools for Data Integration
  - New Approaches to Biodiversity Infrastructure
  - New Approaches to Species Identification
  - New Approaches to Mapping Biodiversity
- National and Regional Biodiversity Databases and Networks

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Useful Literature for Biodiversity Informatics by GBIF

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Ecotourism: An approach to sustainable livelihoods

1st IFC

AK Bhattacharya

Backdrop

- Tourism - one of the fastest growing industries
- Ecotourism
  - only non-consumptive use of natural resources
  - one of the most effective ways to ensure development hand in hand with conservation
- Benefits –
  - **Economic**
    (Livelihoods to locals, employment)
  - **Social**
    (Improvement in health, education and o facilities)
  - **Environmental**

Definition

- The International Union for the Conservation of Nature (IUCN) defines 'ecotourism' as

  "environmentally-responsible travel and visitation to relatively undisturbed natural areas, to enjoy, study and appreciate nature (and accompanying cultural features, both past and present), that promotes conservation, has lower visitor impact, and provides for beneficially active socio- economic involvement of local populations."

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The future of tourism..... *Ecotourism*

"Ecotourism, as it is called, is the mantra of the new age travel industry. As ecotourism has mostly to do with nature and wilderness, the Forest Department becomes a key actor in the activity centred on ecotourism. The Department's capacity needs to be augmented, infrastructure raised and mechanisms of inter-department and inter-sectoral collaboration worked out"

- National Forest Commission, 2006



Ecotourism Objectives

(i) Avoids negative impacts that damage or destroy the natural or cultural environments being visited;

(ii) Educates the traveler on the importance of conservation;

(iii) Directs revenues to the conservation of natural areas and the management of protected areas;

(iv) Brings economic benefits to local communities and directs revenues to local people living adjacent to protected areas;

(v) Emphasizes need for planning and sustainable growth of tourism and seeks to ensure that tourism development does not exceed the social and environmental "capacity";

(vi) Retains majority revenue in the local community by stressing the use of locally-owned facilities and services.

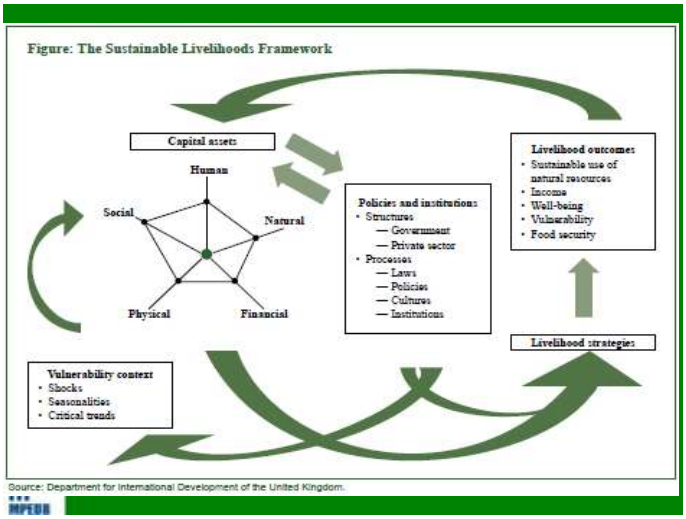
Sustainable Livelihoods Approach

- Livelihood essentially means
  - – the capabilities, assets, and activities required for living
- Sustainable livelihood should have
  - – a capacity to absorb shocks and be resilient towards stress, continuously adapting with the changes
- SLA Framework –
  - – A framework to understand the factors affecting sustainable livelihoods in a rural economy.

Sustainable Livelihoods Approach

- Guiding Principles
  - i) People Centred
  - ii) Responsive and participatory
  - iii) Multilevel
  - iv) Conducted in partnership
  - v) Dynamic
  - vi)Sustainable – Economically, institutionally, socially and y





Sustainable Livelihoods Approach in Ecotourism

- Community based Ecotourism proves to be an idealistic model for community development and sustainable livelihoods
- Ecotourism enterprises that are owned and managed by the community and involves conservation, business enterprise and community development.
  1. Self- Initiated and community managed
  2. NGO Initiated and community owned
  3. Co-managed i.e. Community Managed and Government Supported

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Ecotourism Entrepreneurship

Protected Areas

- Locals can be involved in
  - guiding,
  - homesteads,
  - local service outlets (vegetable hawkers, cobblers, mechanics, cleaners, etc.),
  - souvenir shops, arts and handicrafts,
  - vehicle owners and drivers,
  - conducting ecotourism activities (boating, cycling, tc)



Ecotourism Entrepreneurship

Forests outside Protected Areas

- Involvement from the planning stage,
- Helping in developing the site ecotourism plan acting as field resources
- Role as entrepreneurs for activities like cafeterias, arts and handicrafts outlets, performance arts groups and other ancillary activities.
- Employment as guides (for nature and cycling trails),
- Boatsmen
- Managers at interpretation centers
- Adventure activities
- Staff for destination

Ecotourism Entrepreneurship

Village areas

- Villagers can collaboratively work for development of homesteads.
- Small homesteads (with 3-4 rooms) where local people provide accommodation
- Act as local tour operators who can organise tours
- Operate traditional centers for publicizing their culture, traditions, arts, crafts, foods, etc.



Ecotourism Entrepreneurship

***Ex situ* Conservation areas (Ecological Gardens, Zoological Parks, Botanical Gardens, Eco-Parks and Biodiversity Parks)**

- Operate ecotourism activities and guided tours to the area
- Can be involved in maintenance jobs like gardeners, cleaners, field staff, guards, caretakers, etc.



SHG – Confederation model

- Different activities and facilities at a destination can be run through SHGs
- The group of SHGs clubbed in a cluster at district level – destination level ecotourism committee.
- A federation combining clusters of the district
- A state level confederation overseeing the working of all the federations can be constituted.



JFMC level Activity based SHG (like Camp management, nature interpretation, adventure sports)	Destination (Range) level Ecotourism Committee (Cluster of SHGs)	Division level Federation of Ecotourism Committees	Circle / State level Confederation of Ecotourism Federations
SHG - A 1	EC – Y 1	F - 1	CF
SHG – A 2			
SHG – A 3			
SHG - B 1	EC – Y 2		
SHG – B 2			
SHG – B 3			
SHG - C 1	EC – Z 2	F - 2	
SHG – C 2			
SHG – C 3			
SHG - D 1	EC – Z 2		
SHG – D 2			
SHG – D 3			

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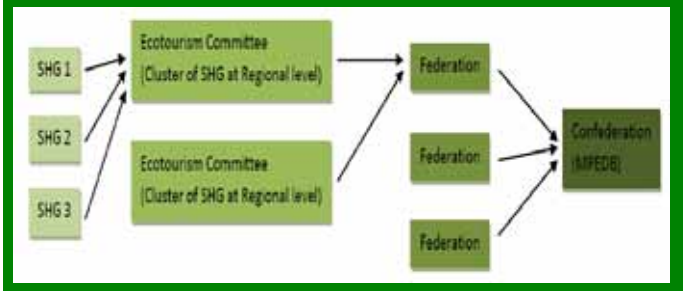

Policies and guidelines need to ensure that

- Existing viable economic opportunities and increased contributions of communities
- Majority income is retained in the local areas,
- There are proper systems for regulation and accreditation of services provided
- There exists initiatives to improve visitors' awareness and sensitivity to environmental issues,
- Ecotourism is small scale, slow growth and has local control,
- Natural resource management concerns are addressed by all stakeholders,

Local culture is not excessively exploited.

Conclusion

- Community development vis-à-vis economic development should be integral to every project
- Community should be the primary focus of every project
- Focus on community based models for ecotourism will help in catering to both - **conservation and livelihood**

Ecotourism has a huge potential to provide communities a sustainable way to earn livelihood with judicious use of available resources.

Capacity Building of local communities for Ensuring Livelihoods

TOURISM & ECOTOURISM (2004)

	FEATURE	TOURISM	ECOTOURISM
WORLD	ARRIVALS (Crores)	76.3	30.5-45.5 (40-60%)
	EARNINGS (Rs Crore)	28,03,500	1,98,000
INDIA	ARRIVALS (LAKH)	33.7	13-20
	EARNINGS (RS CRORE)	22,000	14500

Ecotourism and Jobs

- Job Potential: 2 Foreigners and 17 Local Tourists Create one job each
- Investment Rs.1.00 Million- 47 direct Jobs
  11 indirect Jobs
- MP National Parks Generate Nearly 50,000 Jobs (not necessarily in MP)
- Surpasses Employment Potential of Agriculture and Industrial Sectors

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Capacity Building for Local Communities

S No	Categories	Number	Amount (Rs Lakh)
1	Guides	432	51.15
2	Boatmen	35	3.08
3	Khansama (Cooks)	379	26.66
4	Women SHG Group	10	0.22
5	Camp Management (Samardha)	24	1.64
	Total	**880**	**82.75**

Guide Training

Number - 432; Expenditure – Rs. 51.15 Lakh

Guide Training

Regular capacity building

Women Guides in Kanha NP

- ✓ First time in Country
- ✓ 13 Women Guides Trained and

Boatmen Training

Trained - 32; Target - 75 in one year

Boatmen Training

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Boatmen Training

Rafting

Boatmen Training

Forest Rest House Caretakers Training

Number - 379; Expenditure – Rs. 26.66 Lakh; Professional Institutes

Forest Rest House Caretakers Training

Paper Mash Training of 10 Women SHG Members

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Camp Management

(Nature Interpretation, Hospitality, Adventure, Cooking)

20 youth at each destination by professional organisations and experts

Trained - 200
Target - 1000 (in five years)

Camp Management (Samardha)

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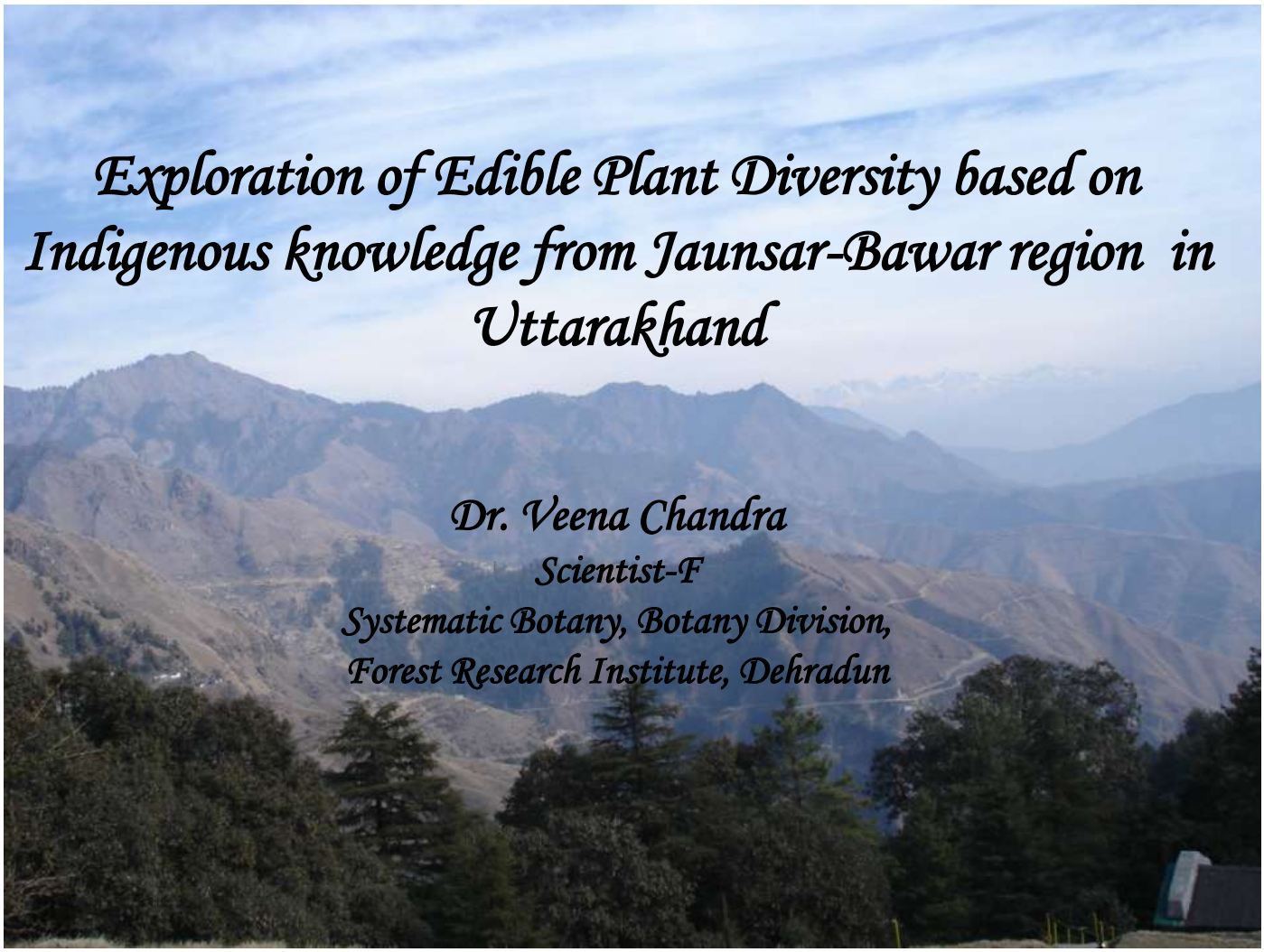

Exploration of Edible Plant Diversity based on Indigenous knowledge from Jaunsar-Bawar region in Uttarakhand

Dr. Veena Chandra
Scientist-F
Systematic Botany, Botany Division,
Forest Research Institute, Dehradun

➢The Jaunsar Bawar is situated in Chakrata tehsil of Dehradun district, which lies between 77°45' and 78°7'20" East to 30°31' and 31°3'3" North.

➢The whole region consists of entirely of mountain tracts. It is most rugged hill tract with gorges.

➢The region is encircled by the Tonns river on the west and Yamuna on the east and south.

➢Plant diversity plays an important role in maintaining the world's foods demands. Even today in Jaunsar Bawar region , a remote, mountainous area in Dehradun district of Uttarakhand, local people gather substantial amounts of wild plants to meet their daily nutritional needs, with several species also used for trade.

➢Information about edible wild plant use was gathered by interviewing knowledgeable villagers over a period of three years (2002-2005).

➢Jaunsar - Bawar forms the northern half of Dehradun District and the people living there are called the Jaunsaries. They are probably of very pure Aryan stock.

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Study Area

Tribes in Uttarakhand

Pithoragarh	:	Boxa
Uttarkashi	:	Bhotia
Chamoli	:	Raji
Dehra Dun	:	Jaunsari
Tehri	:	Jaunsari
Terai-Babhar	:	Tharus

Medico Ethnobotanists

Dependency on fodder

Broom prepared by Jaunsaris

Traditional dress of Jaunsaris

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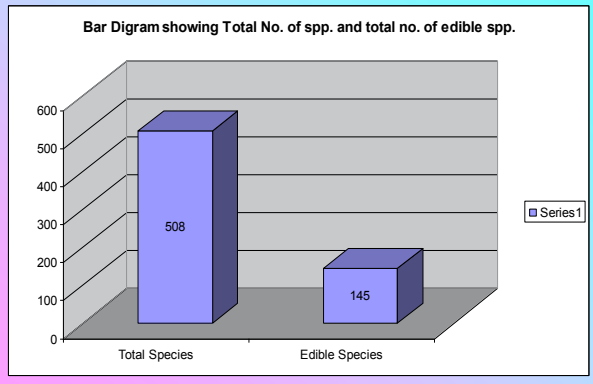
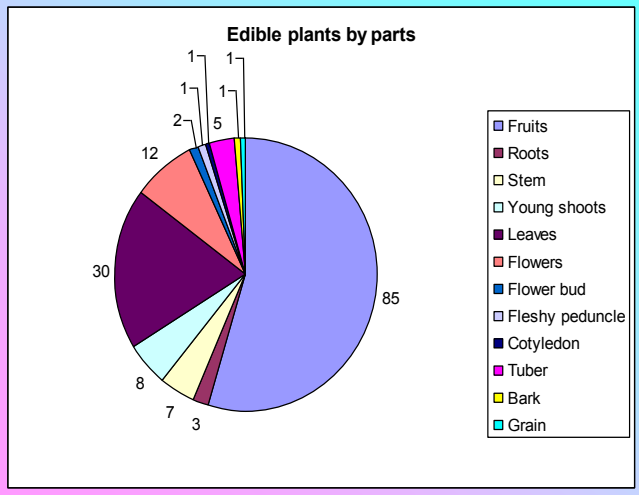
Grewia optiva





Pueraria tuberosa

Dioscorea belophylla

Tubers 5 spp.

Arisaema tortuosum

Colocasia antiquorum

Leaves (30 species)

Murraya koenigii

Bauhinia malabarica

Oxalis corniculata

Viola odorata

Plantago major

Moringa oleifera

Bauhinia purpurea

B. variegata

Rhododenderon arboreum

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Desmodium tiliaefolium

Bombax ceiba

Cassia floxibunda

Hypericum perforatum

Stem (2 Species)

Chenopodium album

Euphorbia royleana

Roots (2 species)

Dactylorhiza hatagirea

Bark (2 species)

Albizzia procera

Cinnamomum tamala

Grain

Coix lachyma-jobi

Aegle marmelos

Emblica officinalis

F R U I T S 80 Spp.

Juglans regia

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Ficus racemosa

13 SPECIES OF FICUS

Ficus auriculata

Ficus hispida

Ficus virens

Coriaria nepaulensis

Punica granatum

Rubus ellipticus

Ziziphus mauritiana

Result

The results of this research will help to play a catalytic role to encourage dialogue among the people of the area, and national and international scientific communities regarding long term bioprospecting research, and shape the creation of a rural livelihood strategy.

Conclusion:

Based on the value of the local consumption, market value and economic feasibility, the indigenous edible plants should be prioritized for *in-situ* and *ex-situ* conservation. Investigations of the nutritive value, superior seed quality, clonal seed orchards and the vegetative propagation need to be taken up; and screening of wild fruits consumed by animals for wildlife conservation and agro-ecological practice are of paramount importance and prospective.

- The traditional Jaunsari head dress made of woolen cloth. Women wear the Ghagra, Kurti and Dhoti and are fond of ornaments.

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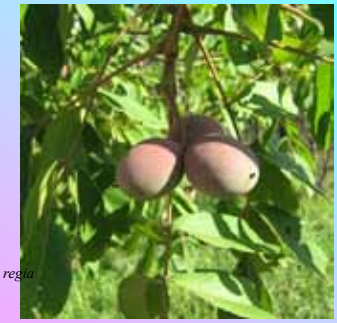
Mukia maderspatana

Myrica esculenta

Grewia sapida

Berberis lycium

Viola pilosa



Juglens regia

Zanthoxylum armatum DC.

Angelica gluca

Emblica officinalis

Saussuria costus

Acorus calamus

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Role of fallen logs in the conservation of xylophagous insects - a study based on Nilgiri Biosphere Reserve

O. K. Remadevi , P. Sarasija

and Y.B. Srinivasa

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Institute of Wood Science & Technology (IWST) [ICFRE], Malleswaram, Bangalore

Wood decomposition is a profoundly important process in forest ecology

It affects

- **Global carbon cycle**
- **Forest soil fertility**
- **Water holding capacity**
- **Water run-off**
- **Home to a variety of life**

Wood undergoes a series of physical and chemical changes during disintegration and decay which brings about definite successional changes in the associated organisms (Graham, 1925)

FRESHLY FALLEN LOGS

↓

PRIMARY XYLOPHAGOUS FORMS

↓ Physical & chemical changes

SECONDARY XYLOPHAGOUS FORMS

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Dead wood is a sparse resource in managed forests and many red listed species of beetles have been reported on them (Rauh and Schmitt, 1991).

Bucking (1998) reports 372 species of xylobiontic beetles occurring in a forest reserve in Germany.

Decaying wood has been found to be extremely important from the stand point of conserving biological diversity (Kolstrom and Lumatjarvi, 1999)

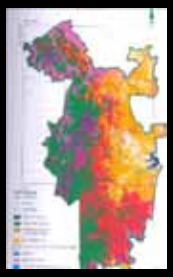
In India, a few workers have dealt with the biology of insects on dead trees (Stebbing, 1914; Beeson, 1941; Mathur and Singh, 1959; Thapa and Singh, 1986)

One study (Singh and Bhandari, 1997) dealt with colonization, succession and preference for tree portion by insects on felled *Picea smithiana* in West Himalayas.

OBJECTIVES

- Identify the species diversity of insects associated with fallen trees .
- Obtain a quantitative description of insect communities using diversity and similarity indices.
- Assess the physical and biochemical changes occurring and establish their relationship with the insect communities.
- Define the role of fallen trees and the associated insect communities in maintaining health of the biosphere reserve.

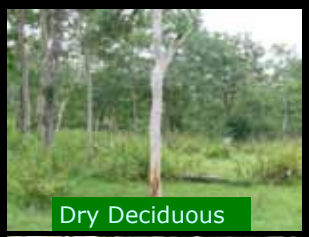
Defining the role played by a fallen log in conserving the biodiversity of xylophagous insects.

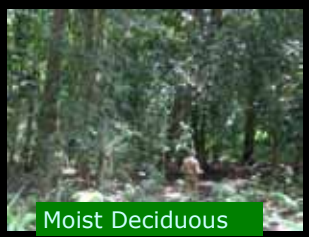


Study Area

Rajiv Gandhi (Nagarahole) National Park
Nilgiri Biosphere Reserve

Forest Types





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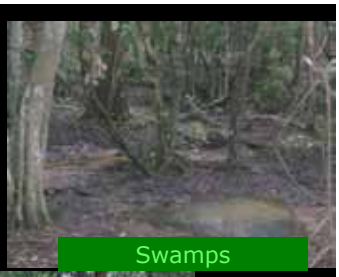
Bamboo thickets


Swamps


Semi-evergreen

WORK PLAN

- Preliminary work regarding standardization of sampling for entomological and biochemical studies .
- Processing, classification and identification of the collected insects.
- Estimation of various biochemical components of different regions of the log.
- Preliminary analysis of data to establish species assemblages and seasonal patterns in species diversity.

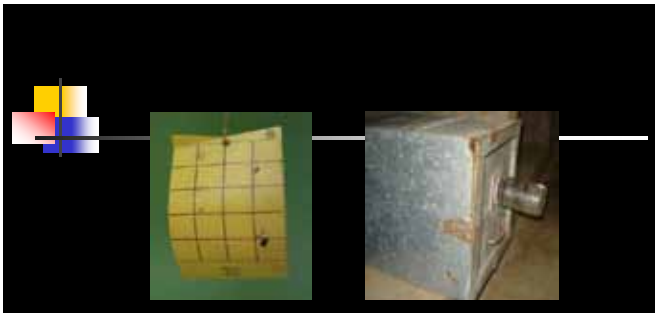
METHODOLOGY

Characterization of Fallen Tree

- Criteria for selection - ≥30 cm diameter are marked
- Species of the tree and forest type
- Physical Characteristic of the Log – Length, Diameter, Colour, Moisture Content, Deterioration (using Pilodyn)
- Chemical Characteristic – Biochemical analysis for lignin, cellulose, amino acids and nitrogen content.
- Surrounding topography

Sampling techniques…

- Lab emergence boxes – Wooden pieces were brought to the lab and placed in emergence boxes.
- Berlese Funnel - Wood Powder was sampled for insects
- Traps including light traps set up


STICKY TRAP EMERGENCE CAGES

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DIRECT SEARCH - Beetles were collected from different species

Emergence of platypodids from a freshly fallen teak log.

Weather Data

- Temperature
- Rainfall
- Humidity

These are monitored using Weather Station installed at Nagarhole

Processing of Collection

- **Laboratory Preservation – using 70% alcohol**
- **Dry Preservation of all species, and as many individuals possible**

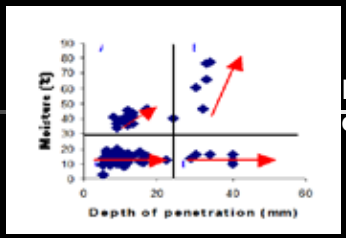
Results

- Various species of logs in different stages of deterioration were selected from three landscape elements – moist deciduous forests, dry deciduous forests and teak plantations.

Tree species and abundance

Sl No	Species	No. of logs	Sl No	Species	No. of logs
1	*Grewia tillifolia*	17	11	*Ficus drupacea*	2
2	*Tectona grandis*	17	12	*Kydia calycina*	2
3	*Bombax ceiba*	13	13	*Syzygium cumini*	1
4	*Lagerstroemia lanceolata*	11	14	*Pittosoporum tetraspermum*	1
5	*Terminalia tomentosa*	11	15	*Anogeissus latifolia*	1
6	*Dalbergia latifolia*	10	16	*Olea dioica Roxb.*	1
7	*Garuga pinnata*	9	17	*Madhuca indica Gmellin.*	1
8	*Pterocarpus marsupium*	8	18	*Stereospermum colais*	1
9	*Clausena anisata*	3	19	*Schleichera oleosa*	1
10	*Cassia siamea*	3	20	UI*	19
				Total	132

*UI – Unidentified trees (this group might comprise of several species of fallen logs



Four distinct categories

- ones with low moisture content and lesser depths of penetration (represented by very durable trees like teak)
- ones with low moisture content but greater depths of penetration (old logs - deteriorated)
- ones with greater moisture content but lower depths of penetration (represented by freshly fallen durable logs)
- ones with greater moisture content and greater depths of penetration (freshly fallen non-durable logs).

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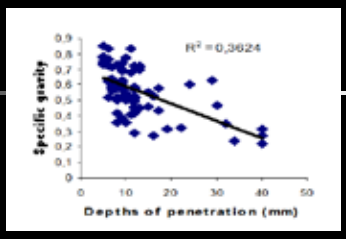
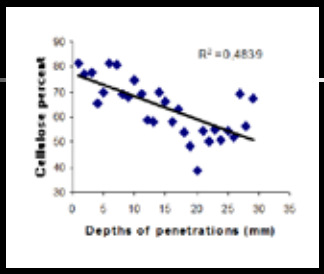


Relation ship between depth of penetration **and specific gravity**



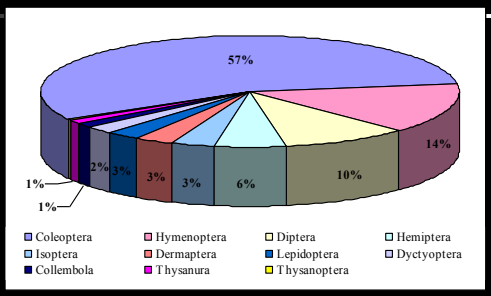
There is a negative relationship between depths of penetration and cellulose percent in the samples suggesting that depths of penetration increase with degradation

Terminology and grouping of saproxylic insects

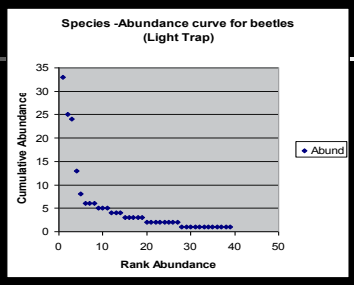
Grouped into 7 classes

1. **Primary saproxylics** — Platypodidae, Bostrichidae; Cerambycidae, Buprestidae, Curculionidae, Anthribidae, Tenebrionidae, Elateridae, Passalidae, Mordellidae, Anobidae, Lyctidae
2. **Secondary saproxylics** — Histeridae, Cucujidae, Passandridae, Anthicidae, Colydiidae, Cleridae, Coccinellidae , Cycyndelidae, Pselaphidae, Staphalinidae, Carabidae
3. **Predator** — Parasitic hymenopterans
4. **Parasitoid** — Ciidae, Erotylidae, Mycetophagidae, Endomychidae, Tenebrionidae, Ptynidae, Dermestidae, Silvanidae, Anthridiidae
5. **Fungivores** — Nitidulidae, Tenebrionidae, Dermaptera, Collembola, Thysanura, Diptera
6. **Saprophytes** — Pyrrhocoridae, Blattoidea
7. **Dwellers**

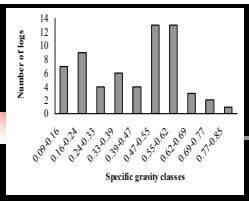
Coleoptera dominant order, followed by Hymenoptera and Diptera

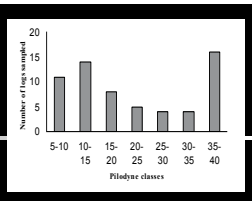


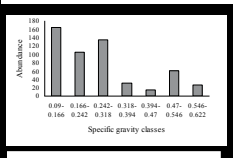
PROPORTIONATE DISTRIBUTION OF INSECTS UNDER DIFFERENT ORDERS

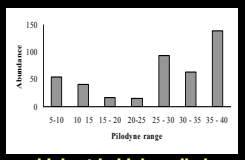


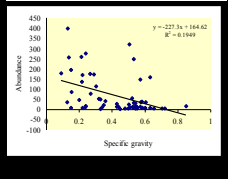
Species-abundance curve for beetles sampled using light traps











Insect abundance was highest in higher pilodyne classes

Newly dead logs with more nutrients and moisture support more diversity than old decayed logs

The logs in later stages of decay mainly serve as termite and ant galleries, which results in high abundance

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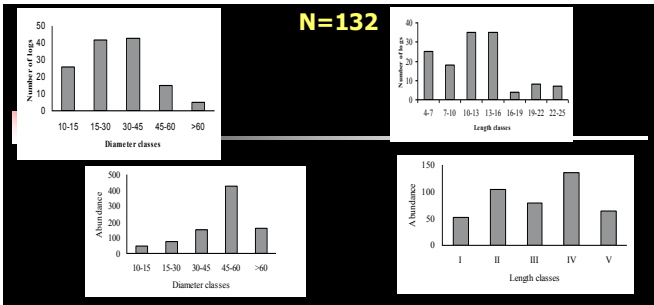


Abundance and species richness are higher in larger diameter classes

Diversity is higher in intermediate diameter classes

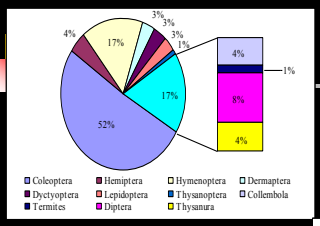
Length does not seem to have any effect on the diversity and species richness

FUNGAL FRUITING BODIES

	Fungal species
1	*Pycnoporus sanguineus (Linn.ex Fr.) Murr.*
2	*Lenzites palisoti* Fr.
3	*Ganoderma australe (Fr.)* Pat.
4	*Phellinus gilvus*
5	*Trametes hirsuta (Wulf.ex Fr.)* Lloyd
6	*Lentinus sp.1*
7	*Lenzitus acuta* Berk.
8	*Trametes cingulata* Berk.
9	*Hexagonia apiaria* (Pres.)Fr.
10	*Lentinus sp.2*
11	*Microporus affinis (Blume & Nees ex Fr.)* Kuntze
12	*Microporus sp.1*
13	*Microporus sp.2*
14	*Flavadon flavus*
15	Un identified sp.2
16	Un identifies sp.3
17	Un identifies sp.4
18	Un identified sp.5
19	Un identified sp.6

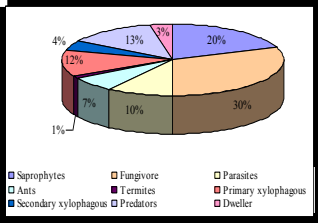
FUNGAL FRUITING BODIES

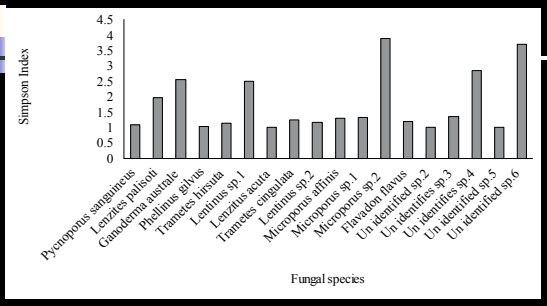
19 fungal species
43,711 insects, belonging to
9 orders and 92 morpho species



TAXONOMIC STRUCTURE

TROPHIC STRUCTURE





Diversity of insects in different species of fruiting bodies

- Among the sampling methods, insects from fungal fruiting bodies contributed more to abundance (69%) followed by direct searching (20%), Sticky trap (5%), emergence cage (3%) and field emergence trap (2%) of the total insects.

- 315 morpho species were collected and maximum number of species (100) was collected by direct search method

- All the sampling methods used were unique in collecting different groups of insects

- The fungal fruiting bodies highly contribute to the insect abundance and diversity. There is a slight positive correlation between the Number of species and weight of fruiting bodies

- Insect emergence is high during the summer, followed by winter, and very less during monsoon

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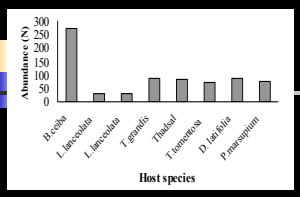
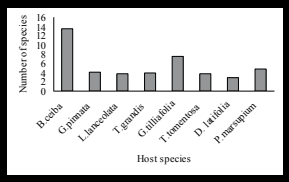


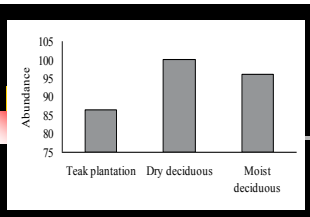


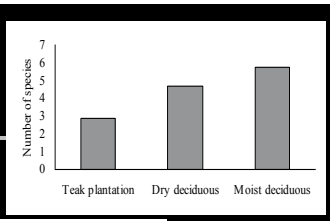
Abundance/Number of insect species on different host species

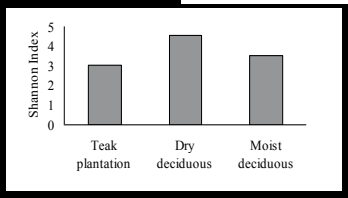
***DMRT* for comparison of host species**

Host species	Number of trees	Mean number of species	Mean number of individuals
B. cieba	13	22.15[a]	273.15[a]
G.tiliaefolia	9	5.11[b]	28.44[b]
L.lanceolata	11	5.18[b]	31.55[b]
T.grandis	17	5.41[b]	89.24[b]
G.tiliaefolia	17	11.18[b]	82.65[b]
T.tomentosa	11	4.18[b]	73.09[b]
D.latifolia	10	3.30[b]	86.60[b]
P.marsupium	8	4.88[b]	74.63[b]

- Less durable species , ***B.ceiba*** dominated in case of diversity , Abundance and species richness.
- ***B.Ceiba*** significantly differed from all the other host species
- Low similarity values between tree species indicate that all the host species are unique in terms of diversity
- More durable species like ***D. latifolia*** and ***T. grandis*** supported comparatively less number of species
- ***Platypus parallelus* (Fabricius)** (Coleoptera: Platypodidae) was the dominant species in *B.ceiba, G. pinnata L. lanceolata, T. grandis, G.tiliaefolia, D.latifolia and P. marsupium*
- ***Xyleborus sp.*** (Coleoptera: Scolytidae) dominated in *T.tomentosa*







Diversity, Abundance and Number of insect species in different forest types

- There is a significant difference in number of species found in different forest types.

Diversity is highest in dry deciduous followed by moist deciduous and least in teak plantations.

Moist deciduous forest is more species rich (Margelef's Index = 0.73) followed by dry deciduous (Margelef's Index = 0.54) and teak plantations (Margelef's Index = 0.34).

Low similarity in species composition of insects in different types of forests show the uniqueness of each forest types

Primary xylophagous forms were abundant in plantations due to the large number of newly fallen teak trees (due to elephant attack).

- Secondary xylophagous and mycophagous insects are more abundant in Moist deciduous forests due to the presence of logs in later stages of decay.

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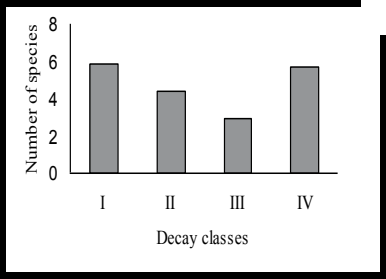
INSECT DIVERSITY ACROSS DECAY CLASSES



SUMMARY AND CONCLUSIONS

- ***Over 50000 saproxylic insects belonging to 345 morpho species and 11 Orders were collected by different sampling methods***
- ***Coleoptera formed the most dominant order, with 82 % of the total abundance and 56 % of the total species***
- ***primary and secondary xylophages together contributed 31 % of the total species***
- ***66 % of the total abundance was contributed by fungivores***

- ***Insects from fungal fruiting bodies contributed more to abundance (69%) followed by direct searching (20%), Sticky trap (5%), Emergence cage (3%) and field emergence trap (2%) of the total insects.***
- ***Softer wood species like B.ceiba support large number of individuals and species than the hard woods like T. grandis and D. latifolia.***
- ***Species richness and diversity were lowest in monoculture Teak plantations compared to other forest types.***
- ***Moisture content, specific gravity and deterioration stage of the logs seemed to have a clear influence on insect diversity and abundance.***

Fallen logs in service to conserve insect diversity

From the conservation point of view, it is important that logs of all degrading stages has to be conserved in all forest types.

Expected Outcomes

- Quantification and inventory of species diversity patterns supported by fallen tree.
- Highlighting the importance of this habitat for future conservation strategies.
- Diversity and community ecology studies of insects/ will be useful in elucidating their role in ecosystem.
- Management and conservation of insect communities in Biosphere Reserves.
- Building up of reference collection of insects for Nilgiri Biosphere Reserves.

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Eco-restoration of an Urban Landscape to Develop a Garden with the Concept of Biodiversity Conservation and Eco-tourism

(A case study)

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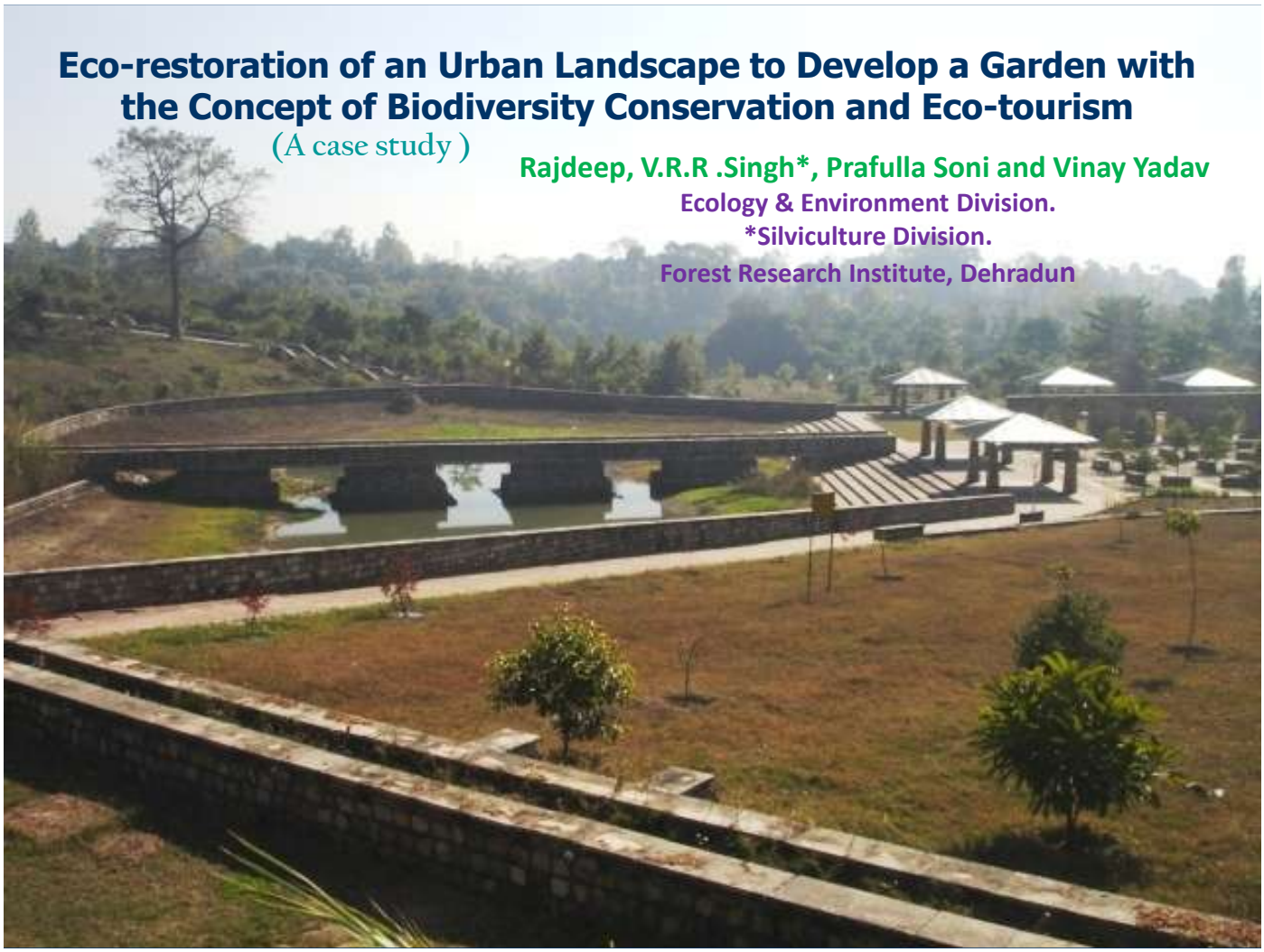

INTRODUCTION

Study highlights the status of the tree plantation at a degraded and derelict land piece that has been ecologically restored through **thematic plantations *viz.* forest types and different gardens**.

Eco-restoration of degraded areas can be achieved successfully through slope stabilization, plantation of indigenous native species and *Ex-site* conservation. It offers valuable insights of research and educational interest while increasing urban greenery.

Study Site

A degraded land of approximately 55 acres, which lies in the campus of Survey of India's Headquarters in Dehradun, was proposed to be developed as a Park (Garden of the Great Arc) to commemorate the 200 years of establishment of Survey of India.

This landscape is characterized by waterways to drain the excess rain water running in north south direction, eroded undulating slopes and gullies in the east.

Its northern edge shares the boundary with the Cantonment Board land and the southern edge with the village of Hathibarkala. Dehradun township lies towards the south of the Hathibarkala Estate.

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Vegetation and soil survey prior to restoration

- The site was represented by degraded Sub-Tropical dry deciduous forest. Trees were very sparse dotted with *Butea monosperma, Dalbergia sissoo, Phoenix sp., Bombax ceiba* and *Syzygium cuminii*
- Understory was mainly dominated by *Achyranthes aspera, Adhatoda vasica, Carissa carandas, Cayopteris wallichiana , Lantana camara, Mimosa himalayana, Murraya koenigii, Solanum torvum, Urtica dioica and Parthinium hysterophorus*
- Common climber species like *Asparagus racemosus, Echinocarpus sp. and Jasminum pubescens* , were also recorded
- The surface soil was badly eroded, compact and slightly acidic with low moisture percentage. Very poor nutrient status and presence of gravels at and below the surface are also major identified soil constraints

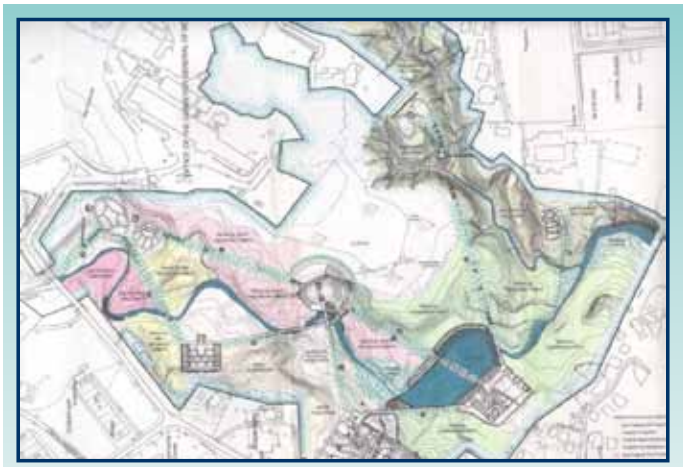
Removal of the unwanted vegetation before Ecorestoration

By Controlled Fire

Manual clearing

Master Plan for Eco-development

1. **Raising green belts:** 3-4 rows of evergreen tree species like *Populus deltoides* , *Acacia auriculiformis* and Bamboos have been planted along the boundary of Park.(approx. 2400 meter)
2. **Stabilization of the degraded slopes:** through appropriate soil stabilization working viz. contour trenching, vegetative plugging and planting of native pioneer species of grasses, herbs, shrubs and trees..
3. **Development of major Indian Forest types:** five different forest types *viz.* tropical evergreen forest type, tropical moist deciduous forest type, tropical dry deciduous forest type, tropical pine forest type and subtropical hill forest type have been raised with their dominant species.
4. **Development of theme gardens:** Some important gardens (vatikas), have been raised are: Dhanvantri Vatika **(Medicinal Plant Garden), Meditation Garden, Rose garden and Foliage garden.** Since National Institute of Visually Handicapped is located just next door to the proposed site, a special '**Garden for visually handicapped**' is dedicated to visually handicapped people. Some rare and endangered species are planted in **'Conservation Garden'.**
5. **Avenue Plantations:** Different suitable tree species *e.g.* *Pterospermum acerifolium, Peltophorum ferrugineum, Cassia javanica, Pterygota alata, Putranjiva roxburghii and Grevillea robusta*, have been planted along the path sides.



Design and Plan Map of Site

Entrance of the Garden

Path-ways

Garden For Visually-handicapped

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Species of the visually handicapped garden

Asparagus officinalis	*Mentah spicata*
Eryngium foetideum	*Jasminum grandiflorum*
Lemmon grass	*Crinum asiaticum*
Piper longum	*Hedychium coronarium*
Stevia sp.	*Sedium hernandezii*
Bryophgyllum pinnatum	*Ophigon viridis*
Aloe vera	*Thuja occidentlis*
Cupressus torulosa	*Acrous calomus*
Adhatoda zeylanica	*Hypericum perforatum*
Achillea millefolia	*Sansevieria zeylanica*
Kaempferia galangal	*Ocimum basilicum*
Murrya koenigii	
Artemisia scoparia	

Conservation Garden

Medicinal Garden

Species of Dhanvantri Vatika (Medicinal Garden)

Acorus calamus		*Eryngium foetidum*
Adhatoda vasica		*Evolvulus alsinoides*
Aloe vera		*Mimosa pudica*
Andrographis paniculata		*Ocimum americanum*
Asparagus racemosus		*Ocimum sanctum*
Azadirachta indica		*Oroxylum indicum*
Bacopa monnieri		*Piper longum*
Bixa orellana		*Plumbago zeylanica*
Catharanthus roseus		*Rauwolfia serpentina*
Centella asiatica		*Rauvolfia tetraphylla*
Cinnamomum tamala		*Spilanthes acmella*
Coleus amboinicus		*Stevia rebaudiana*
Curcuma aromatica		*Terminalia balerica*
Elaeocarpus sphaericus		*Terminalia chibula*
Elettaria cardamomum		*Tinospora cordifolia*
Emblica officinalis		

Foliage and Rose garden

Picnic Garden

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Meditation garden

Avenue Plantation

Stabilization of slopes using *Tridex Sp.*

Tropical Evergreen Forest Type

Tropical Evergreen Forest Type

Tropical Dry Deciduous Forest Type

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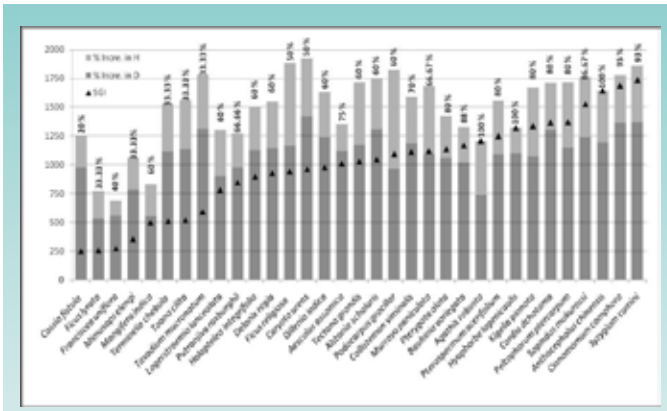
Materials and methods

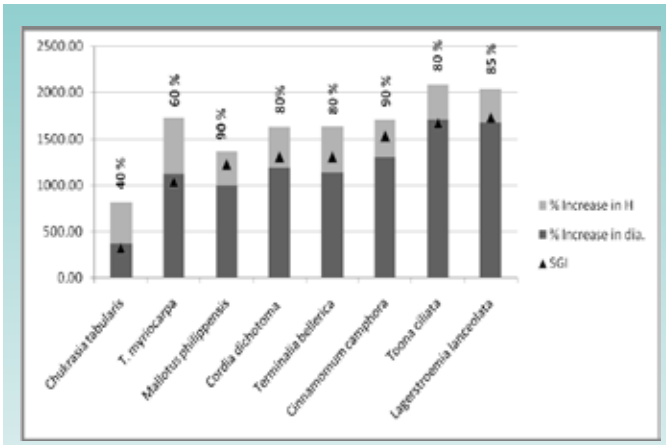
- All tree species grown in the 5 different forest types and in the 5 avenues at the selected site have been monitored for their survival and growth. Height and diameter of each individual of every species were also recorded.
- Present and Initial data set of height , diameter and survival have been used for calculations .
- A simple formula for 'Survival and growth index' has been developed and applied as following.

$$SGI = \frac{\%\ survival}{100} \times (\%\ Diameter\ increment + \%\ Height\ increment)$$

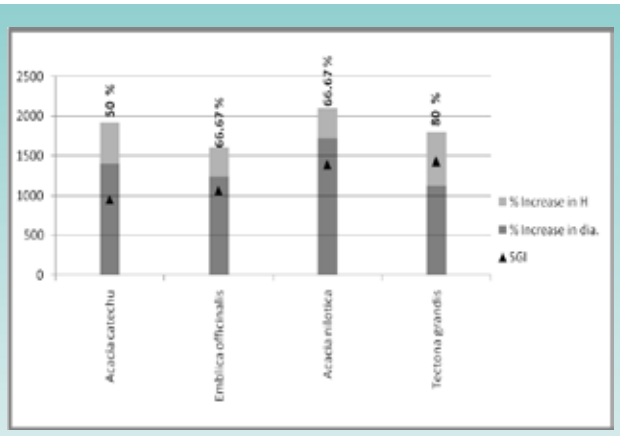
RESULTS



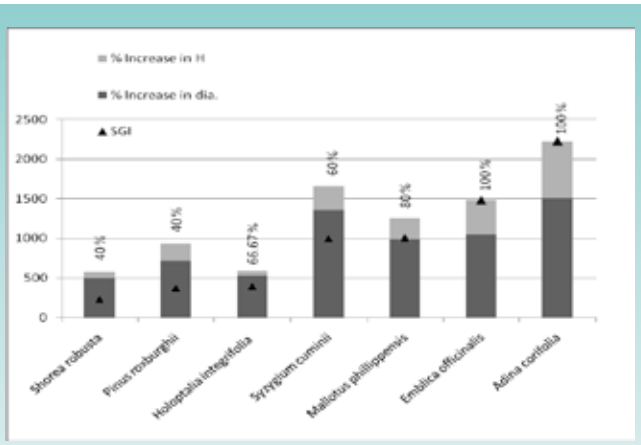
Survival & Growth Status of 'Tropical Evergreen Forest Type'



Survival & Growth Status of 'Tropical Moist Deciduous Forest Type'



Survival & Growth Status of 'Tropical Dry Deciduous Forest Type'



Survival & Growth Status of 'Subtropical Pine Forest Type'

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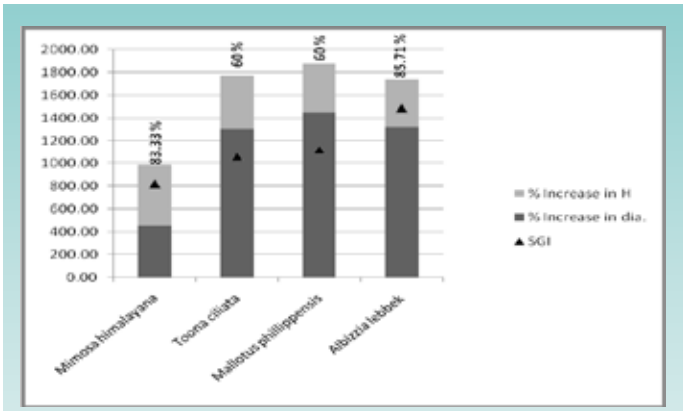
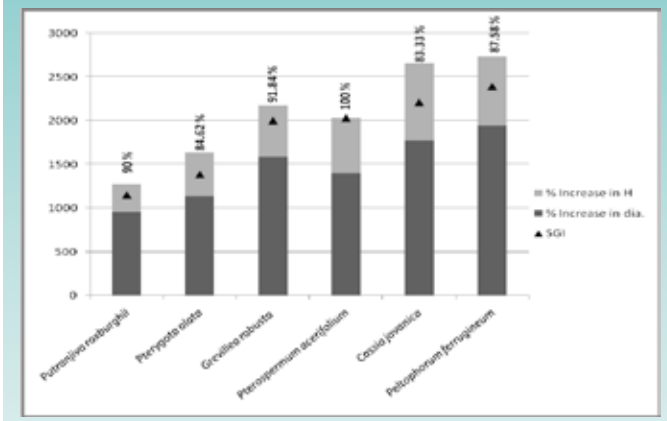


Survival & Growth Status of 'Subtropical Hill Forest Type'



Survival & Growth Status of 'Avenue Plantations'

Status of total carbon and nitrogen percentages in soil

Pre-restoration TOC	Post-restoration TOC	Increased TOC	Pre-restoration N	Post-restoration N	Increased N	Pre-restoration C/N ratio	Post-restoration C/N ratio
1.24	2.21	0.73	0.13	0.19	0.07	9.83	11.51

DISSCUSSION

Status of the Tree Plantations

- Total 70 species were planted initially on the 5 different forests types and 5 avenues (in the year 2005 to 2007)
- Only 58 species survived (82.85 % survival)
- *Peltophorum ferrugineum* represented highest SGI among all the species. Other species that also showed higher values of SGI are, *Cassia javanica, Syzygium cumini, Grevillea robusta, Cinnamon camphora, Adina cordifolia, Tectona grandis, Albizia lebbek and Toona cilita*
- Some species that showed very low growth and survival with lesser values of SGI, are *Shorea robusta, Ficus lyrata, Franciscea uniflora, Mangifera indicia, Cassia fistula, Mimusops elengi and Mimosa himalayana*

Soil amelioration

- Carbon and nitrogen both have shown an increment after 5 years.
- C/N ratio has increased
- Litter fall and decomposition have been contributing to increase carbon level in soil.

CONCLUSION

- Trees play a vital role in preserving environment values. Urban forestry practice including development of gardens helps to curb the extra carbon. Trees affect energy consumption by shading and cooling, blocking winter winds and summer waves.
- Ecologically, some species assume importance for their conservation because they provide appropriate habitat and support specific and distinct population of flora and fauna thus responsible for biodiversity maintenance of the area.
- The development of 'Garden of the great arc' will enhance the beauty and environment of Dehradun city while becoming an example of Ecorestoration and bio-conservation . It will also serve many educational and awareness purposes to the students and visitors about various trees, their penology and products.

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